Multiple Boiler Application Instructions for

Series 8HE

WARNING

This manual must only be used by a qualified heating installer/service technician. BEFORE installing, read all instructions in this manual and all other information shipped with the boiler. Post all instructions and manuals near the boiler for reference by service personnel. Perform steps in the order given. Failure to comply could result in severe personal injury, death or substantial property damage.

BURNHAM Commercial Boilers

www.burnhamcommercial.com

111924-01 - 2/23

IMPORTANT INFORMATION - READ and save these instructions for reference.

HAZARD DEFINITIONS

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels or to important information concerning the life of the product.

⚠ DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

⚠ WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

NOTICE: Indicates special instructions on installation, operation, or service which are important but not related to personal injury hazards.

⚠ DANGER

DO NOT store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.

If you smell gas or fuel oil vapors, do not try to operate the burner/boiler system. Do not touch any electrical switch or use any phone in the building. Immediately call the gas or oil supplier from a remotely located phone.

Burner/boiler systems produce steam or hot water in a pressurized vessel by mixing extremely flammable gaseous, liquid or solid fuels with air to produce combustion and very hot products of combustion. Explosions, fires severe personal injury, death and/or property damage will result from improper, careless or inadequate installation, operation or maintenance of fuel-burning and boiler equipment.

⚠ WARNING

- Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Failure to follow all instructions in the proper order can cause personal injury or death. Read and understand all instructions, including all those contained in component manufacturers manuals which are provided with the appliance before installing, starting-up, operating, maintaining or servicing this appliance. Keep this manual and literature in legible condition and posted near appliance for reference by owner and service technician.
- These boilers require regular maintenance and service to operate safely. Follow the instructions contained in the Series 8HE Installation, Operating and Service Instructions.
- Installation, maintenance, and service must be performed only by an experienced, skilled and knowledgeable installer or service agency.
- All heating systems should be designed by competent contractors and only persons knowledgeable in the layout and installation of hydronic heating systems should attempt installation of any boiler.
- It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when the installation is completed.
- Installation is not complete unless a pressure relief valve is installed into the specified tapping on the top of appliance - See the Series 8HE Installation, Operating and Service Instructions for details.
- These boilers are NOT suitable for installation on combustible flooring.
- Do not tamper with or alter the boiler or controls. Retain your contractor or a competent serviceman to assure that the unit is properly adjusted and maintained.
- Inspect boilers at least once a year - preferably at the start of the heating season to remove soot and scale. The inside of the combustion chamber should also be cleaned and inspected at the same time.
- Have Burner and Controls checked at least once a year or as may be necessitated. Do not operate unit with jumpered or absent controls or safety devices. Do not operate unit if any control, switch, component, or device has been subject to water.

⚠ WARNING

- Appliance materials of construction, products of combustion and the fuel contain alumina, silica, heavy metals, carbon monoxide, nitrogen oxides, aldehydes and/or other toxic or harmful substances which can cause death or serious injury and which are known to the state of California to cause cancer, birth defects and other reproductive harm. Always use proper safety clothing, respirators and equipment when servicing or working nearby the appliance..
- These boilers contain very hot water under high pressure. Do not unscrew any pipe fittings nor attempt to disconnect any components of this boiler without positively assuring the water is cool and has no pressure. Always wear protective clothing and equipment when installing, starting up or servicing this boiler to prevent scald injuries. Do not rely on the pressure and temperature gauges to determine the temperature and pressure of the boiler. This boiler contains components which become very hot when the boiler is operating. Do not touch any components unless they are cool.
- All appliances must be properly vented and connected to an approved vent system in good condition. Do not operate boilers with the absence of an approved vent system.
- These boilers need fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
- The interior of the venting and air intake systems must be inspected and cleaned before the start of the heating season and should be inspected periodically throughout the heating season for any obstructions. Clean and unobstructed venting and air intake systems are necessary to allow noxious fumes that could cause injury or loss of life to vent safely and will contribute toward maintaining the boiler's efficiency.
- These boilers are supplied with controls which may cause the boiler to shut down and not re-start without service. If damage due to frozen pipes is a possibility, the heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on the heating system to prevent damage if the boiler is inoperative.
- This boiler is designed to burn natural gas only. Do not use gasoline, crankcase drainings, or any oil containing gasoline. Never burn garbage or paper in this boiler. Do not convert to any solid fuel (i.e. wood, coal). All flammable debris, rags, paper, wood scraps, etc., should be kept clear of the boiler at all times. Keep the boiler area clean and free of fire hazards.
- Float type low water cutoff devices require annual inspection and maintenance. Refer to manufacturer's instructions.

NOTICE: All Series 8HE cast iron boilers are designed, built, marked and tested in accordance with the ASME Boiler and Pressure Vessel Code, Section IV, Heating Boilers. An ASME Data Label is factory applied to each 8HE jacket, which indicates the boiler Maximum Allowable working Pressure (MAWP). Each cast iron section is permanently marked with the MAWP listed on the boiler's ASME Data Label. The MAWP for all Series 8HE Boiler is 50 psi (Water Only).

It is common and acceptable practice to install these boilers in lower pressure systems, below the boiler MAWP. Therefore, in addition to Safety Relief Valves set for 50 psi, Burnham also offers Safety Relief Valves set for 30 psi (By Special Order Only).

⚠ CAUTION

Series 8HE Boilers are NOT suitable for direct installation on combustible flooring.

Refer to the 8HE Installation, Operating and Service Instructions for Installation Instructions for Floor Shields that are available and required for combustible floor installations.

Important Product Safety Information:
Refractory Ceramic Fiber Product

⚠ WARNING

Some boiler components use materials that contain refractory ceramic fibers (RCF). RCF has been classified as a possible human carcinogen. When exposed to elevated temperatures, RCF may change into crystalline silica, a known carcinogen. When disturbed as a result of servicing or repair, these substances become airborne and, if inhaled, may be hazardous to your health. Avoid breathing RCF particulates and dust.

Precautionary Measures:

- Do not handle RCF parts or attempt any service or repair work involving RCF without wearing the following protective gear:
    1. A properly fitting National Institute for Occupational Safety and Health (NIOSH)-certified air-purifying respirator with a filter efficiency of at least 95%. Respirator should also include a full facepiece when handling used RCF. Other types of respirators may be required depending on site conditions. Current NIOSH recommendations may be found on the NIOSH website http://www.cdc.gov/niosh/homepage.html NIOSH-approved manufacturers, respirators and associated user instructions are listed on the NIOSH website.
    2. Long sleeved, loose fitting clothing that is sufficiently tight around potential entry points for RCF dust.
    3. Gloves.
    4. Eye protection, such as goggles, safety glasses with side shields, or full facepiece.
- Take steps to assure adequate ventilation.
- Handle RCF carefully to minimize airborne dust. Use hand tools whenever possible.
- Dampen used RCF with light water spray prior to removal to prevent airborne dust.
- Do not use compressed air or dry sweeping for clean-up. Frequently clean work area with a vacuum or by wet sweeping to minimize debris accumulation.
- Vacuum work clothes before leaving work area. Wash work clothes separately from other laundry and rinse washing machine after use to avoid contaminating other clothes.
- Wash all exposed body areas gently with soap and water after contact.
- Discard used RCF components by sealing in an airtight plastic bag or container. Refer to local, regional, state or provincial regulations to identify applicable disposal requirements.

First Aid Procedures:

- Eye contact: Flush with water for at least 15 minutes. **Do not rub eyes**. Seek immediate medical attention if irritation persists.
- Skin contact: Wash affected area gently with soap and water. Do not rub or scratch affected skin. Seek immediate medical attention if irritation persists.
- Nose and throat contact: If these become irritated, leave the area and move to a location with clean fresh air. Drink water and blow nose. Seek immediate medical attention if symptoms persist.

1 Air for Ventilation and Combustion

⚠ WARNING

Provide combustion and ventilation air in accordance with section "Air for Combustion and Ventilation", of National Fuel Gas Code, ANSI Z223.1/NFPA 54, or applicable requirements of local building codes.

⚠ CAUTION

Do not store flammable liquids, combustible materials, or potential combustion air contaminants in boiler area.

1.1 Insufficient ventilation air may cause incomplete combustion, poor ignition, accumulation of soot in the boiler, or the production of toxic gases. Many service calls for dirty boilers, nuisance lock outs, noisy ignition, or obnoxious odors are traceable to insufficient ventilation air.

1.2 The information below is from the National Fuel Gas Code, ANSI Z223.1/NFPA 54. See NFPA 54 for further details.

1.3 Determine the boiler input required to the system. Determine load of the heated space using methods contained in the ASHRAE Handbook or other engineering methods. If domestic water heater is to be added, calculate the added boiler capacity as described in paragraph 3.21 of this manual. Size boilers per total net rating as shown on Table 1-2.

1.4. Determine Required Room Volume

Air openings are required for all boiler rooms smaller than 50 ft.^{3} / 1,000 Btu/hr.

If it is known or suspected that the air infiltration rate is less than 0.4 ACH (air changes per hour), the minimum required room volume is calculated using the formula:

$$\textbf{Room Volume Required per 1,000 Btu/hr} = \frac{21}{ACH}$$

Adjacent rooms may be included in the boiler room volume if the adjacent room(s) are communicating directly (no doors) or have internal air openings sized per Table 1-1.

1.5 .Determine Free Area of Air Openings

Size air openings for the total appliance input as shown in Table 1-1. See also Figure 1-3 and Figure 1-4.

Upper Opening or Single Opening – Opening shall commence within 12 in. of the top of the enclosure. See also paragraph 1.7.h.

Lower Opening – Opening shall commence within 12 in. of the bottom of the enclosure. See also paragraph 1.7.h.

1.6 Louvers, Grilles, and Screens - The required size of openings for combustion, ventilation, and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver, grille, or screen is known, it shall be used in calculating the size opening required to provide the free area specified. Where the louver and grille design and free area are not known, it shall be assumed that wood louvers have 25 percent free area, and metal louvers and grilles have 75 percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. Screens shall not be smaller than 1/4 in. mesh.

Table 1-1: Air for Combustion and Ventilation

Free Area of Each Air Opening*	Air Opening Type		
1 in^2 / MBH	Indoor Air	Two Openings	Combining Space on the Same Story.
2 in^2 / MBH			Combining Spaces in Different Stories.
1 in^2 / 4 MBH (0.25in^2 / MBH)	Outdoor Air	Two Openings	Vertical Ducts or Direct Communication (vertical or horizontal).
1 in^2 / 2 MBH (0.5 in^2 / MBH)			Horizontal Ducts.
1 in^2 / 3 MBH (0.33 in^2 / MBH)**		Single Opening	Vertical or Horizontal Ducts or Direct Communication (vertical or horizontal).

* Use total input from all appliances.
** Single opening free area must also be not less than sum of areas of all vent connectors in space.

1 Air for Ventilation and Combustion *(continued)*

Motorized louvers shall be interlocked with each appliance so they are proven in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting should the louver fail to open during burner startup and to shut down the main burner if the louvers close during burner operation.

1.7 Combustion Air Ducts

a. Ducts shall be constructed of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity.

b. Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances.

c. Ducts shall serve a single space.

d. Ducts shall not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air.

e. Ducts shall not be screened where terminating in an attic space.

f. Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air.

g. The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry, metal, or factory built chimney shall not be used to supply combustion air.

h. Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located at least 12 in. vertically from the expected snow height.

1.8 Combination Indoor and Outdoor Combustion Air. The use of a combination of indoor and outdoor combustion air shall be in accordance with the following:

a. Indoor openings. Where used, openings connecting the interior spaces shall comply with Table 1-1.

b. Outdoor opening(s) shall be located in accordance with Section 1.5.

c. Outdoor opening(s) size. The outdoor opening(s) size shall be calculated in accordance with the following:

i. The ratio of the interior spaces shall be the available volume of all communicating spaces divided by the required volume.

ii. The outdoor size reduction factor shall be 1 minus the ratio of interior spaces.

iii. The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Table 1-1, multiplied by the reduction factor. The minimum dimension of air openings shall not be less than 3 inches.

1.9 Mechanical Combustion Air Supply - Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from outdoors at the minimum rate of 0.35 ft3/min/1000 Btu/hr for all appliances located within the space.

Where exhaust fans are installed, additional air shall be provided to replace the exhausted air.

Each of the appliances served shall be interlocked to the mechanical air supply system to prevent main burner operation where the mechanical air supply system is not in operation.

Where combustion air is provided by the building's mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air.

1 Air for Ventilation and Combustion *(continued)*

1.10 Example: A 3 story apartment house needs a total boiler capacity including domestic water heating, of 1,250,000 Btu/Hr net rating. Boiler room is 20 feet long, 10 feet wide with a clear ceiling of 12 feet. Typical 0.4 ACH air filtration rate, similar in layout to Figure 1-4.

a. Find boiler combination with closest total net output from Table 1-2:

Input = 1,734 MBH. (5) 806HE and (1) 805HE.

b. Determine if the room size is adequate without adding openings for additional air:

$$\frac{\text{Room Volume}}{\text{MBH Input}} = \frac{20 \text{ ft} \times 10 \text{ ft} \times 12 \text{ ft}}{1734 \text{ MBH}} = 1.4 \text{ ft}^3/\text{MBH}$$

Since 1.4 ft^3 / MBH < 50 ft^3/MBH, additional air is required.

c. Find Required Free Area of each opening from Table 1-1:

1 in^2 / 4 MBH * 1734 MBH = 434 in^2.

Table 1-2: Recommended Number of Boilers

Total Input MBH	Total Gross Output* MBH	Total Net Output** MBH	Boiler Qty.	
			805HE	806HE
239	201	175	1	0
299	251	218	0	1
478	402	350	2	0
538	452	393	1	1
598	502	436	0	2
717	603	525	3	0
777	653	568	2	1
837	703	611	1	2
897	753	654	0	3
956	804	700	4	0
1016	854	743	3	1
1076	904	786	2	2
1136	954	829	1	3
1196	1004	872	0	4
1255	1055	918	4	1
1315	1105	961	3	2
1375	1155	1004	2	3
1435	1205	1047	1	4
1495	1255	1090	0	5
1554	1306	1136	4	2
1614	1356	1179	3	3
1674	1406	1222	2	4
1734	1456	1265	1	5
1794	1506	1308	0	6

* Total Gross Output based on 84% Combustion Efficiency

** Total Net Output based on piping and pickup allowance of 1.15.

1 Air for Ventilation and Combustion *(continued)*

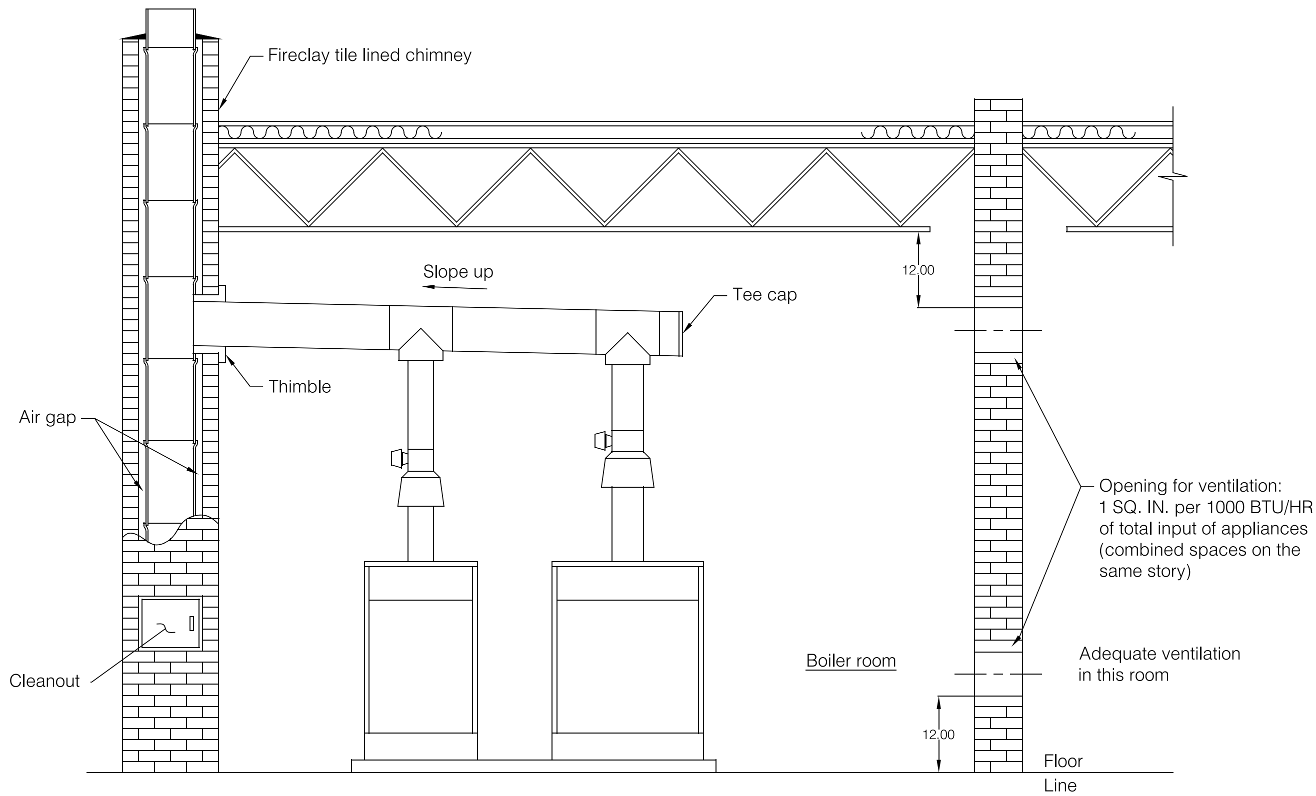


Figure 1-3: Ventilation Air Provided from Inside Building

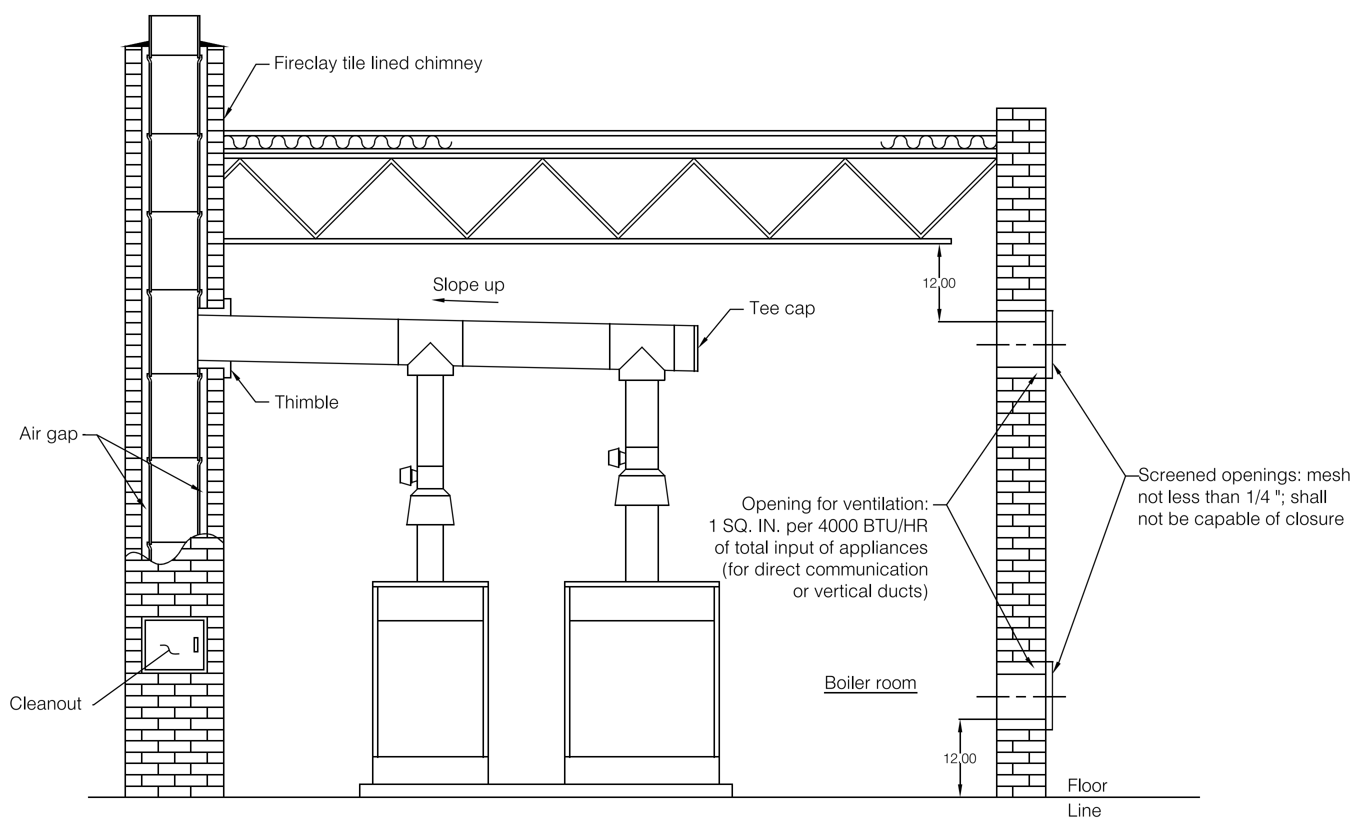


Figure 1-4: Ventilation Air Provided from Outdoors

2 Venting

⚠ WARNING

Asphyxiation Hazard.

- Failure to vent this boiler in accordance with these instructions could cause products of combustion and/or carbon monoxide to enter living space, resulting in severe personal injury, death or substantial proper damage.
- Vent installation shall be in accordance with local codes, authority having jurisdiction, National Fuel Code - ANSI Z223.1/NFPA 54, ASHRAE Handbook, or applicable requirements of the local building codes.
- Inspect existing chimney before installing boilers.
- Maintain clearances to vent piping and draft hood.
- Do not alter boiler draft hood or place any obstruction or non-approved damper in the breeching or vent system.

2.1 Avoiding Flue Gas Condensation

⚠ WARNING

Vent system must not experience signs of continuous wetness.

Masonry chimneys, and in particular exterior masonry chimneys, are more susceptible to the formulation of condensate. If a masonry chimney experience signs of continuous wetness, a listed metal liner must be installed or an alternate vent system must be used. All masonry chimneys must use either a clay tile liner or listed metal liner.

Recommend use of listed metal chimney liner with external masonry chimneys.

For external masonry chimneys that do not include a listed metal chimney liner:

- Recommend double wall vent connectors and double wall vent manifolds. Use only double wall material on long runs.
- For common vent installations with 5 or 6 boilers, recommend sequencing boilers to fire minimum of 2 boilers simultaneously. Up to eight boilers may be vented into a single vent system if a minimum of two boilers are fired simultaneously. See also Section 5 – Controls.

See also Section 3, Water Piping, for methods to avoid flue gas condensation from low return water temperatures.

2.2 General

Vent systems are generally less flexible in design location than are water pipes, gas pipes or electrical lines. To avoid conflicts for a given location, design and layout the vents in this section before proceeding to other sections of this manual. If the factory fabricated water manifolds are to be used, boilers should be laid out with 28½ in. spacing.

Vent terminations - provide clearances as shown in Figure 2-3 and Figure 2-4 to minimize adverse wind effects or pressure areas which may reduce or impede vent flow. A UL Listed vent cap is also recommended to minimize adverse wind effects.

Follow manufacturer's instructions of venting system components in addition to National Fuel Gas Code - ANSI Z223.1/NFPA 54, ASHRAE Handbook, or applicable requirements of local building codes.

Vent system design must address the following:

- Support of lateral runs so that vent pipe does not sag.
- Support of common vent where it passes thru a ceiling or roof.
- Firestops
- Flashing and storm collars.
- Guying or bracing of common vent pipe above roof.
- Securing and gas tightness of joints.
- Lightning arrester if top of metal vent is one of the highest points on the roof.
- Support of common vent where it passes thru a ceiling or roof.
- Proper insertion of vent connection at masonry chimney – vent should enter chimney at a point above the extreme bottom of chimney – vent should be flush with inside of chimney and sealed (see Figures 1-3 and 1-4).
- Never connect a gas vent to a chimney serving a fireplace unless the fireplace has been permanently sealed.
- Never pass any portion of a vent system thru a circulating air duct or plenum.

2.3 Clearances

See Table 2-2 for minimum clearances around boilers to combustible materials and for service access. Provide thimbles through combustible construction.

2 Venting *(continued)*

2.4 Determine the input required to the system. See Section 1.3 and Table 1-2.

2.5 Individual Vents

Individual vents are highly recommended if the job site conditions allow. Individual vents are particularly useful in boiler rooms having a low ceiling height. Individual vents are easy to design and in many cases result in the lowest installed cost. They also are the most dependable in operation and less susceptible to condensation than are combined vents.

Install individual vents per National Fuel Code - ANSI Z223.1/NFPA 54.

2.6 Common Vents

See Section 2.1, "Avoiding Flue Gas Condensation", and see Figures 2-3 through 2-8 and Table 2-9.

Combined vents will perform satisfactorily if strict design procedures are followed. Referring to Table 2-10, note that a connector rise of at least one foot is required. Where the vent dampers are mounted vertically, include damper height in the connector rise. A connector rise of three feet is desirable.

Keep horizontal laterals as short as possible. Place the first boiler as close to the chimney as practical.

The horizontal vent manifold is an extension of the vertical common vent.

2.6.1 Common Vent Sizing

Size the common vent CV per Table 2-9. Note that the CV diameter applies to both the chimney and the vent manifold / lateral.

Size the vent connector diameter CN per Table 2-10.

If a tapered or graduated manifold vent is desired, use the same procedures above for sizing the intermediate manifold diameter but for the total input of the boilers served by intermediate tapered or graduated manifold vent.

Within Table 2-9 are several entries of NR. This means that the combination involved is not recommended. The most common reason for a combination to be designated NR is that condensation inside the vent pipe is likely to occur. This is particularly true of single wall vent pipe.

If a masonry chimney is desired, the minimum cross sectional area of the chimney is found in Table 2-11 as a function of the vent diameter.

Confirm adequate ceiling height. Referring to Table 2-10, note that a connector rise of at least one foot is required. Where the vent dampers are mounted vertically, include damper height in the connector rise. A connector rise of three feet is desirable. Thus, to make the desired connector rise and have space for the manifold vent, the minimum boiler room ceiling height must be equal to:

32½ in.	Boiler Height
+ D	Drafthood Height
+ F	Minimum Connector Rise (include the height of vertically mounted vent dampers)
+ CV	Manifold Diameter
+ 6 in.	Clearance
=	Minimum Ceiling Height

If the minimum ceiling height above is not available, common vents will not perform satisfactorily and should not be used.

2.6.2 Example of Common Venting:

Start with the previous example of a 3 story apartment building that will use five 806HE and one 805HE boiler.

For a common vent layout as shown in Figure 2-3 use Table 2-9 to find the common vent size, CV, at 1734 MBH input. Common Vent required is 15 ft. high, 18 in. Diameter Double Wall. Single Wall Vent is Not Recommend.

Find vent connector using Table 2-10. For Type B connectors with 3 ft. rise, 805HE uses 8 in. diameter and 806HE uses 9 in. connector.

Calculate minimum ceiling height.

32½ in. Boiler Height

+ 27 13/16 in. Height to Outlet of Drafthood, D

+ 36 in. Desired Conn. Rise, F (incl. damper hgt)

+ 18 in. Manifold Diameter, CV

+ 6 in. Clearance

~ 10 ft.1 in. Minimum Ceiling Height

An eleven foot clear ceiling height will work. With only one elbow, no correction is necessary. The design of a constant diameter manifold vent is complete. Mark these vent and connector sizes on the drawing of the boiler room.

2 Venting *(continued)*

If a tapered or graduated manifold vent is desired, such as in Figure 2-4, the horizontal and vertical portion of the vent serving all six boilers is also complete with the above. However, to size the manifold vent at an intermediate position such as CV2 in Figure 2-7, use Table 2-9 for the MBH Input of the boilers served by that position of the manifold vent The Input MBH of each boiler can be determined from Figure 2-1. In this case CV2 serves three boilers for a combined input of 897 MBH. Find CV2 = 14 in. diameter double wall manifold section.

2.6.3 The above procedure is based on data found in the ASHRAE Handbook, Equipment Volume, Chapter 35. The basic chimney equation is expressed as follows:

$$I = 4.13 \times 10^5 \times \frac{(di)^2}{M} \times \left[\frac{\Delta P \times B}{K \times Tm}\right]^{0.5}$$

where: I = Operating heat input, BTUH.

di = Inside diameter of the common vent or manifold vent.

M = Mass flow input ratio, lb. of products per 1000 BTU of fuel burned. A value of 1.54 was used based on 5.3% CO_2 after dilution.

ΔP = Pressure difference or loss in the system acting to cause flow, inches of water. Use 0.37 inches water per 100 ft. of pipe.

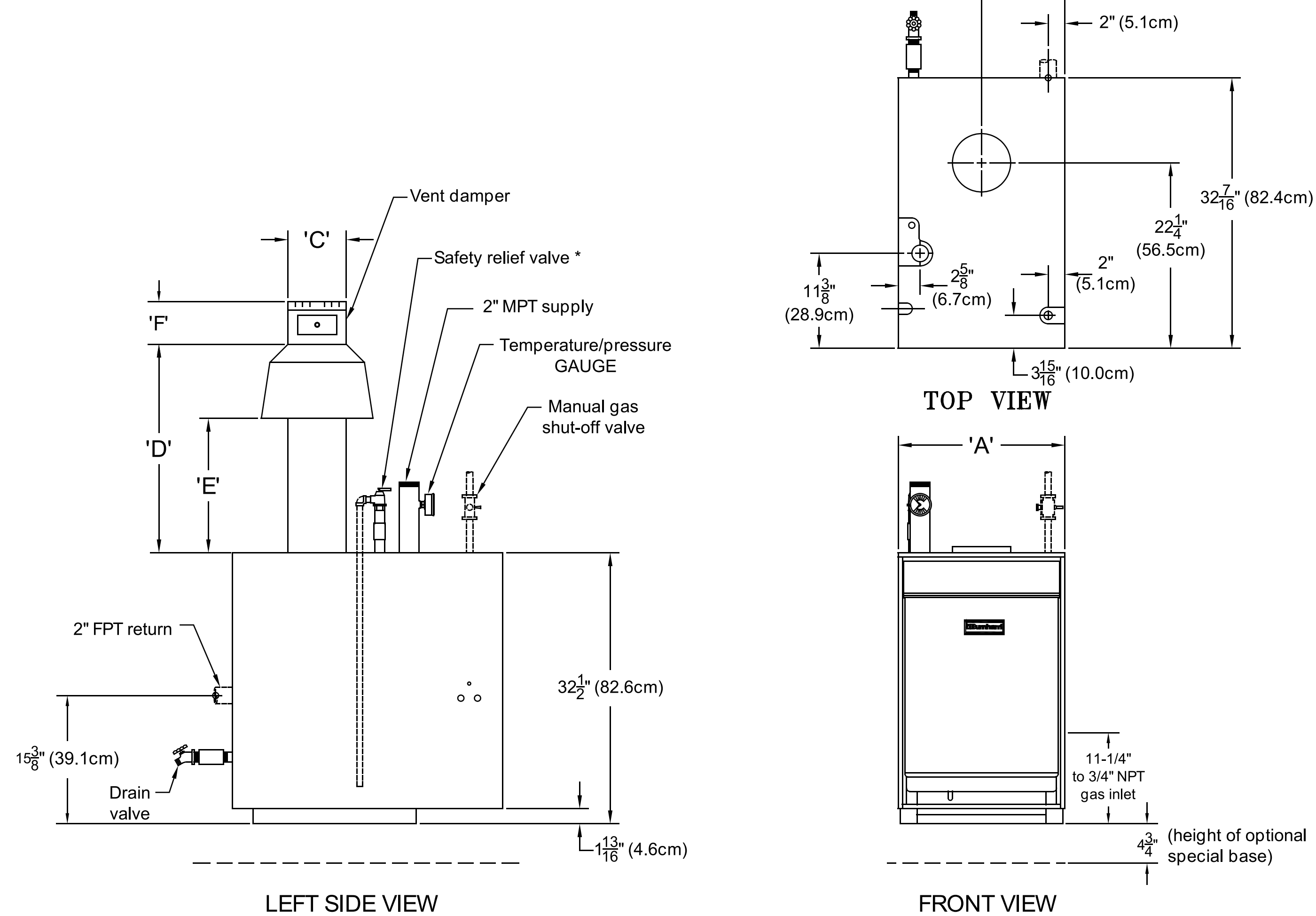
B = Sea level barometer used —29.92 in. Hg.

K = Resistance loss coefficients, dimensionless.

Tm = Average absolute temperature in vent system at average conditions (add 460° to vent temperature).

If system conditions do not fall within the limit of the tables, vent sizes must be calculated using the chimney equation above as described in the ASHRAE Handbook. The values in Tables 2-3, 2-4, and 2-5 should not be extrapolated.

2 Venting *(continued)*



BOILER MODEL	INPUT (MBH)	DIMENSIONS (INCHES)						WATER CONTENT (GALLONS)	APPROX. SHIPPING WEIGHT (LB)	
		'A'	'B'	'C'	'D'	'E'	'F'		PACKAGED	KNOCKDOWN
805HE	239	20	10	7	21-1/2	11-5/8	6	11.9	600	610
806HE	299	23-3/4	11-7/8	8	27-13/16	18	7-1/8	13.9	690	700

* Maximum allowable working pressure: 50 psi (water only)

Figure 2-1: Boiler Dimensions

Table 2-2: Minimum Installation Clearances Around Boilers

	Rear, Sides, Drafthood & Vent Connector	Top of Jacket	Front	Side-by-Side [1,2]	Back-to-Side	Back-to-Back[2]	Front-to-Front[2]
To Combustible Construction	6 in.	36 in.	18 in.	N/A	N/A	N/A	N/A
Recommended for Servicing	N/A	36 in.	24 in.	1 in.	1 in.	26"	36 in.

N/A: Not Applicable
1 - 28.5 in. when using prefabricated water manifolds.
2 - Also consult local codes for minimum spacing of multiple boilers.

2 Venting *(continued)*

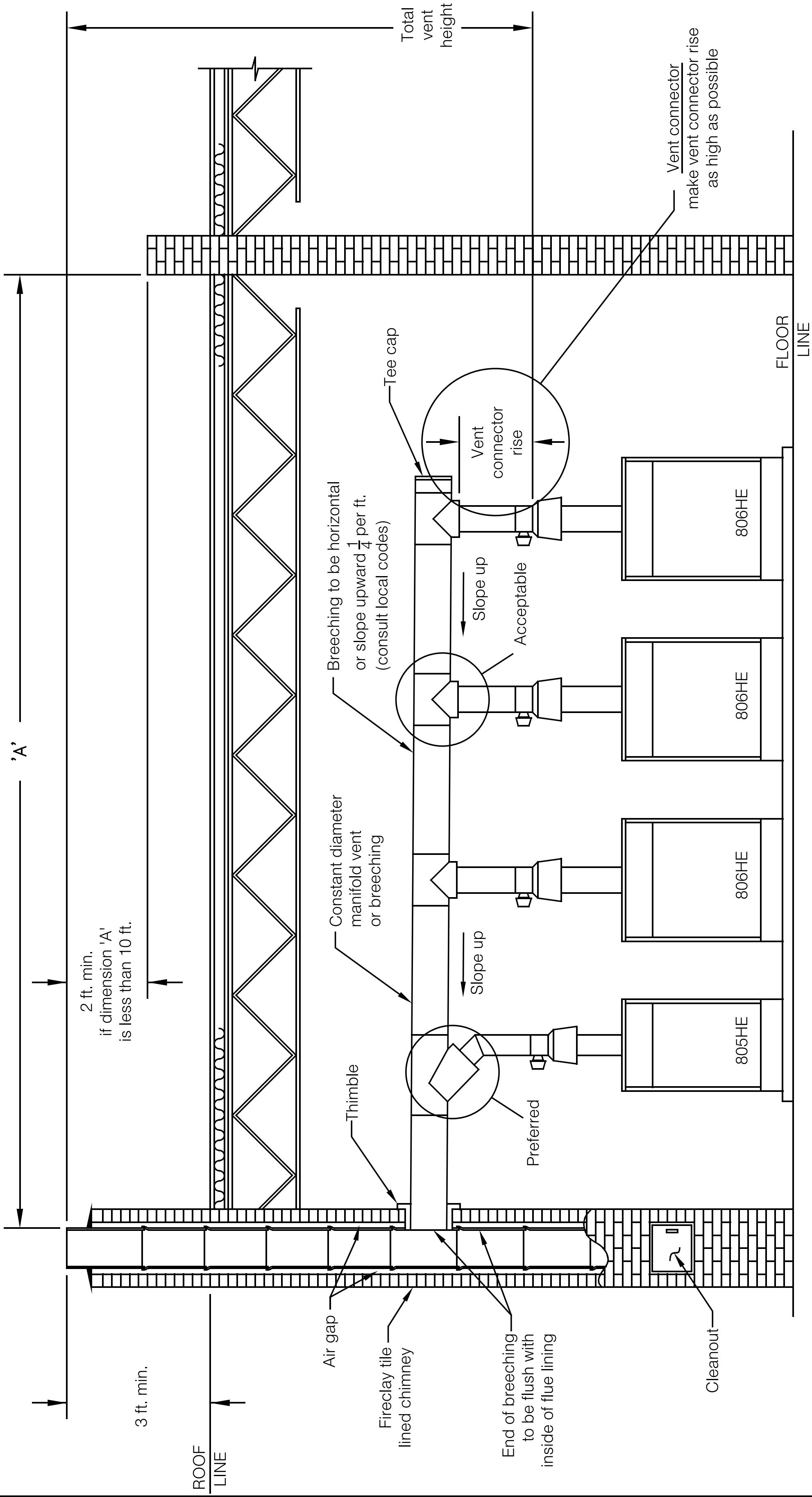


Figure 2-3: Constant Diameter Manifold Vent

2 Venting *(continued)*

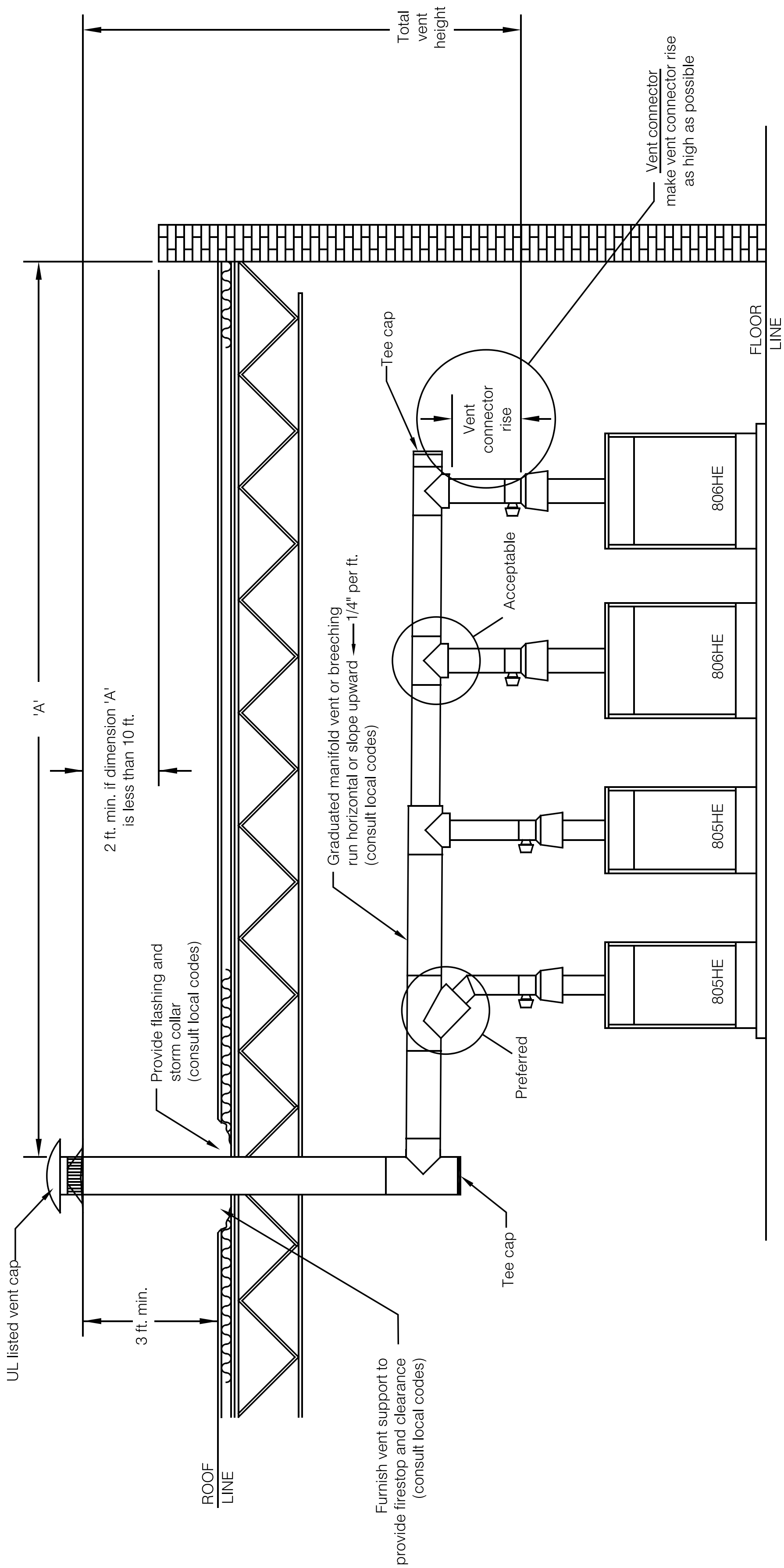
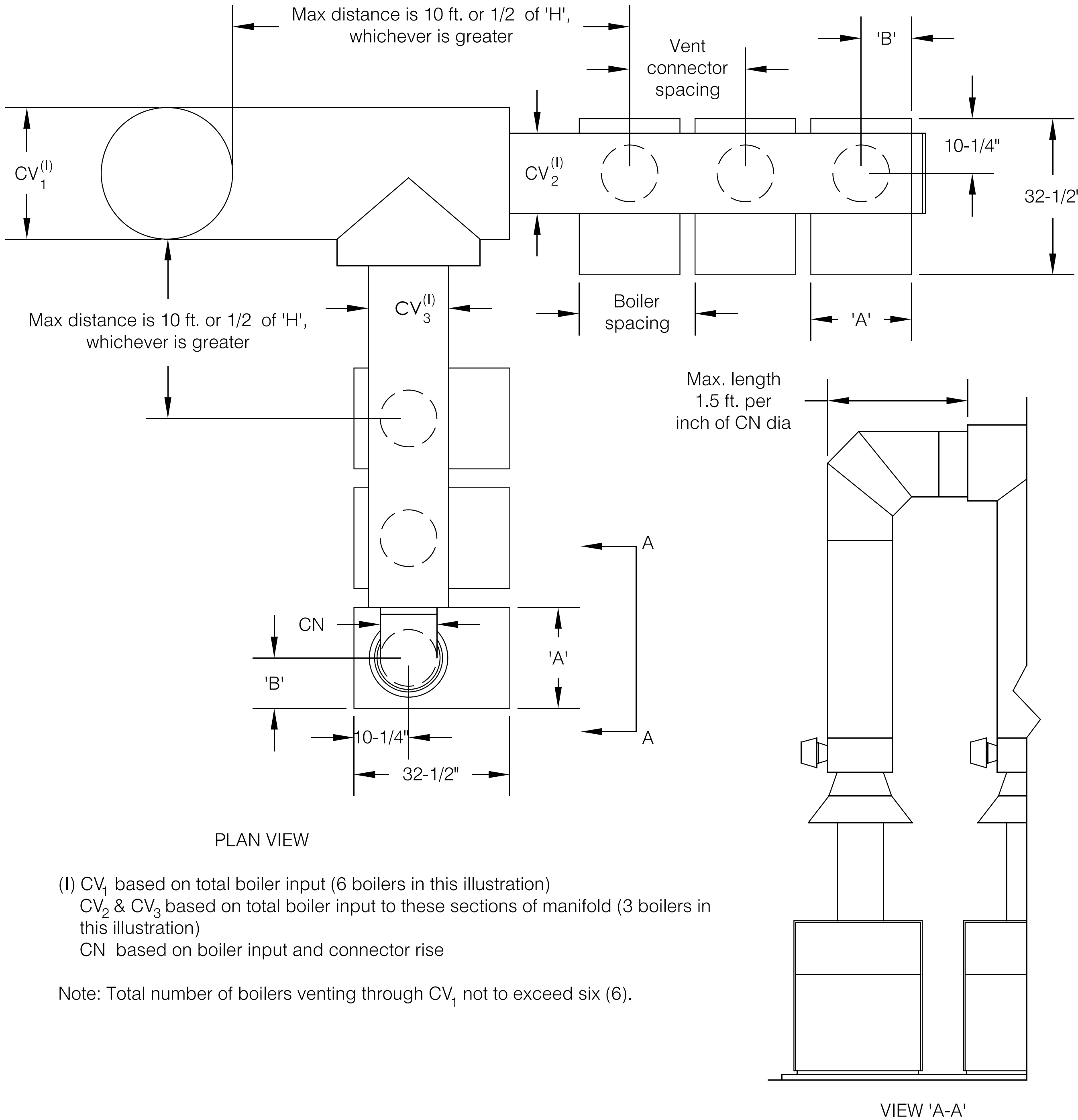


Figure 2-4: Graduated Manifold Vent

2 Venting *(continued)*

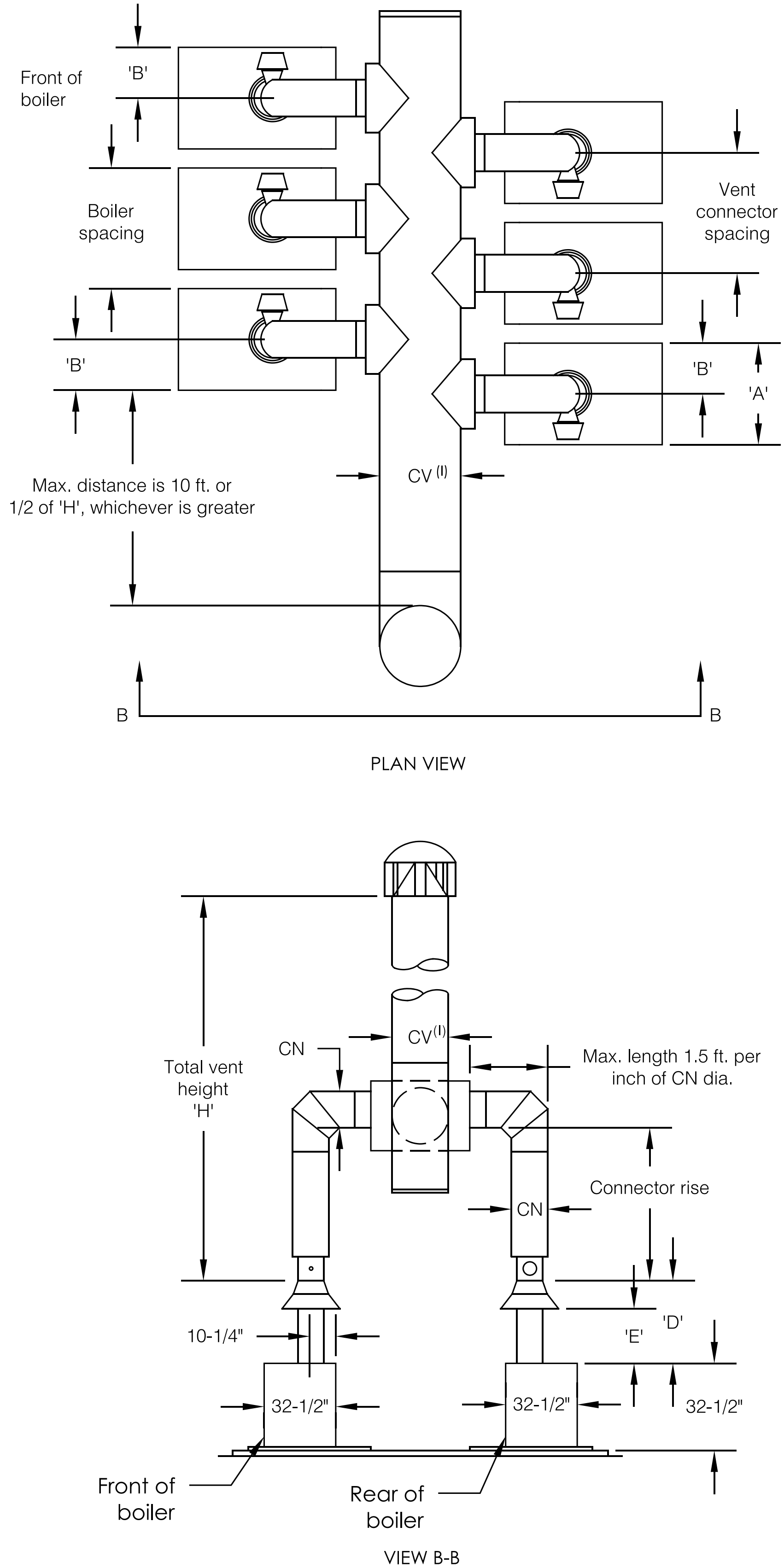


(I) CV_1 based on total boiler input (6 boilers in this illustration)
CV_2 & CV_3 based on total boiler input to these sections of manifold (3 boilers in this illustration)
CN based on boiler input and connector rise

Note: Total number of boilers venting through CV_1 not to exceed six (6).

Figure 2-5: Dual Constant Diameter Manifold Vent

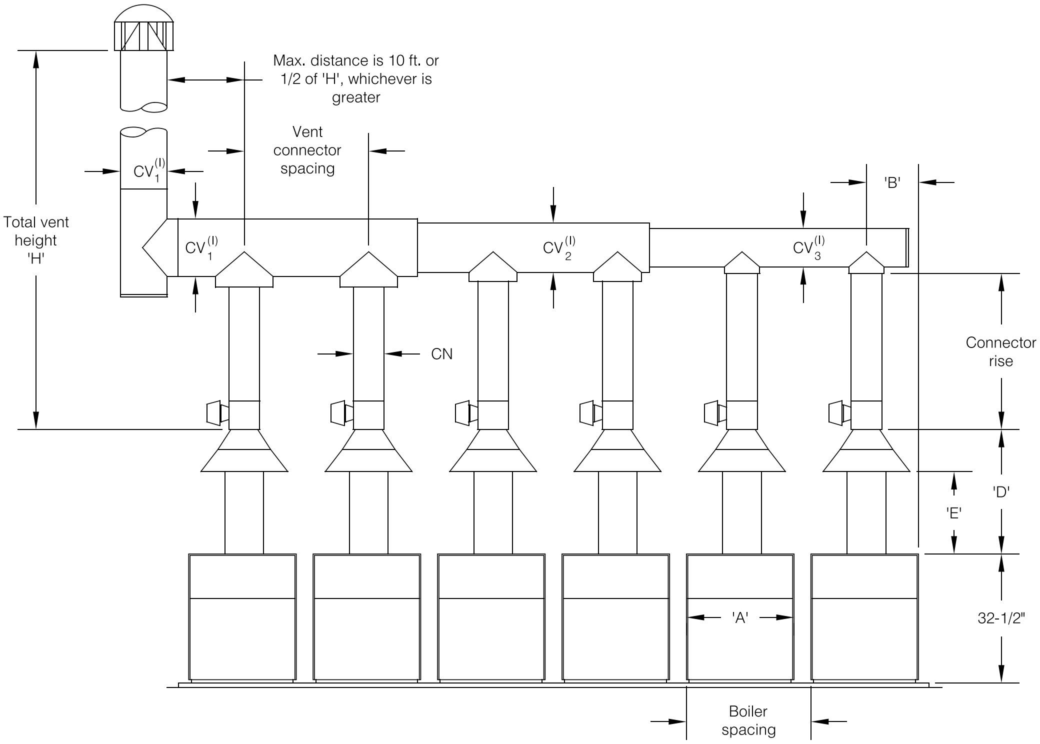
2 Venting *(continued)*



(I) CV dia. based on total boiler input
Note: Max. number of boilers venting through CV not to exceed six (6)

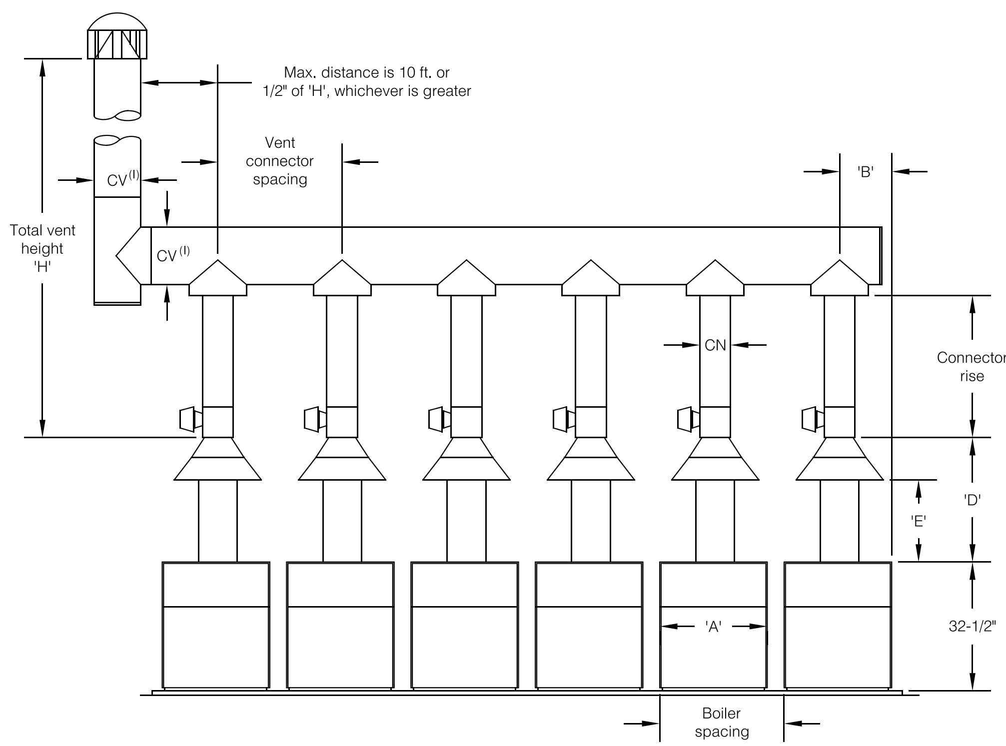
Figure 2-6: Constant Diameter Manifold with Laterals in Vent Connectors

2 Venting *(continued)*



(I) CV_1 dia. based on total boiler input (6 boilers in this illustration)
CV_2 dia. based on total boiler input to this section of manifold (4 boilers in this illustration)
CV_3 dia. based on total boiler input to this section of manifold (2 boilers in this illustration)
Note: Max. number of boilers venting through CV_1 not to exceed six (6)

Figure 2-7: Graduated Manifold



(I) CV based on total boiler input
Note: Max. number of boilers venting through CV not to exceed six (6)

Figure 2-8: Constant Diameter Manifold

2 Venting *(continued)*

Table 2-9: Vent Diameter for Common Venting

<table>
<tr><th colspan="13">Diameter of Common Vent & Manifolds (CV), inches</th></tr>
<tr><th colspan="2">Boiler Qty</th><th rowspan="3">Total Input MBH</th><th colspan="10">H - Total Vent Height (ft.)</th></tr>
<tr><th rowspan="2">805HE</th><th rowspan="2">806HE</th><th colspan="2">6</th><th colspan="2">10</th><th colspan="2">15</th><th colspan="2">20</th><th colspan="2">30</th></tr>
<tr><th>DW</th><th>SW</th><th>DW</th><th>SW</th><th>DW</th><th>SW</th><th>DW</th><th>SW</th><th>DW</th><th>SW</th></tr>
<tr><td>2</td><td>0</td><td>478</td><td rowspan="2">14</td><td rowspan="2">14</td><td rowspan="2">12</td><td>12</td><td rowspan="3">12</td><td rowspan="3">12</td><td rowspan="3">12</td><td rowspan="3">12</td><td rowspan="2">10</td><td>10</td></tr>
<tr><td>1</td><td>1</td><td>538</td><td rowspan="3">14</td><td rowspan="3">12</td></tr>
<tr><td>0</td><td>2</td><td>598</td><td rowspan="3">16</td><td rowspan="3">16</td><td rowspan="2">14</td><td rowspan="3">12</td></tr>
<tr><td>3</td><td>0</td><td>717</td><td rowspan="3">14</td><td rowspan="3">14</td><td rowspan="5">14</td><td rowspan="5">14</td></tr>
<tr><td>2</td><td>1</td><td>777</td><td rowspan="4">16</td><td rowspan="4">16</td><td rowspan="6">14</td></tr>
<tr><td>1</td><td>2</td><td>837</td><td rowspan="3">18</td><td rowspan="3">18</td><td rowspan="6">14</td></tr>
<tr><td>0</td><td>3</td><td>897</td><td rowspan="5">16</td><td rowspan="5">16</td></tr>
<tr><td>4</td><td>0</td><td>956</td></tr>
<tr><td>3</td><td>1</td><td>1016</td><td rowspan="14">NR</td><td rowspan="14">NR</td><td rowspan="5">18</td><td rowspan="4">18</td><td rowspan="6">16</td><td rowspan="5">16</td></tr>
<tr><td>2</td><td>2</td><td>1076</td></tr>
<tr><td>1</td><td>3</td><td>1136</td><td rowspan="6">16</td></tr>
<tr><td>0</td><td>4</td><td>1196</td><td rowspan="6">18</td><td rowspan="5">18</td><td rowspan="6">16</td></tr>
<tr><td>4</td><td>1</td><td>1255</td><td rowspan="10">NR</td></tr>
<tr><td>3</td><td>2</td><td>1315</td><td rowspan="9">NR</td><td rowspan="6">18</td></tr>
<tr><td>2</td><td>3</td><td>1375</td><td rowspan="6">18</td></tr>
<tr><td>1</td><td>4</td><td>1435</td></tr>
<tr><td>0</td><td>5</td><td>1495</td><td rowspan="6">NR</td><td rowspan="6">18</td></tr>
<tr><td>4</td><td>2</td><td>1554</td><td rowspan="5">NR</td><td rowspan="5">18</td></tr>
<tr><td>3</td><td>3</td><td>1614</td></tr>
<tr><td>2</td><td>4</td><td>1674</td><td rowspan="3">NR</td></tr>
<tr><td>1</td><td>5</td><td>1734</td><td rowspan="2">NR</td></tr>
<tr><td>0</td><td>6</td><td>1794</td></tr>
</table>

Table Notes:

- DW = Double Wall Type B or Type L Vent. SW = Single Wall Vent
- NR = Not Recommended. Vent Diameter would exceed 7 times area of drafthood outlet.
- Table based on ASHRAE Handbook formulas/tables.
- Values based on pipe fitting flow resistance of (1) elbow in vent connector, (1) tee at vertical transition to chimney, and typical chimney cap.
- Values based on manifold lateral max. length between chimney and closest boiler of 10 ft., or 1/2 in. total height, which is greater. See dimensional figures.

2 Venting *(continued)*

Table 2-10: Vent Connector Diameters for Common Venting, inches

Vent Connector Diameters for Common Venting, (CN), inches					
Total Vent Height (ft.)	Connector Rise (ft.)	805HE		806HE	
		Double Wall	Single Wall	Double Wall	Single Wall
6	1	10	10	12	NR
	2	9	9	10	10
	3	8	8	9	9
8	1	9	9	10	10
	2	9	9	10	10
	3	8	8	9	9
10	1	9	9	10	10
	2	9	9	9	9
	3	8	8	9	9
15	1	9	9	10	10
	2	8	8	9	9
	3	8	8	9	9
20	1	9	9	10	10
	2	8	8	9	9
	3	8	8	8	9
30	1	9	9	9	10
	2	8	8	9	9
	3	7	8	8	8
50	1	8	8	9	9
	2	8	8	8	9
	3	7	7	8	8

Table Notes:
- Vent Connector Diameters for Common Venting per ANSI Z223.1/NFPA 54.
- Lateral max. length is 1.5 ft. per inch diameter per ANSI Z223.1/NFPA 54.

2 Venting *(continued)*

Table 2-11: Masonry Chimney Liner Dimensions with Circular Equivalents

Inside Equivalent Diameter (in.)	Equivalent Area (in.)	Nominal Liner Size (in.)	Inside Dimensions of Liner (in.)
6	28.3		
7	38.3		
7.4	42.7	8 x 8	6.75 x 6.75
8	50.3		
9	63.6	8 x 12	6.5 x 10.5
10	78.5		
10.4	83.3	12 x 12	9.75 x 9.75
11	95		
11.8	107.5	12 x 16	9.5 x 13.5
12	113		
14	153.9		
14.5	162.9	16 x 16	13.25 x 13.25
15	176.7		
16.2	206.1	16 x 20	13 x 17
18	254.4		
18.2	260.2	20 x 20	16.5 x 16.75
20	314.1		

Per ANSI Z223.1/NFPA 54.

3 Water Piping

⚠ WARNING

- Pressure relief valve discharge piping must be piped such that the potential of severe burns is eliminated. DO NOT pipe in any area where freezing could occur. DO NOT install any shut off valves, plugs or caps. See boiler manual for further information.
- Continued boiler operation for prolonged periods of time under conditions when temperature differential across the system exceeds 40°F and/or return water temperature stays below 135°F may result in pre-mature boiler and vent system failure due to flue gas condensation and/or thermal shock.

Section 3 Contents:

Section 3 Figures and Tables:

3.1 Avoiding Condensation – Large volume systems during the "shoulder" heating seasons or systems with aggressive set back or low temperature systems will cause extended condensation periods that will shorten boiler life. Maintain return water temperature at minimum of 135°F temperature and differential (drop) across the system at 40°F or less. Methods to avoid condensation include by-pass piping, recirculation loops, and mixing valves discussed in paragraphs and Figures below.

3.2 General Layout Considerations - Venting is generally less flexible in design location than are water pipes. To avoid conflicts for a given location, design and layout the venting before proceeding with water piping in this section.

Consider proximity of piping to items that need access for service. Do not block passageways with piping. Do not block access panels on the boiler jackets.

3.3 Component Sizing – General. The purpose of Section 3.0 is to recommend piping systems and accessories that can be used with Series 8HE Gas Boilers. Although recommended design procedures are presented, the final sizing of mains, pumps and expansion tank must be left to the designer of the total system because only that designer has available the requirements and capacities of the connected system.

3 Water Piping *(continued)*

3.4 Water Quality Requirements:

pH: 6.0 – 9.5

Total hardness grains / gal: <7

chlorides: < 50 ppm

3.5 Primary-Secondary Piping

Primary-Secondary Piping is recommended to prevent flow through boilers that are not firing to decrease stand-by losses.

For example, on a six boiler system, only one boiler may be required to meet the connected load demand on a day that is 55°F outdoors. That would be a highly efficient operation. However, if the system water is allowed to flow through the other five boilers, they too are kept warm and the total jacket and flue losses of the six boilers may be as great as that of a single large boiler. Thus, intended benefit is lost.

An additional advantage of Primary-Secondary Piping over Parallel Piping is that water temperature rise and flow rate thru each boiler are independent of the system temperature drop and flow rate. Hence, boiler piping to and from the manifold and the boiler circulators on a primary-secondary application may be based on a higher temperature rise thru the boiler, such as 30° or 40°F, and downsized from the lateral connections. The boiler piping, valves, and circulator for primary-secondary piping may be sized from the data in Table 3-6.

3.5.1 Primary/Secondary Piping with Thermostatic Mixing Valve is shown in Figure 3-1. Thermostatic mixing valves are recommended to provide the most direct control to minimize the potential for condensation.

3.5.2 Primary/Secondary Piping with Fixed ByPass is shown in Figure 3-2. A fixed bypass may be used to reduce the potential for condensation on systems that do not have large fluctuations in return water temperatures.

3.5.3 Primary/Secondary using Pre-Fabricated Water Manifolds and Domestic Water is shown in Figure 3-5. See paragraphs further below for more information regarding Pre-Fabricated Water Manifolds and Domestic Water.

3.6 . Parallel Piping - Figure 3-3. Parallel piping is not preferred due to losses stated above, If Parallel Piping is used, the following are recommended:

* A recirculation loop as shown in Figure 3-3 to reduce the potential for condensation. Variable speed circulators with return sensors are recommended.

* Reverse-Return, as shown in Figure 3-3. Direct Return is inherently unbalanced and may prevent some boilers from delivering their rated capacities.

* A motorized valve placed on the supply pipe on each boiler and controlled to open only when that boiler is fired. However, with motorized valves, the owner may find objectionable noise from high velocity water flow under light loads when the entire flow of the system pump is directed through only one boiler of the group.

3.7 Modular vs. Multiple Boiler Installations – ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers, defines a modular boiler assembly as a grouping of individual boilers intended to be installed as a unit with no intervening stop valves. Where stop valves are installed for the individual boilers, the installation is considered a multiple boiler installation. The Series 8HE may be installed as either a modular boiler system or a multiple boiler system. See sections below for control requirements for each type of system.

3.8 EXPANSION TANK—Selection of the compression tank must be based on the following items:

a. volume of water in the system
b. initial fill pressure of the system
c. maximum operating pressure of the system
d. maximum operating temperature of the system

3.8 Limit Controls - Each boiler is supplied with a Hydrolevel HydroStatR high limit control. To meet ASME requirements, a second limit control is required. For a modular boiler installation (see Section 3.7), a single limit control may be used. For a multiple boiler installation, a limit control is to be installed in the supply piping of each boiler. For CSD-1 installations, the limit control(s) are to be manual reset. The Resideo L4006E manual reset high limit control is available as an accessory.

3.9 Low Water Cut-Offs - The Hydrolevel HydroStatR limit control supplied with each boiler includes a low water cut-off function. The low water cut-off function can be set to manual reset, which is required for CSD-1 installations.

3.10 Relief Valves - Each boiler is supplied with its own pressure relief valve. No additional relief valves need be installed on the manifolds. If domestic water heating is added to a boiler, it is recommended that a relief valve be installed

3 Water Piping *(continued)*

as shown in Figure 3-13. Pressure relief valve discharge piping must be piped such that the potential of severe burns is eliminated. DO NOT pipe in any area where freezing could occur. DO NOT install any shut off valves, plugs or caps. See boiler manual for further information.

3.11 Pressure & Temperature Gauge - Each boiler is supplied with its own temperature/pressure gauge so that the performance of each boiler can be observed without installation of additional gauges.

3.12 Fill Valve - An automatic fill valve is recommended to maintain the minimum pressure in the system at the fill pressure required by the height of the piping system.

3.13 System Circulator - To avoid placing the head pressure of the system circulator on the boiler and expansion tank, the system circulator should be installed such that it pumps away from the boiler and expansion tank. See Figures 3-1 thru 3-3.

3.14 Strainers - A start-up strainer is recommended for practically all multiple installations (new and replacement alike) to prevent system debris and sediment from ending up in the boilers where it will inhibit heat transfer and may eventually cause a cast iron section to crack from overheating.

3.15.1 Figure 3-7 is a typical friction-velocity-flow diagram used by most designers of large systems. The lower scale, Heat Conveyed, is based on a 20°F temperature drop. However, the flow rate in gpm is shown on the upper scale, and can be used to size pipe at other temperature drops by converting heat conveyed to flow rate in gpm.

Example: Find the pipe size required to convey 1,000,000 Btuh in iron pipe at a friction loss of 500 mill inches/ft. and temperature drops of 20°F, 30°F or 40°F.

Solution: The gpm flow rate for 1,000,000 Btuh is found by dividing:

1,000,000 by (500 x 20) = 100 gpm for 20° drop

1,000,000 by (500 x 30) = 66.7 gpm for 30° drop

1,000,000 by (500 x 40) = 50 gpm or 40° drop

Enter Figure 3-7 on the horizontal line for 500 mill inches per ft. and read across to the right to the vertical lines for 100 gpm, 66.7 gpm and 50 gpm.

On the slanted lines read the corresponding pipe sizes (use the larger if between two pipe sizes)

100 gpm = 3 in. Pipe

66.7 gpm = 2. in. Pipe

50 gpm = 2. in. Pipe

Figure 3-8 can be used in a similar manner for copper pipe.

3.15.2 The size of the terminal units (baseboard, convectors, fan coils, etc.) must be adjusted according to the actual temperature of water flowing in those units. In general, the first terminal unit on a circuit will receive hotter than average water and should be undersized, and the last terminal unit will receive cooler than average water and should be oversized.

3.15.3 It should be noted that the selection of system temperature drop has no effect on the sizing of the boiler.

3.15.4 On replacement jobs it is generally too expensive to modify the terminal units for temperature drops other than that used by the original system designer. It is not “safe” to assume that the original design was based on 20°F drop and thus the owner’s records should be consulted.

3.16 Main Piping - Selection of Main Size and the system pump must go together. The system designer can select the pump and size the pipe accordingly, but more often the best economics of pipe and pump causes the system designer to select the minimum pipe size based on a maximum pressure drop and then select a pump(s) to meet flow and pressure drop requirements of the total system. It is recommended that pipe sizes be selected in the unshaded portions of Figure 3-7 or 3-8. The minimum pipe size will occur on or close to the upper limit of the unshaded areas.

Example: Find the minimum main size and corresponding friction for three 806HE boilers using iron pipe and a 20°F temperature drop.

Solution:

1. The output of three 806HE boilers is 753 MBH.
2. Enter Figure 3-7 on the lower horizontal scale at 753 MBH and move vertically to the upper limit of the unshaded area.
3. On the lines that slant upward to the right, read the pipe size. In this case, the pipe size is greater than 2 in. but less than 2. in. Select the larger of 2. in.

3 Water Piping *(continued)*

4. From the point in 2) above move down vertically to the 2. pipe line and horizontally to the left hand scale. Pick off 480 mill inches per foot friction.

3.16.1 In calculating the total equivalent length of pipe it is necessary to consider the additional resistance of elbows. Figure 3-9 shows the equivalent lengths. The total equivalent length of pipe in a circuit is the measured length plus the equivalent length of all elbows in that circuit. The total equivalent length of the longest circuit in the system is useful in determining the head requirement of the system pump.

3.17 Expansion Tank - Selection of the expansion tank must be based on the following items:

a. volume of water in the system

b. initial fill pressure of the system

c. maximum operating pressure of the system

d. maximum operating temperature of the system

3.17.1 It is necessary to calculate the volume of water contained in the total system including piping, boilers and terminal units. Table 3-10 can be used to determine the volume of the piping by measuring the length of each size of pipe and multiplying by the appropriate factor from Table 3-10.

Example: Find the water volume in the piping of a system having 40 ft. of 3 in. pipe, 72 ft. of 2 in. pipe, and 52 ft. of 1. in. pipe.

Solution: From Table 3-10 obtain the gallons/ft. from each size of pipe and multiply by the length of that size of pipe.

1. in. Copper = .065 gal/ft. x 52 ft. = 3.4 Gal.

+ 2 in. Copper = .161 gal/ft. x 72 ft. = 11.6 Gal.

+ 3 in. Copper = .357 gal/ft. x 40 ft. = 14.3 Gal.

Total volume in piping = 29.3 Gal.

3.17.1.1 Use Table 3-6 to calculate the volume of the boilers.

Example: Find the volume of water in four 806HE boilers.

Solution: From Table 3-6 find that the water volume of one 806HE is 13.9 gallons and multiply by the number of boilers: 13.9 x 4 = 55.6 gallons in the boilers.

3.17.1.2 The water side of terminal units must be known in order to determine their volume. Tubular units such as baseboard, commercial finned tube, convectors and fan coils can be computed by knowing the length and size of the tubes.

Example: Find the water volume in 528 ft. of 1. in copper dual tiered commercial finned tube.

Solution: From Table 3-10 obtain the value of .065 gal/ft. for 1. in. copper and multiply by 528 ft. and by 2 tiers: 0.65 gal/ft. x 528 ft. x 2 tiers = 68.6 Gallons in the Finned Tube.

3.17.1.3 From the above examples the total volume of the system can be added:

Volume of piping = 29.3 Gal.

+ Volume of boilers = 55.6 Gal.

+ Volume of Finned Tube = 68.6 Gal.

Total Volume of System = 153.5 Gal.

3.17.2 Conventional (open) expansion tanks can be sized by using Tables 3-11 and 3-12. Enter Table 3-11 in the left hand column at the water volume of the system, move across to the right to the maximum water temperature of the system and read the uncorrected tank size.

To find the correction factor, enter Table 3-12 in the left hand column of the initial fill pressure and move across to the right to column for the system pressure increase and read the tank correction factor. Multiply the uncorrected tank size by the correction factor to find the final tank size.

Example: Find the conventional expansion tank size for a system having a water volume of 153.5 gallons, a design water temperature of 220°F, a 50 psi relief valve and a system height of 30 ft.

Solution:

1. Enter Table 3-11 in the left hand column and move down to 200 gallons (which is the next largest value to 153.5 gallons). Read across to the column for 220°F design water temperature and read 32 gallons uncorrected tank size.
2. Find the initial fill pressure by multiplying the system height by 0.433:

   30 x 0.433 = 13 psi
3. Enter Table 3-12 in the left hand column and move down to 12 psi fill pressure (closest to 13 psi). Move across to the column headed 40 psi pressure increase (closest column to 40 psi minus 13 psi) and read a correction factor of 0.63.
4. Multiply 0.63 x 32 38 Gal. = 20 24 gallons corrected tank size.
5. Select a conventional expansion tank size of at least 20 24 gallons. In some cases, greater accuracy may be obtained by interpolation in Tables 3-11 and 3-12.

3 Water Piping *(continued)*

3.17.3 Diaphragm type expansion tanks – size per tank manufacturer's instructions.

3.18 Water Manifolds

3.18.1 Optional fabricated manifolds are available as a convenience to the installer and are highly recommended with four or more boilers.

3.18.2 Factory fabricated manifolds are lightweight and quite forgiving of minor piping misalignments common to multiple boiler installations. Each end of the 4 in. manifold is ready for connection to another manifold section or to the field piping by means of:

1. Optional self-restrained pipe couplings, or
2. Field roll-grooving for use of groove style couplings.

One lateral connection on each manifold is threaded and intended to be made-up first to positively locate the manifold during its installation. The other lateral connections on each manifold are longer and also threaded for those installations where threaded fittings, such as unions, are desired, but it is recommended that these longer threaded laterals be cut off to yield plain ends for applying the same style couplings as on the 4 in. ends.

3.18.3 The lateral connections on the factory fabricated manifolds are 1. in. schedule 40, equally spaced on 28. in. centers.

3.18.4 Manifolds are available to serve two or three boilers. Two- boiler manifolds have two return and two supply lateral connections, three boiler manifolds have three of each.

3.18.5 The manifolds are adaptable to parallel pumping applications by capping half of the lateral connections and using two manifolds: one for supply and one for return. Refer to Figure 3-3.

3.18.6 For parallel pumping applications boiler piping should equal the lateral connection sizes. Refer to Table 3-6 for boiler flow rates and pressure drop.

3.18.7 The maximum flow capacity of the factory fabricated manifold is 265 GPM. If the system is based on a 20°F ΔT, these manifolds could serve boilers with a total input of 3400 MBH. If the system is based on ad 30°F ΔT, these manifolds could serve boilers with a total input of up to 5100 MBH.

3.18.8 If the optional flex couplings are to be used, they should be installed according to the instructions in section 3.19.

3.18.9 If groove style couplings are to be used, they should be installed according to the instructions in section 3.20.

3.18.10 On fewer than four boilers, the designer may elect to use commercial schedule 40 pipe and fittings of a smaller size than the 4 in. pipe size of the fabricated manifolds. Refer to 3.15.1 for the procedure used to size a field fabricated manifold. It should be noted that in the case of primary-secondary pumping the return line to each boiler should not be down stream of the supply line from that same boiler to avoid short circuiting of heated water within that boiler.

3.19 Installation procedure for optional flex couplings.

3.19.1 Pipe End Preparation

a. 4 in. ends of fabricated manifolds: with a manual or automatic pipe cutter, cut 1-1/8 in. off each end of the manifold to provide the proper gap between pipe ends.

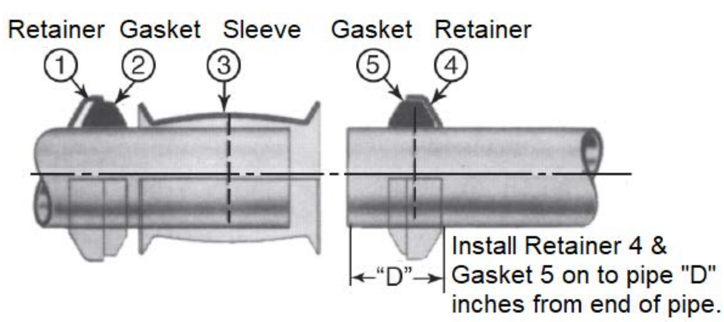
b. 1. in. laterals of fabricated manifolds: with a manual pipe cutter, cut 1. in. off each of the 4 in. long laterals to remove the pipe threads. Do not cut the threads off the shorter 2. in. long lateral, as this connection is intended to be piped rigid to locate the manifold during installation. If the manifold is to be used for parallel pumping, do not cut the threads off the laterals that are to be capped.

c. Deburr and clean pipe ends.

d. Special surface finish on pipe is not required. Surface to be free of deep scratches, gouges, dents, etc.

3.19.2 Joint Installation

a. Install retainer (1), gasket (2) and sleeve (3) on one pipe end or manifold in sequence shown below.



3 Water Piping *(continued)*

b. Install remaining retainer (4) and gasket (5) on other pipe end or manifold.

c. Position retainer (4) and gasket (5) to proper pipe insertion depth “D”:

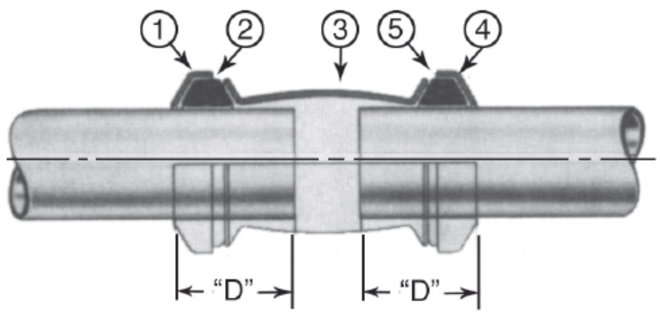
Pipe Insertion Depth "D"

Pipe Size Nominal Max. Min.

1-1/2 in. 1-3/8 in. 1.62 in. 1.16 in.

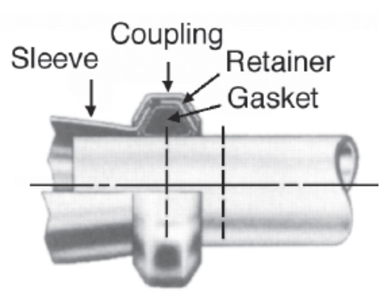
4 in. 2-1/16 in. 2.44 in. 1.7 in."

d. Slide sleeve (3) to gasket (5) and move gasket (2) and retainer (1) into position as shown. Pipe must be inserted to proper depth “D” into both gaskets.



3.19.3 Coupler Installation

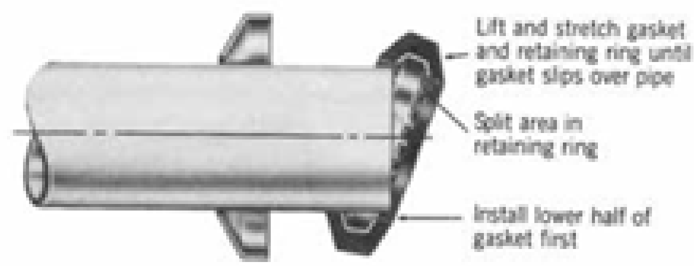
Install both V-couplings, encompassing the retainer, gasket and sleeve. Do not tighten either coupling until entire joint has been assembled. Tighten nuts of 4 in. couplings to 280-300 inch-lbs. and 1. in. couplings to 140-160 inch-lbs., or to a minimum of 1/16 in. clearance between coupling lugs, whichever occurs first. Retightening of the coupler will be necessary if leakage occurs. A completed V-coupling installation is shown below.



3.19.4 Special Notes

a. Assembly of gaskets can be made easier by dipping gaskets in water or wiping them with a small amount of liquid hand soap. Other rubber lubricants cannot be used.

b. To simplify installation of the self-restrained gasket, install the lower half of the gasket first, leaving the split area in the steel retaining ring free at the top. Then, stretch the gasket and split area of the retaining ring until they slip over the pipe and into position as shown below.



3.20 Installation notes for V-groove couplings.

3.20.1 Pipe End Preparation

a. 4 in. ends of fabricated manifolds: since the 4" pipe of the manifold is schedule 10, the ends should be roll-grooved. DO NOT cut-groove the 4 in. ends of the fabricated manifolds.

b. 1½ in. or 2 in. laterals of fabricated manifolds: with a manual pipe cutter, cut 1½ in. off each of the 4 in. long laterals to remove the pipe threads. Do not cut the threads off the shorter 2½ in. long lateral, as this connection is intended to be piped rigid to locate the manifold during installation. If the manifold is to be used for parallel pumping, do not cut the threads off the laterals that are to be capped. The laterals are schedule 40 so those intended for V-groove couplings may be roll-grooved or cutgrooved.

3.20.2 Gasket and Coupling Installation

Specific installation procedures vary from one coupling manufacturer to another. Follow the coupling manufacturer's recommendations for installation.

3.21 Domestic Water Heating - An external water heater may be added to any boiler on either primary-secondary or parallel circulation system. If heavy water heating loads are0 anticipated an additional boiler(s) may be added to the water heating circuit. Refer to Figure 3-13 for recommended boiler water piping for domestic water heating, with parallel piping. Refer to Figure 3-5 for recommended piping when using an Alliance Indirect hot water tank with Primary Secondary Piping.

3 Water Piping *(continued)*

3.21.1 Water heater size may be determined in the following manner:

1. From Table 3-14, find the appropriate factor for each fixture in the building and add them together to find the total fixture units.
2. From Figure 3-15, convert the fixture units to hot water capacity in gallons per minute based on 40-140°F temperature rise.
3. Select water heater based on gallons per minute from 2) above.

3.21.2 The addition of water heating may not necessarily add to the size of the boilers. Since the maximum space heating load and the maximum water heating load rarely occur at the same time, only a portion of the water heating load is added to the space heating load to size the boilers as follows:

1. Calculate the water heating load in Btuh:

___gpm x 8.33 Lb/Gal x 60 Min/Hr x 100

ΔT = ___________Btuh

2. Calculate ratio = Water Heating Load Space Heating Load
3. From Figure 3-16, using the ratio found in 2), find factor for sizing the “boiler added capacity”.
4. Calculate “boiler added capacity” by multiplying factor from 3) by water heating load.
5. Total the space heating load and the “boiler added capacity”.
6. Select boilers from Table 1-2 using the total net input.
7. Divide water heating load by gross output of one boiler to determine the number of boilers to be used in the water heating circuit.

Example - An office building has 10 basins and 1 slop sink and a space heating load of 1,000,000 Btuh.

Size the water heater and boiler.

Solution:

1. 10 basins x . units = 7.5 Fixture Units

1 slop sink x 1. units = 1.5 Fixture Units

Total = 9 Fixture Units

2. In Figure 3-15, using curve “C” for office building, find that for 9 Fixture Units 6 gpm is required.
3. Select water heater at 6 gpm and 40-140°F temperature rise.
4. Calculate water heating load in Btu.

6 x 8.33 x 60 x 100 = 299,880 Btuh

5. Calculate ratio = Water Heating Space Heating

= 299,880 = .30

1,000,000

6. From Figure 3-16 find that for a ratio of 0.3 is 10%.
7. Determine the total load:

1,000,000 + 10%*1,000,000 = 1,100,000 Btuh

8. Determine number of boilers from Table 1-2 using the Total Net Output column. Select (4) 805HE and (1) 806HE boilers for a total net output of 1,136,000 Btuh.
9. The water heating load of 299,880 Btuh can be handled by any two of the boilers.

3.21.3 The domestic water heater sizing procedures outlined in this section are based on methods recommended in the ASHRAE Handbook and, HVAC Applications Volume, “Service Water Heating” Chapter.

3.22 Oxygen Corrosion

Oxygen contamination of the boiler water will cause corrosion of the iron and steel boiler components, which can lead to failure. As such, any system must be designed to prevent oxygen absorption in the first place or prevent it from reaching the boiler. Problems caused by oxygen contamination of boiler water are not covered by Burnham's standard warranty.

There are many possible causes of oxygen contamination such as:

- Addition of excessive make-up water as a result of system leaks.
- Absorption through open tanks and fittings.
- Oxygen permeable materials in the distribution system.

In order to insure long product life, oxygen sources should be eliminated. This can be accomplished by taking the following measures:

- Repairing system leaks to eliminate the need for addition of make-up water.
- Eliminating open tanks from the system.
- Eliminating and/or repairing fittings which allow oxygen absorption.
- Use of non-permeable materials in the distribution system.
- Isolating the boiler from the system water by installing a heat exchanger.

3 Water Piping *(continued)*

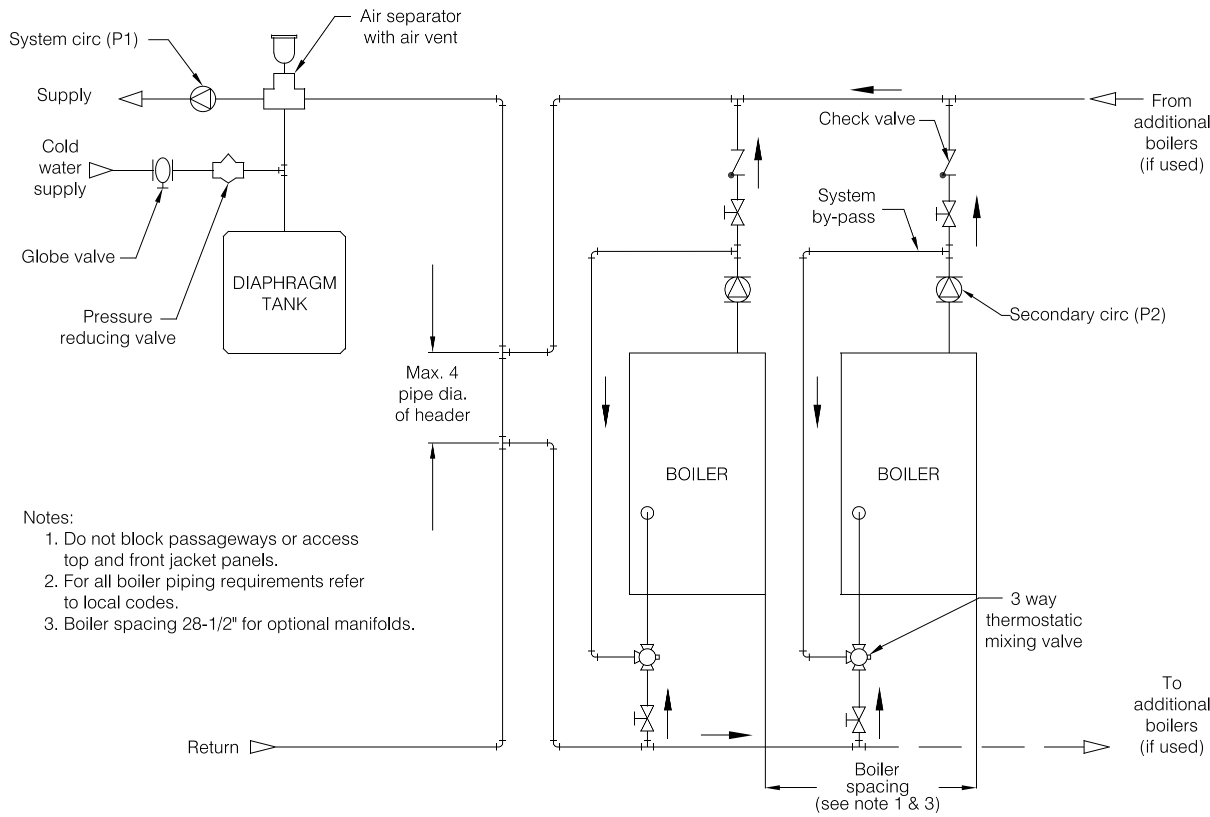


Figure 3-1: Piping Diagram (2 Boilers), Primary/Secondary with Mixing Valves

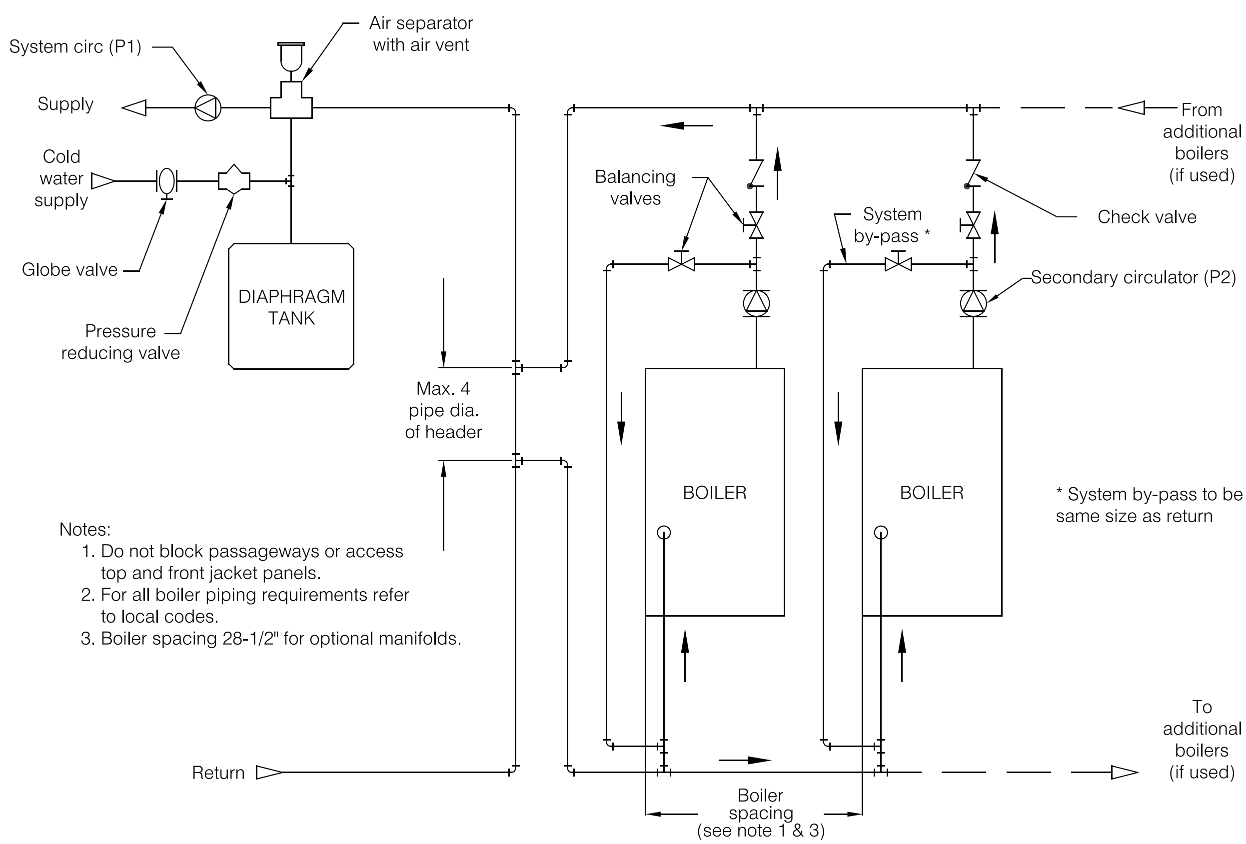


Figure 3-2: Piping Diagram (2 Boilers), Primary/Secondary with By-Pass

3 Water Piping *(continued)*

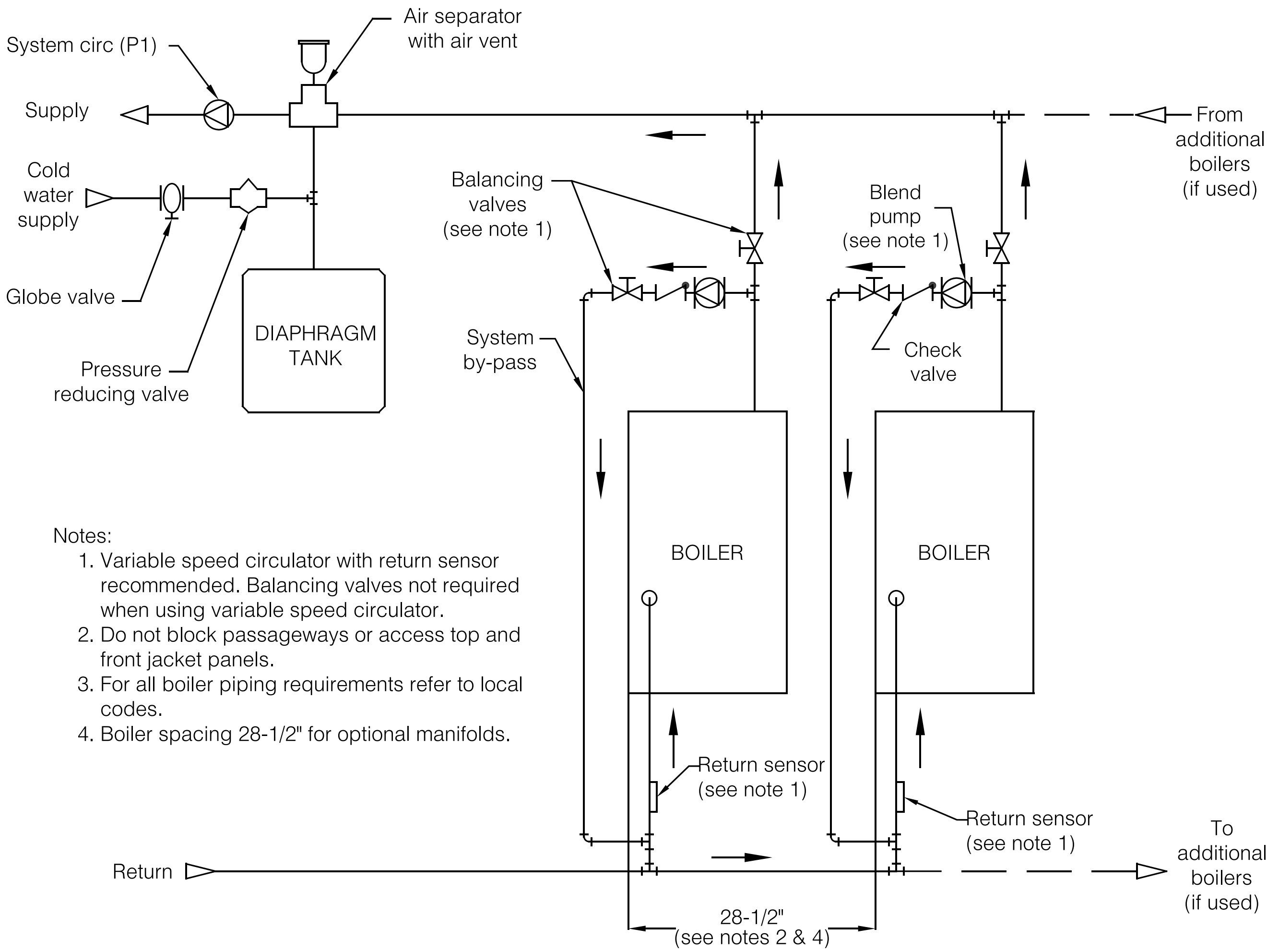


Figure 3-3: Piping Diagram (2 Boilers), Parallel Piping with Recirculation Loop

3 Water Piping *(continued)*

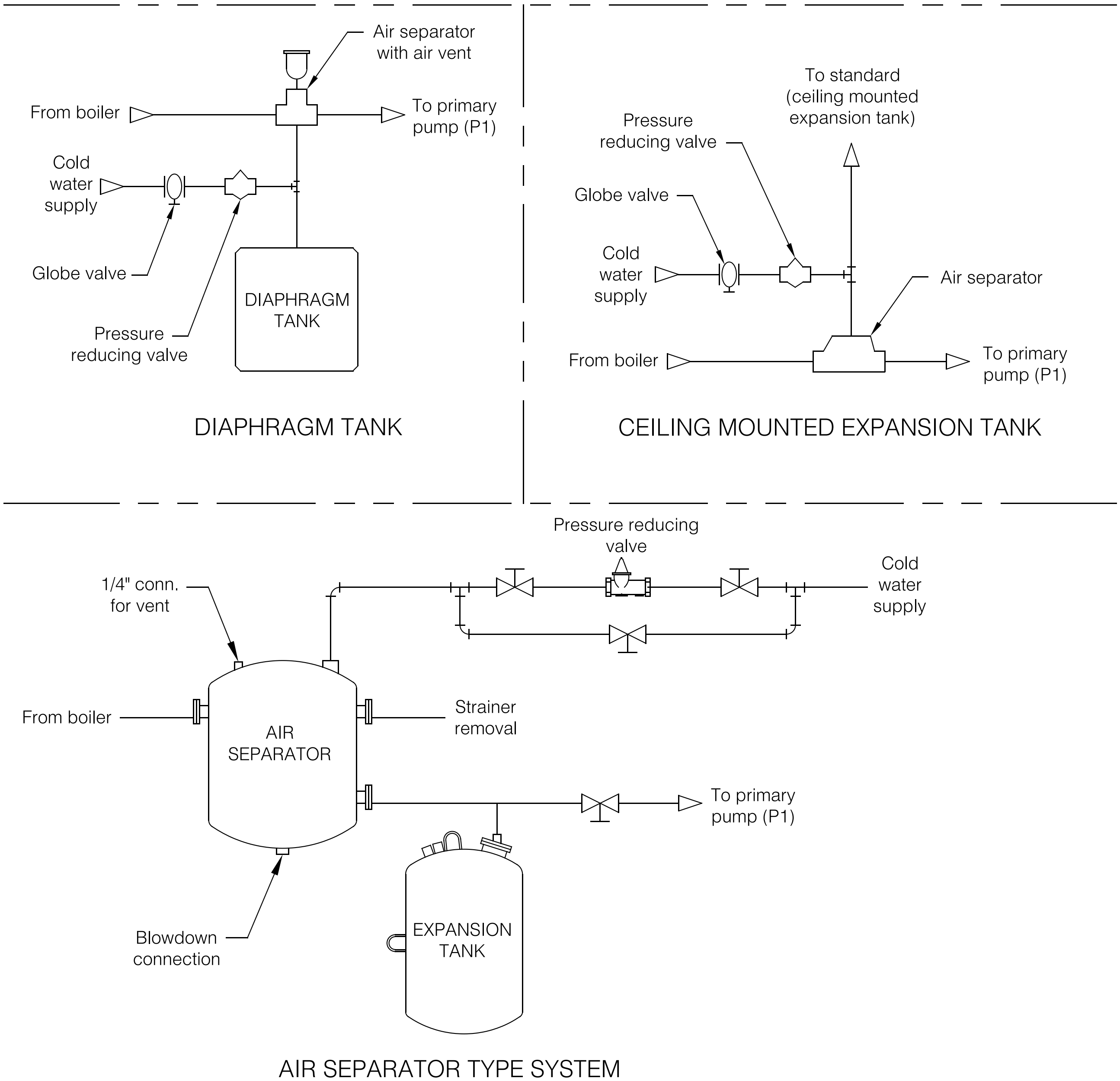


Figure 3-4: Expansion and Air Elimination Details

3 Water Piping *(continued)*

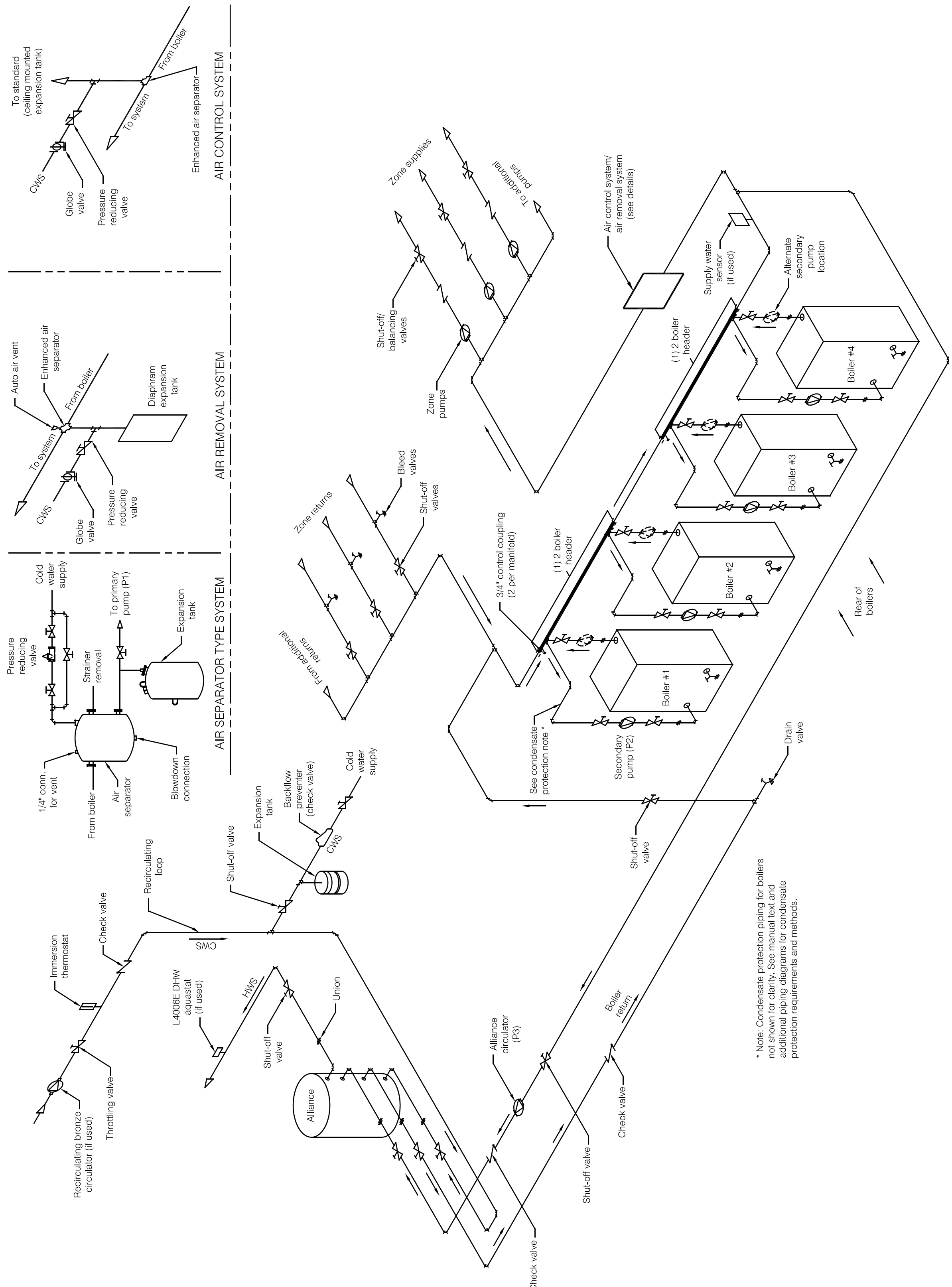


Figure 3-5: Piping Diagram, Primary/Secondary with Pre-Fabricated Manifolds and DHW

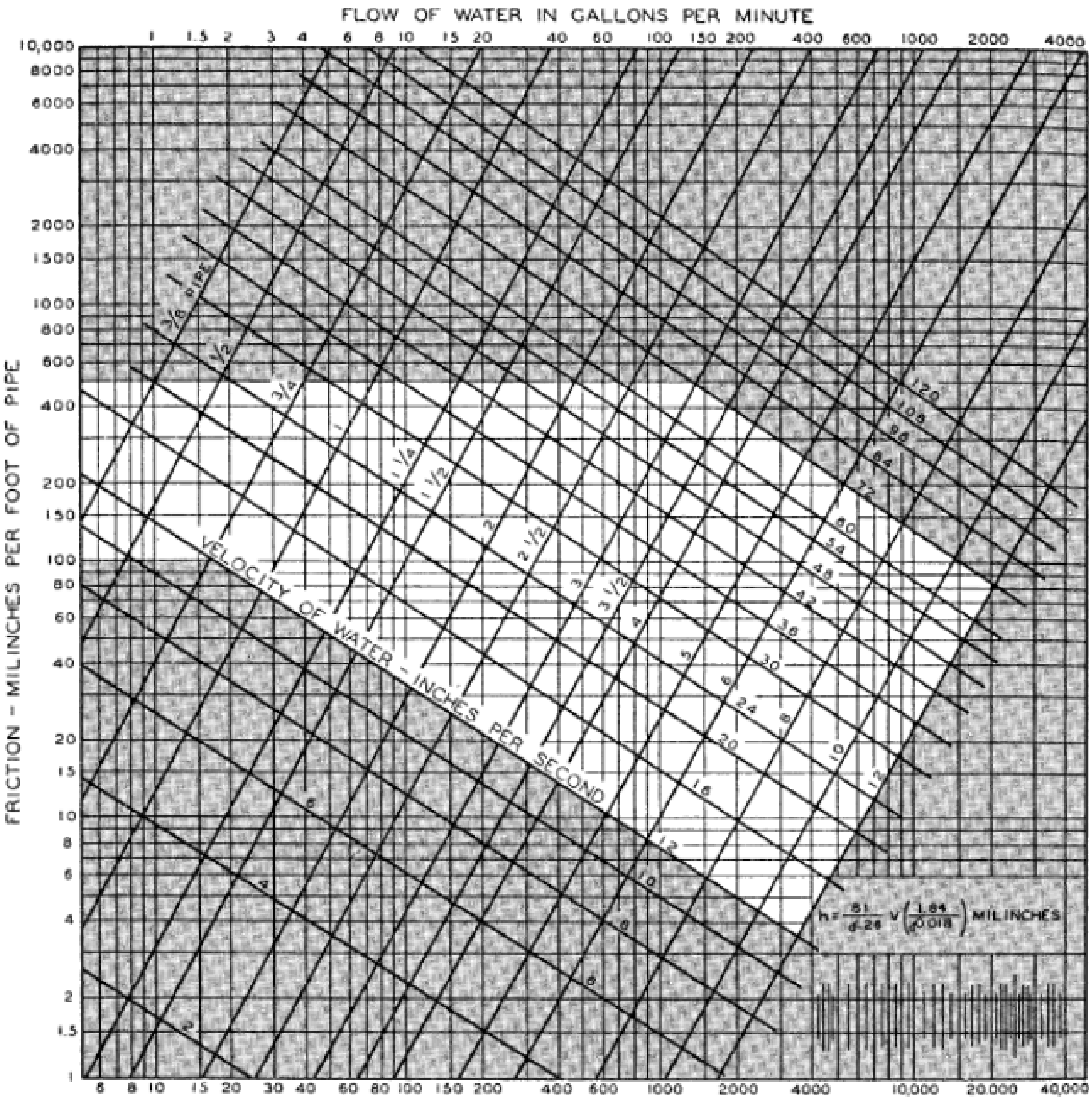
3 Water Piping *(continued)*

Table 3-6: Boiler Water Data

Boiler Size	Water Volume (Gal)	Heating Surface (Ft²)	Flow Rate (GPM)	Temp. Rise thru Boiler (°F)	Min. Boiler Piping (NPT)	Boiler Pressure Drop (ft.)
805HE	11.9	34.4	20	20°F	1-1/2 in.	3 ft.
			13	30°F	1-1/4 in.	2 ft.
			10	40°F	1-1/4 in.	1 ft.
806HE	13.9	42.6	25	20°F	1-1/2 in.	3 ft.
			17	30°F	1-1/2 in.	2 ft.
			13	40°F	1-1/4 in.	1 ft.

1. In a primary-secondary pumping installation temperature rise thru the boiler has no relation to system ΔT. In a parallel pumping installation temperature rise thru the boiler equals the temperature drop of the system.
2. In a primary-secondary pumping installation pressure drop thru the boiler does not add to system circulator head. In a parallel pumping installation pressure drop thru the boiler does add to system circulator head load.
3. 40°F Temperature rise thru boiler recommended for Primary-Secondary pumping.

3 Water Piping *(continued)*



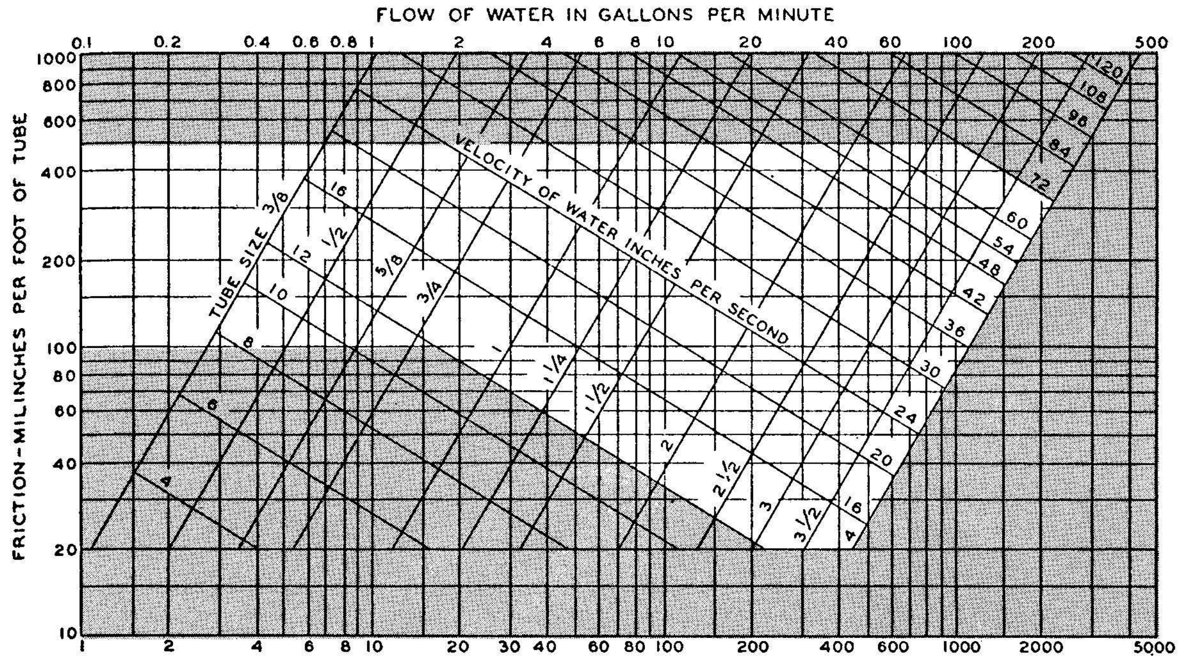
HEAT CONVEYED PER HOUR, MBH (20°F TEMPERATURE DROP)

To use this Figure:

1. Enter horizontal scale at desired flow,
2. Move down vertically to upper limit of unshaded area,
3. Pick off minimum pipe size on diagonal lines sloping upward to the right.
4. Pick off water velocity on diagonal lines sloping upward to the left.

Figure 3-7: Friction vs. Water Flow - Iron Pipe

3 Water Piping *(continued)*



HEAT CONVEYED PER HOUR, MBH, (20°F TEMPERATURE DROP)

To use this Figure:

1. Enter horizontal scale at desired flow,
2. Move down vertically to upper limit of unshaded area,
3. Pick off minimum pipe size on diagonal lines sloping upward to the right.
4. Pick off water velocity on diagonal lines sloping upward to the left.

Figure 3-8: Friction vs. Water Flow – Copper Pipe

Table 3-9: Equivalent Length of Pipe for 90° Elbow

Vol. Fps	Pipe Size													
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12
1	1.2	1.7	2.2	3.0	3.5	4.5	5.4	6.7	7.7	8.6	10.5	12.2	15.4	18.7	22.2
2	1.4	1.9	2.5	3.3	3.9	5.1	6.0	7.5	8.6	9.5	11.7	13.7	17.3	20.8	24.8
3	1.5	2.0	2.7	3.6	4.2	5.4	6.4	8.0	9.2	10.2	12.5	14.6	18.4	22.3	26.5
4	1.5	2.1	2.8	3.7	4.4	5.6	6.7	8.3	9.6	10.6	13.1	15.2	19.2	23.2	27.6
5	1.6	2.2	2.9	3.9	4.5	5.9	7.0	8.7	10.0	11.1	13.6	15.8	19.8	24.2	28.8
6	1.7	2.3	3.0	4.0	4.7	6.0	7.2	8.9	10.3	11.4	14.0	16.3	20.5	24.9	29.6
7	1.7	2.3	3.0	4.1	4.8	6.2	7.4	9.1	10.5	11.7	14.3	16.7	21.0	25.5	30.3
8	1.7	2.4	3.1	4.2	4.9	6.3	7.5	9.3	10.8	11.9	14.6	17.1	21.5	26.1	31.0
9	1.8	2.4	3.2	4.3	5.0	6.4	7.7	9.5	11.0	12.2	14.9	17.4	21.9	26.6	31.6
10	1.8	2.5	3.2	4.3	5.1	6.5	7.8	9.7	11.2	12.4	15.2	17.7	22.2	27.0	32.0

To use this table:

1. Enter left hand column at desired water velocity.
2. Move horizontally to the right to the column headed by the desired pipe size.
3. Read the equivalent length of pipe for each 90° elbow to be added to the measured length at the piping circuit.

3 Water Piping *(continued)*

Table 3-10: Volume of Water in Steel Pipe and Copper Tube - Gal/ft.

Size	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Copper Tube	.012	.025	.043	.065	.092	.161	.250	.357	.625	1.00	1.40	2.43	3.78	5.40
Steel Pipe	.016	.028	.045	.078	.102	.172	.250	.385	.667	1.00	1.50	2.63	4.20	5.90

To use this table:
1. Enter left hand column at desired type of pipe.
2. Move to the right to the desired pipe size.
3. Read the resulting gallons per foot of pipe.

Table 3-11: Expansion Tank Capacity

Water Volume= in Gallons	Mean Design Water Temperature °F						
	150°	160°	180°	200°	220°	240°	250°
10	0.60	0.8	1.0	1.3	1.6	1.9	2.0
20	1.2	1.7	2.0	2.6	3.2	3.8	4.1
30	1.8	2.5	3.0	4.0	4.8	5.7	6.1
40	2.4	3.3	4.0	5.3	6.4	7.6	8.2
50	3.0	4.2	5.0	6.6	8.0	9.5	10
60	3.6	5.0	6.0	7.9	9.7	11	12
70	4.2	5.8	7.0	9.2	11	13	14
80	4.7	6.7	8.0	11	13	15	16
90	5.3	7.5	9.0	12	14	17	18
100	5.9	8.0	10	13	15	19	20
200	12	17	20	26	32	38	41
300	18	25	30	40	48	57	61
400	24	33	40	53	64	76	82
500	30	42	50	66	80	95	102
600	36	50	60	79	97	114	122
700	42	58	70	92	113	133	143
800	47	67	80	110	129	150	163
900	53	75	90	120	145	170	184
1,000	59	80	100	130	161	190	200
2,000	120	170	200	260	320	380	410
3,000	180	250	300	400	480	570	610
4,000	240	330	400	530	640	760	820
5,000	300	420	500	660	800	950	1,020
6,000	360	500	600	790	970	1,140	1,220
8,000	470	670	800	1,100	1,290	1,500	1,630
10,000	590	800	1,000	1,300	1,610	1,900	2,000

To use this table:
1. Enter left hand column at water volume of the system,
2. Move to the right to the maximum water temperature of the system.
3. Read the uncorrected tank size,
4. Proceed to Table 3-10.

3 Water Piping *(continued)*

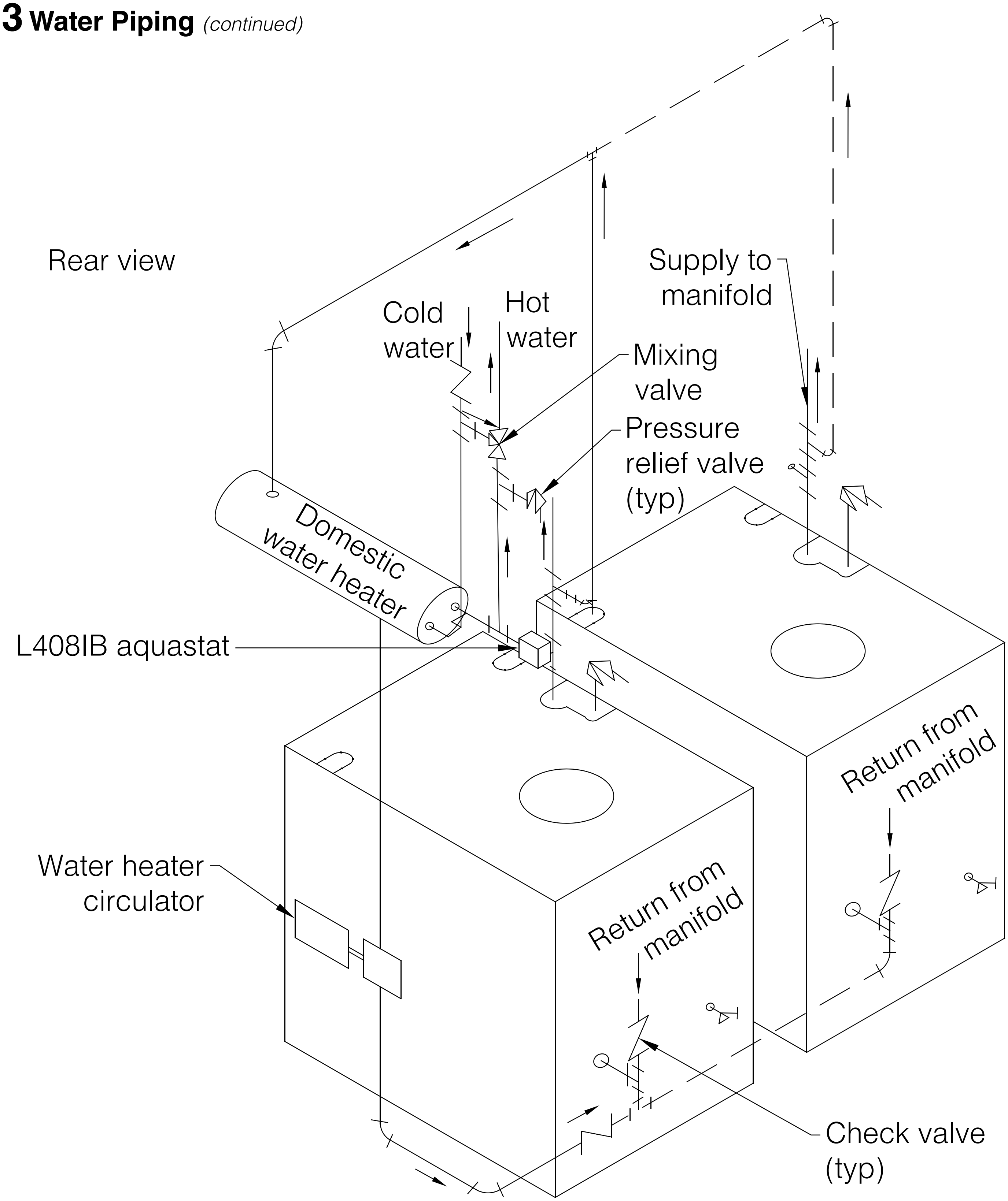
Table 3-12: Expansion Tank Correction Factor

Initial Pressure on Compression Tank	Allowable System Pressure Increase*											
	6 psi	8 psi	10 psi	12 psi	14 psi	16 psi	20 psi	25 psi	30 psi	40 psi	50 psi	75 psi
4 psi	1.0	.8	.68	.62	.59	.55	.5	.49	.48	.48	.48	.48
8 psi	1.6	1.2	1.05	.92	.85	.8	.7	.6	.6	.5	.5	.5
12 psi	2.0	1.7	1.43	1.25	1.15	1.07	.95	.75	.75	.63	.55	.54
18 psi	3.0	2.55	2.2	1.94	1.75	1.6	1.35	.98	.98	.8	.72	.7
24 psi	4.6	3.65	3.1	2.65	2.38	2.15	1.78	1.35	1.35	1.12	1.02	1.0
30 psi	--	5.0	4.2	3.6	3.1	2.7	2.3	1.8	1.8	1.43	1.25	1.1
38 psi	--	--	5.3	4.6	4.1	3.7	3.05	2.25	2.25	1.95	1.7	1.4
50 psi	--	--	--	--	--	--	4.7	3.1	3.1	2.6	2.3	2.0
60 psi	--	--	--	--	--	--	--	3.8	3.8	3.1	2.7	2.4
70 psi	--	--	--	--	--	--	--	5.2	5.2	3.9	3.5	3.1

* Relief valve setting minus initial pressure on relief valve, pump on.

To use this table:
1. Enter left hand column at initial pressure,
2. Move to the right to column headed with the allowable system pressure increase,
3. Read correction factor.
4. Multiply correction factor by the uncorrected tank size found from Table 3-11 to obtain the corrected compression tank size.

3 Water Piping *(continued)*



- Install if additional boilers are needed for water heating. Do not block passageways nor access to top and front jacket panels.

Figure 3-13: Piping Diagram, Domestic Water Heating

3 Water Piping *(continued)*

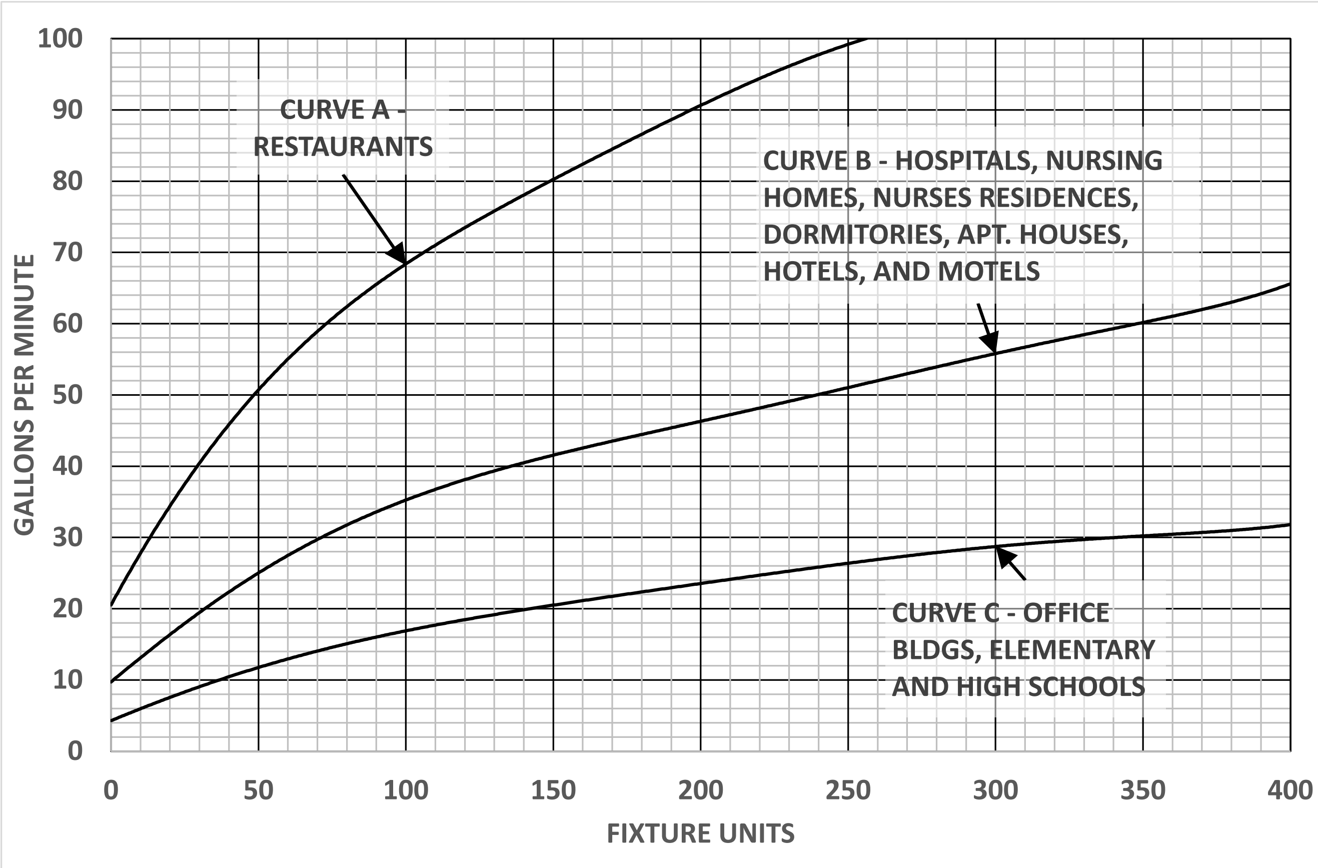
Table 3-14: Service Hot Water Demand

	Apartment House	Club	Gymnasium	Hospital	Hotels and Dormitories	Industrial Plant	Office Bldg.	School	YMCA
Basins, Private Lavatory	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
Basins, Public Lavatory	--	1	1	1	1	1	1	1	1
Bathtubs	1 1/2	1 1/2	--	1 1/2	1 1/2	--	--	--	--
Dishwashers	1 1/2	Five (5) Fixture Units per 250 seating capacity							
Theraputic Bath	--	--	--	5	--	--	--	--	--
Kitchen Sink	3/4	1 1/2	--	3	1 1/2	3	--	3/4	3
Pantry Sink	--	2 1/2	--	2 1/2	2 1/2	--	--	2 1/2	2 1/2
Slop Sink	1 1/2	2 1/2		2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
Showers*	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	3	--	1 1/2	1 1/2
Circular Wash Fountain	--	2 1/2	2 1/2	2 1/2	--	4	--	2 1/2	2 1/2
Semi-circular Wash Fountain	--	1 1/2	1 1/2	1 1/2	--	3	--	1 1/2	1 1/2

*In applications where principal use is showers, as in gymnasiums or at end of shift in industrial plants, use conversion factor of 1.00 to obtain design water flow rate in gpm.

To use this Table:
1. For the type of fixture and type of building, read directly the Fixture Units.
2. Multiply the Fixture Units by the total number of fixtures of one type.
3. Add together the Fixture Units for each type to obtain the total Fixture Units for the building.
4. Proceed to Figure 3-15.

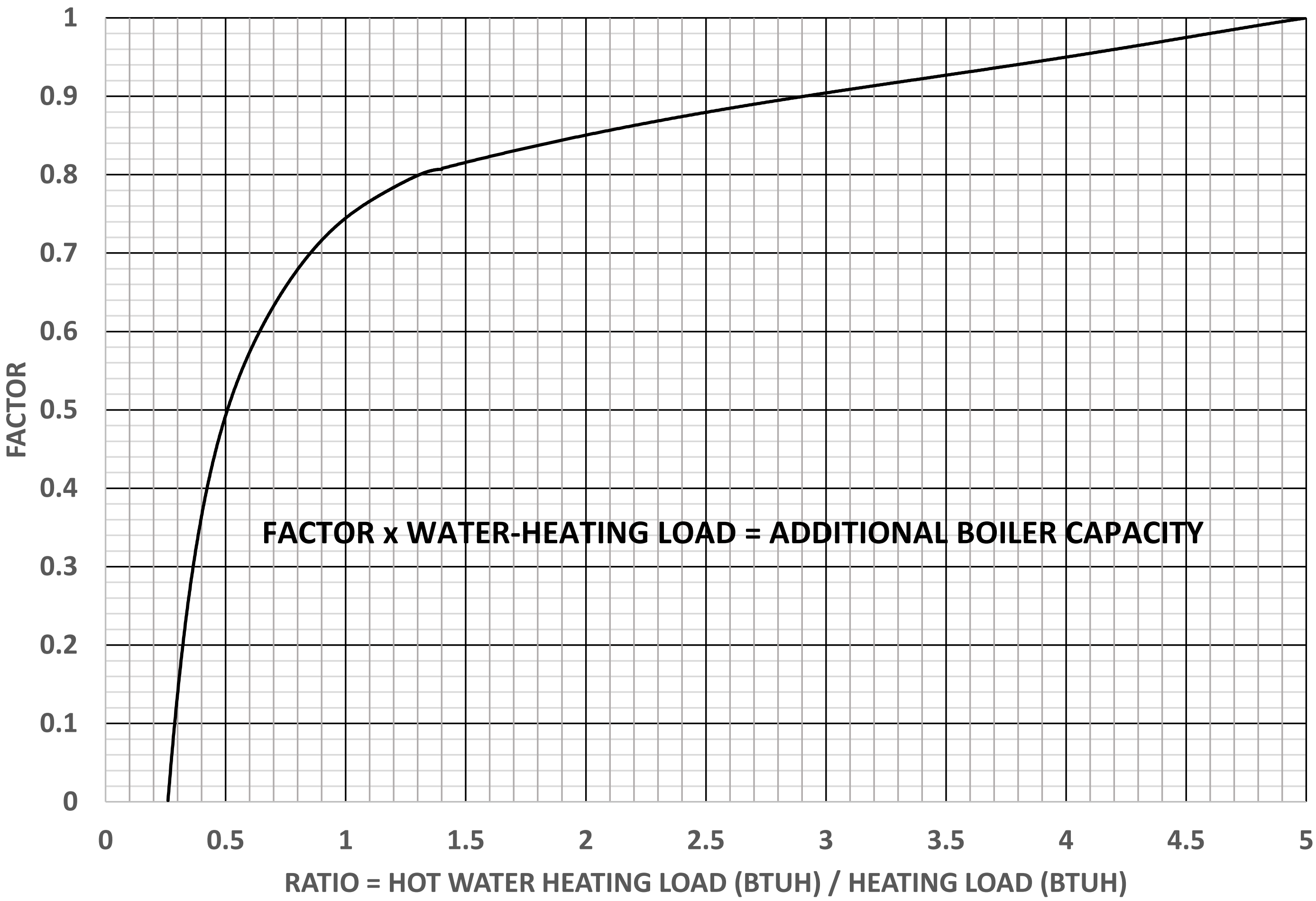
3 Water Piping *(continued)*



To use this Figure:
1. Enter the horizontal scale at the total Fixture Units obtained from Figure 3-14.
2. Move up vertically to the curve marked for the type of building.
3. Read the required service water flow rate on the vertical scale.

Figure 3-15: Service Hot Water Flow Rate

3 Water Piping *(continued)*



To use this Figure:
1. Calculate ratio of hot water heating load to heating load.
2. Enter horizontal scale and move upward to the curve .
3. Read hot water heating load factor on the vertical scale.
4. Multiply factor by the heating load to obtain the hot water "added boiler capacity."
5. Select boilers with total net rating equal to heating load plus hot water "added boiler capacity."

Figure 3-16: Sizing Factors for Combination Heating / Domestic Hot Water

4 Gas Piping

⚠ WARNING

- Failure to properly pipe gas supply to boiler may result in improper operation and damage to the boiler or structure. Always assure gas piping is absolutely leak free and if the proper size and type for the connected load. An additional gas pressure regulator may be needed. Consult gas supplier.
- Failure to use proper thread compounds on all gas connectors may result in leaks of flammable gas.
- Gas supply to boiler and system must be shut off prior to installing or servicing boiler gas piping.

4.1 General – Venting and water pipes are generally less flexible in design location than are gas pipes. To avoid conflicts for a given location, design and layout breeching ducts and water piping before proceeding with gas piping in this section.

4.2 Gas Piping Design and Layout – On a scaled drawing of the boiler room, locate the boilers as planned in Sections 1 and 2. Locate the gas meter on the drawing. Observe that the opening in the jacket for gas piping is on the top surface at the right side front corner. The gas connection to the gas train is inside the vestibule and on the right side approximately 11 $^1/_4$ in. above the floor.

4.2.1 Using Figures 4-1 and 4-2 decide on the simplest piping arrangement for the layout. The location of the gas meter in relation to the boilers has a large effect on the length and size of the gas piping. Long mains with many fittings should be avoided as the minimum pipe size required increases as the length of pipe and number of fittings increases. For this reason it is desirable to ask the gas supplier to set the gas meter as close to the boiler room as possible.

4.2.3 On the plans, draw the gas piping using the shortest possible route from meter to boilers while observing the need to keep passageways open around all boilers for servicing. It is highly recommended that the gas main be located horizontal, at the ceiling level of the boiler room, and directly over the front base line of the boilers. The branch lines from the main should be vertical and direct to the boilers.

4.2.4 On the plans, measure the total distance, including vertical runs, from the gas meter to the farthest boiler, and count the main fitting ells in that farthest run. (Straight flow through a tee is not counted as a fitting)

4.2.5 Obtain from the gas supplier the following information:

a. type of gas (natural or propane)
b. specific gravity
c.heating value

4.3 Gas Pipe Sizing – Series Connections

4.3.1 Table 4-3 may be used for sizing pipes and fittings if all of the following conditions are met:

a. the distance from the gas meter to the farthest boiler is no more than fifty feet and has no more than three ells, and
b. the maximum supply gas pressure at the meter is 0.5 psig, and
c. the maximum supply gas pressure drop is 0.3 inches water column, and

4.3.2 The procedure for sizing using Table 4-3 is as follows:

1. Total the Input MBH (from Table 2-3) of all boilers to be supplied by the gas pipe (and/or fitting) to be sized.
2. Locate this value in the left column.
3. Read the pipe and/or fitting size in the right column. Record this on the gas pipe drawing.
4. The size of individual boiler supply piping -A, and the manual valve-B, should be a minimum of 3/4 in. NPT.

Example #1: Six 806HE boilers are to be piped in line, similar to Figure 4-1, on natural gas. Size the piping:

1. A check of the conditions for this job shows the measured length of pipe from the gas meter to the farthest boiler is 45 ft. with 3 ells. The gas supplier says that his system will deliver 4224 cubic feet at 0.5 psig at the meter. Table 4-3 can be used.
2. The piping (D^6) between the gas meter and the first boiler take-off (C^6) serves six boilers. From Table 1-2, six 806HE boiler require 1794 MBH input.
3. Enter the left column in Table 4-3 with 1794 total input MBH, which falls between the figure values of 1320-1980.
4. Read across to the “Natural Gas” column and pick off a pipe/fitting size of 2 $^1/_2$ in. Record this on the gas pipe drawing as D^6.
5. The next piping segment, D^5, serves five boilers. 5 x 299 = 1495 MBH – Total Input thru D^5.
6. Enter Table 4-3 with 1495 Total Input MBH and again pick off a pipe/fitting size of 2 $^1/_2$ in. Record this as D^5.
7. In like manner:
   D^4 = 2 in. D^1, C^1 = 1 $^1/_4$ in.
   D^3 = 2 in.

4 Gas Piping *(continued)*

$D^2 = 1\ ^1/_2$ in.

8. Since all boilers require the same input MBH, $D^1 - 1^1/_4$ in. applies to the vertical drops to each boiler.
9. Record each boiler's supply piping (A) and manual valve (B) sizes as a minimum of 3/4 in. NPT.
10. By inspection the reducing tee fittings (C) in the horizontal gas line can be sized based on the adjacent pipe sizes.

    C^6 is between D^6 which is $2^1/_2$ in. and D^5 which is also $2^1/_2$ in. and feeds D^1 which is $1^1/_4$ in. Hence C^6 should be recorded on the drawing as $2^1/_2$ in. x $2\ ^1/_2$ in. x $1^1/_4$ in.
11. In like manner:

    $C^5 = 2\ ^1/_2 \times 2 \times 1\ ^1/_4$

    $C^4 = 2 \times 2 \times 1\ ^1/_4$

    $C^3 = 2 \times 1\ ^1/_2 \times 1\ ^1/_4$

    $C^2 = 1\ ½ \times 1\ ^1/_4 \times 1\ ^1/_4$
12. Record all pipe and fitting sizes on the gas pipe drawing for reference during installation.

4.4 Gas Pipe Sizing - Combination Parallel and Series Connections

4.4.1 If all of the conditions for using Table 4-3 are not met, the following procedure must be used to size gas piping:

1. Determine the total equivalent length of pipe from the meter to the farthest boiler by adding to the measured length the equivalent length of each fitting from Table 4-4. (Straight thru flow through a tee is not considered a fitting).
2. Determine the actual cubic feet of gas to be carried by the main segment by dividing the BTU requirement by the heating value of the gas.
3. Enter Table 4-5 under column for the total equivalent length of pipe as found in 1) above.
4. Read down until finding a number equal to or greater than the equivalent cubic feet from 3) above, which the main segment is required to carry.
5. Read across to the left hand column and pick off the minimum pipe size required.

Example #2: Six 806HE boilers are to be piped in line with propane from a tank source 115 feet from the gas meter to farthest boiler. Size the piping:

a. To the measured length of 115 ft. add the equivalent length of 8 ells x 10.1 ft/Ell for a total equivalent of 195.8 ft. (The factor of 10.1 comes from Table 4-4 under the column for ells at an estimated 4 in. main size.)

b. The actual cubic feet required in main D^6 is

<u>6 (boilers) x 299,000 (Btu/806HE)</u> = 1,794 ft^3/Hr

In a like manner the actual cubic feet required in the remaining main segments are found to be:

Flow D^5 = 5 x 299,000 = 1495 ft^3/Hr
Flow D^4 = 4 x 299,000 = 1196 ft^3/Hr
Flow D^3 = 3 x 299,000 = 897 ft^3/Hr
Flow D^2 = 2 x 299,000 = 598 ft^3/Hr
Flow D^1 = 1 x 299,000 = 299 ft^3/Hr

c. Enter Table 4-5 from the top at column marked 200 ft. of pipe. The length found in a) above was 195.8 ft. which is between column marked 175 and 200 ft. Use next larger of 200 ft.

d. Read down until finding a number equal to or greater than the equivalent cubic foot flow requirement found in c) above.

e. Read across to the left hand column and pick off the following required minimum pipe sizes:

Size D^6 = 4 in.
Size D^5 = 3 in.
Size D^4 = 3 in.
Size D^3 = 2½ in.
Size D^2 = 2 in.
Size D^1 = 1½ in.

f. D1 = 1½ in. becomes the vertical riser from each of the boilers to the overhead horizontal main.

g. Mark all pipe sizes on the plan for reference during installation.

4.5 Gas Pipe Installation

With boilers fully assembled, including jackets, install gas supply piping in accordance with the current edition of "National Fuel Gas Code" (ANSI Z223.1) and all requirements of the gas supplier and municipality.

4.5.1 Please consider the serviceman who must periodically clean and adjust the boilers, and repair accessories. Do not block passageways with piping. Do not block access panels on the boiler jackets.

4.5.2 Material – Use only Schedule 40 steel or wrought-iron pipe. Make sure all threads are fully formed and free of burrs. Threaded joints

4 Gas Piping *(continued)*

should be sealed with an approved compound to prevent leaks.

4.5.3 Traps – Install a trap similar to that shown in Figure 4-7 at the low end of the vertical run to each boiler.

4.5.4 Supports – Pipe supports should be installed according to Table 4-6. Supports should encircle the pipe at ceiling level but allow movement for expansion of the piping. The weight of the gas piping must not be placed upon the gas connection.

4.5.5 Grounding – Gas piping must be grounded. If any non-conductive fittings are used they must be bridged with an appropriately sized ground wire.

DANGER

Explosion Hazard.
Do not use matches, candles, open flames or other ignition sources to check for leaks. Failure to comply could result in severe personal injury, death or substantial property damage.

4.5.6 Pressure Test - Gas lines must be pressure tested before placing boilers in operation. Follow National Fuel Gas Code, ANSI Z223.1/NFPA 54.

4.6 Gas Piping Maintenance – Piping should be inspected annually or after any extended shut down period.

4.6.1 Any pipe or fitting showing unusual rust or corrosion should be replaced.

4.6.2 Gas piping should not be used as an electrical conductor. Relocate any electrical circuit which is found to be using the gas piping as a conductor.

4.6.3 Gas piping should not be used to support any other pipe or heavy object. Find other means to support any such heavy object.

4 Gas Piping *(continued)*

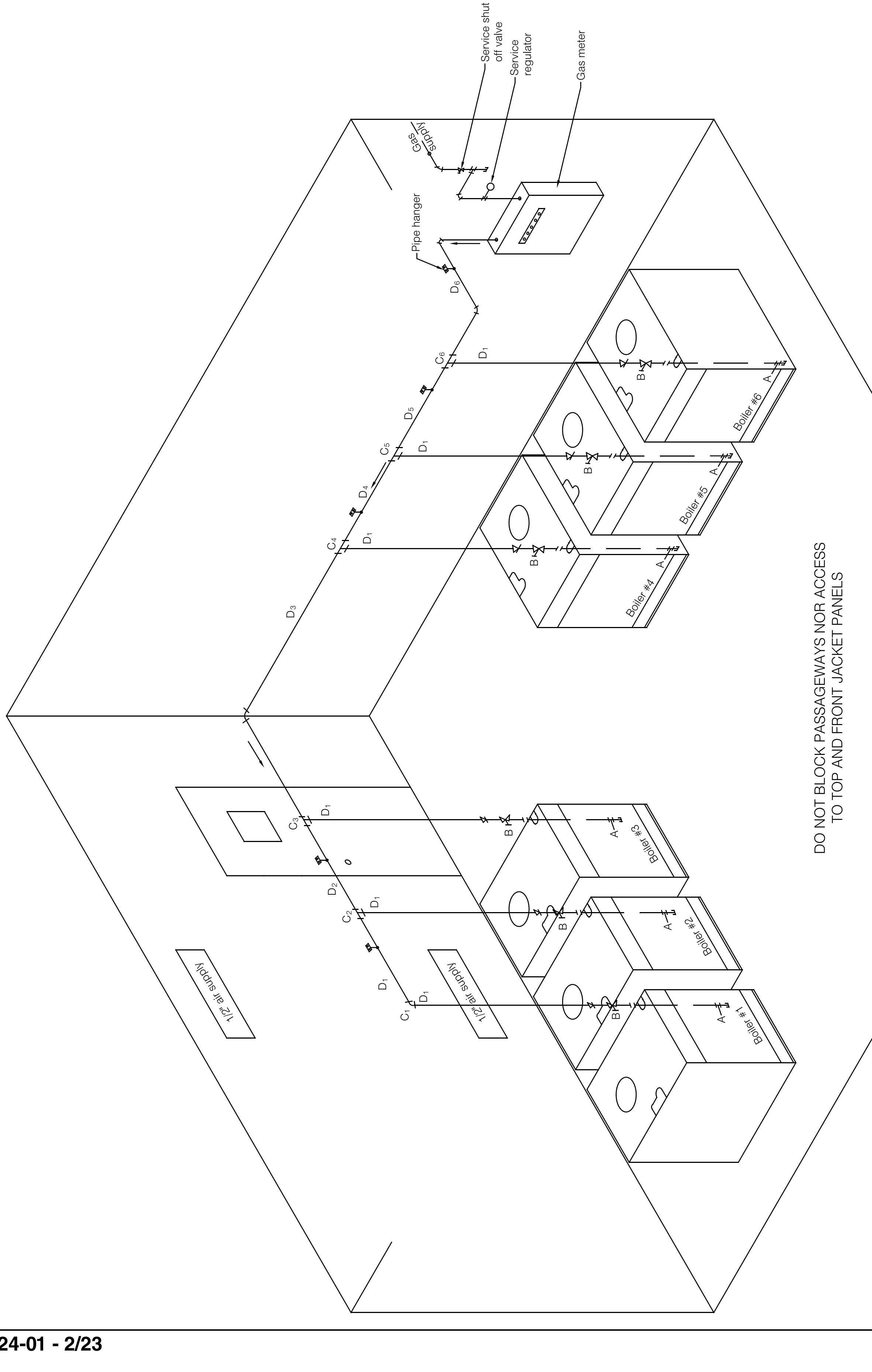


Figure 4-1: Gas Supply Piping - 1 through 6 Series Connections (all piping shown supplied by installer)

4 Gas Piping *(continued)*

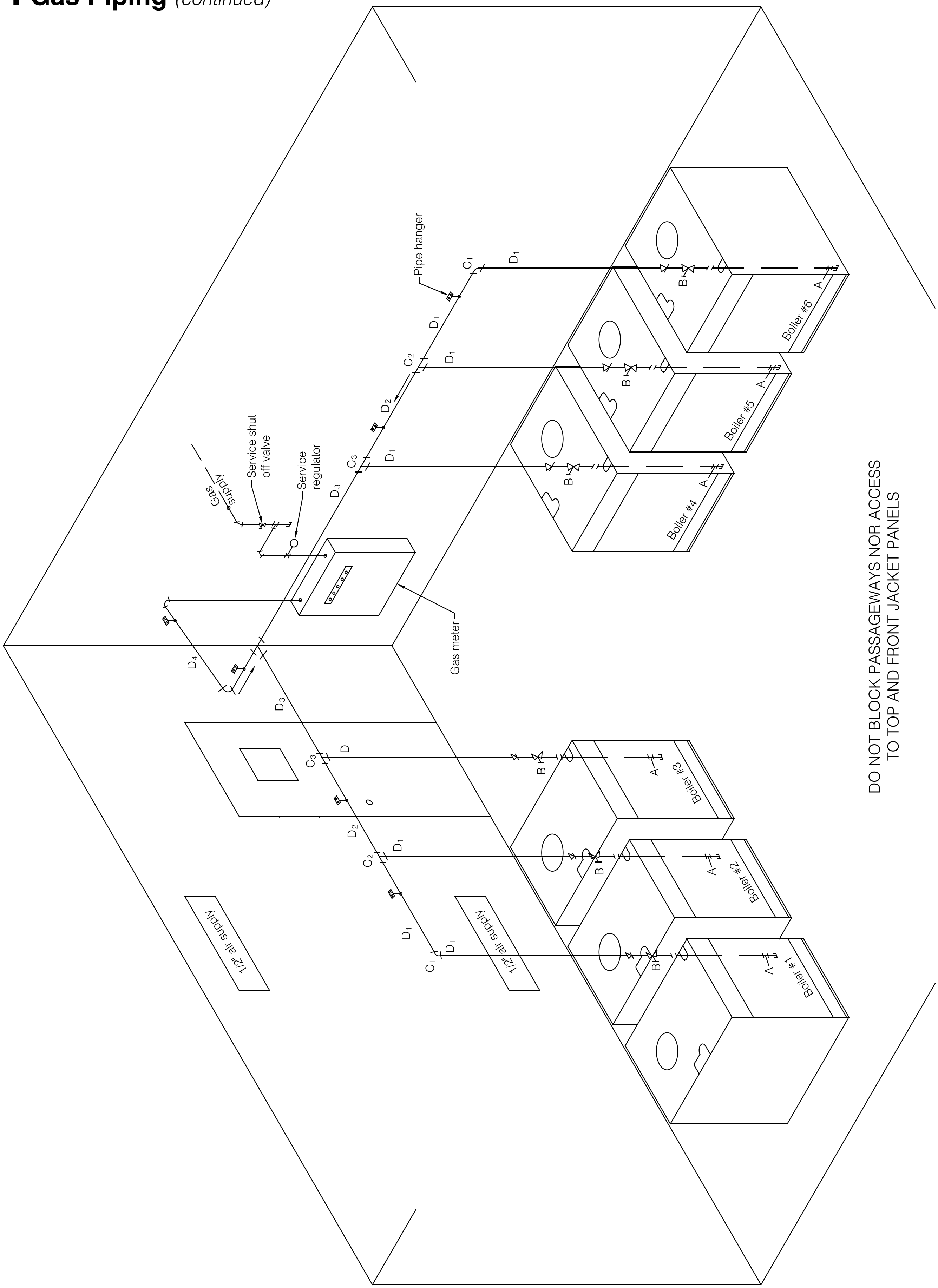


Figure 4-2: Gas Supply Piping - Combination Parallel and Series Connections (all piping shown supplied by installer)

4 Gas Piping *(continued)*

NOTICE:

Use this table only if all of the following conditions are met:

1. 50 ft. maximum plus 3 ells from Meter to furthest Boiler Gas Connection
2. 0.5 PSIG Maximum Gas Pressure
3. 0.3 Inch Water Column Pressure Drop

Otherwise, refer to the Alternate Method of Gas Pipe Sizing in 4.4.

Table 4-3:

Total Input MBH of Boiler(s) Served by Pipe/Fitting	Pipe/Fitting Size (NPT)
	Natural Gas
264. - 330.	1¼ in.
396.	1¼ in.
462. - 660.	1½ in.
726. - 990.	2 in.
1056. - 1254.	2 in.
1320. - 1980.	2½ in.

To use this table:
1. Total the Input MBH (from Figure 2-3) of all boilers to be supplied by the gas pipe (and/or fitting) to be sized.
2. Locate this Total MBH in the left column
3. Move to the right to the appropriate gas column
4. Read the pipe and/or fitting size.

Table 4-4: Equivalent Length of Fitting and Valves - Gas Pipe (ft.)

Nominal Pipe Size, In.	Inside Dia., Schedule 40, In.	Screwed Fittings				Valves (screwed, flanged, or welded)			
		45° Ell	90° Ell	180° Close Return Bends	Tee	Gate	Globe	Angle	Swing Check
½	0.622	0.73	1.55	3.47	3.10	0.36	17.3	8.65	4.32
¾	0.824	0.96	2.06	4.60	4.12	0.48	22.9	11.4	5.72
1	1.019	1.22	2.62	5.82	5.24	0.61	29.1	14.6	7.27
1¼	1.380	1.61	3.45	7.66	6.90	0.81	38.3	19.1	9.58
1½	1.610	1.88	4.02	8.95	8.04	0.94	44.7	22.4	11.2
2	2.067	2.41	5.17	11.5	10.3	1.21	57.4	28.7	14.4
2½	2.469	2.88	6.16	13.7	12.3	1.44	68.5	34.3	17.1
3	3.068	3.58	7.67	17.1	15.3	1.79	85.2	42.6	21.3
4	4.026	4.70	10.1	22.4	20.2	2.35	112	56.0	28.0
5	5.047	5.88	12.6	28.0	25.2	2.94	140	70.0	35.0

To use this table:
1. Enter left hand column at required pipe size.
2. Move to the right to the right to the column for the type of fitting.
3. Read the equivalent length of straight pipe for that one fitting.
4. Total the equivalent length for every fitting in the supply line.
5. Add the total equivalent length for fittings to the measured length of straight pipe to obtain the equivalent length of the supply line.

4 Gas Piping *(continued)*

Table 4-5: Maximum Capacity of Pipe (ft^3/HR)

Nominal Iron Pipe Size, In.	Internal Dia., In.	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	.364	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	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	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	3.068	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

(Based on gas pressure at 0.5 psig., pressure drop of 0.3 in. water column, and 0.60 specific gravity.)

To use this table: (1) Enter the top row at the total equivalent length of pipe obtained from 4.4.1 - 1). (2) Move down to the equivalent gas flow obtained from 4.4.1 - 3). (3) Move across to the left hand column. (4) Read the required pipe size.

4 Gas Piping *(continued)*

Table 4-6: Support of Piping

Size of Pipe (Inches)	Spacing of Supports (Feet)
½	6
¾ or 1	8
1¼ or larger (horizontal)	10
1¼ or larger (vertical)	Every floor level

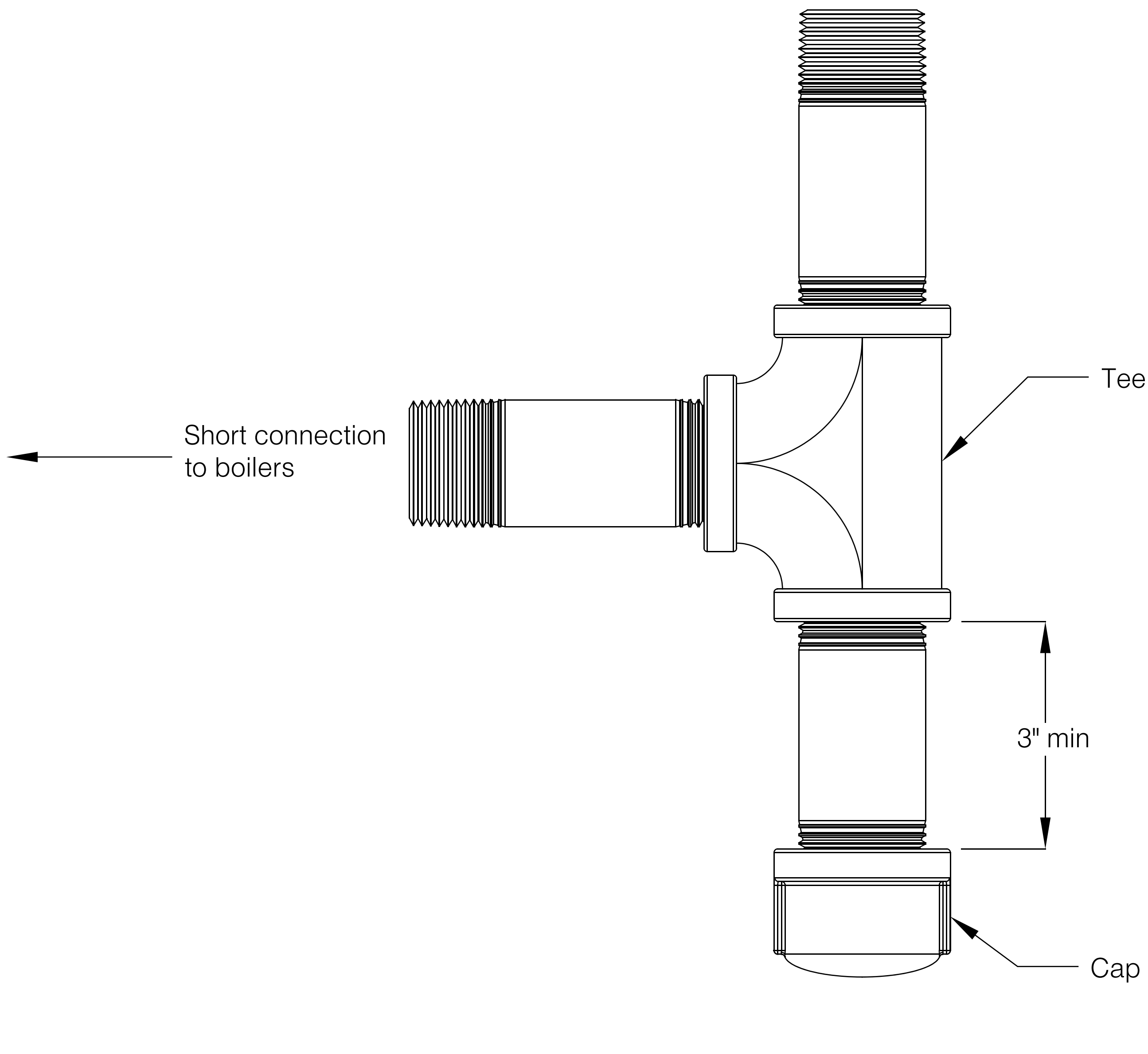


Figure 4-7: Moisture and Dirt Trap for Gas Supply to Each Boiler

5 Controls

⚠ WARNING

Do not bypass any boiler safety or operating controls. See boiler IO&S Instructions for boiler controls and wiring information.

5.1.1 Install multi-stage boiler control(s). Follow all control manufacturers' instructions. Manufacturers of multi-stage boiler controls include Tekmar, Heat-Timer and Argo.

5.1.2 For installations venting 5 or more boilers into a single vent system, recommend staging boilers to fire minimum of 2 boilers simultaneously to avoid the potential of flue gas condensation in the vent system. See also Section 2 - Venting.

If multi-stage control does not provide option to fire minimum of 2 boilers simultaneously, use relays to group boilers in pairs or groups of three. It is not recommended to directly pair thermostat connections due to potential interference between the transformers in the boiler HydroStat controls. See example in Figure 5.1.

Note – HydroStat Economy and Thermal Pre-Purge features may not allow boilers to operate exactly simultaneously, but operation will still be similar. HydroStat settings are also adjustable.

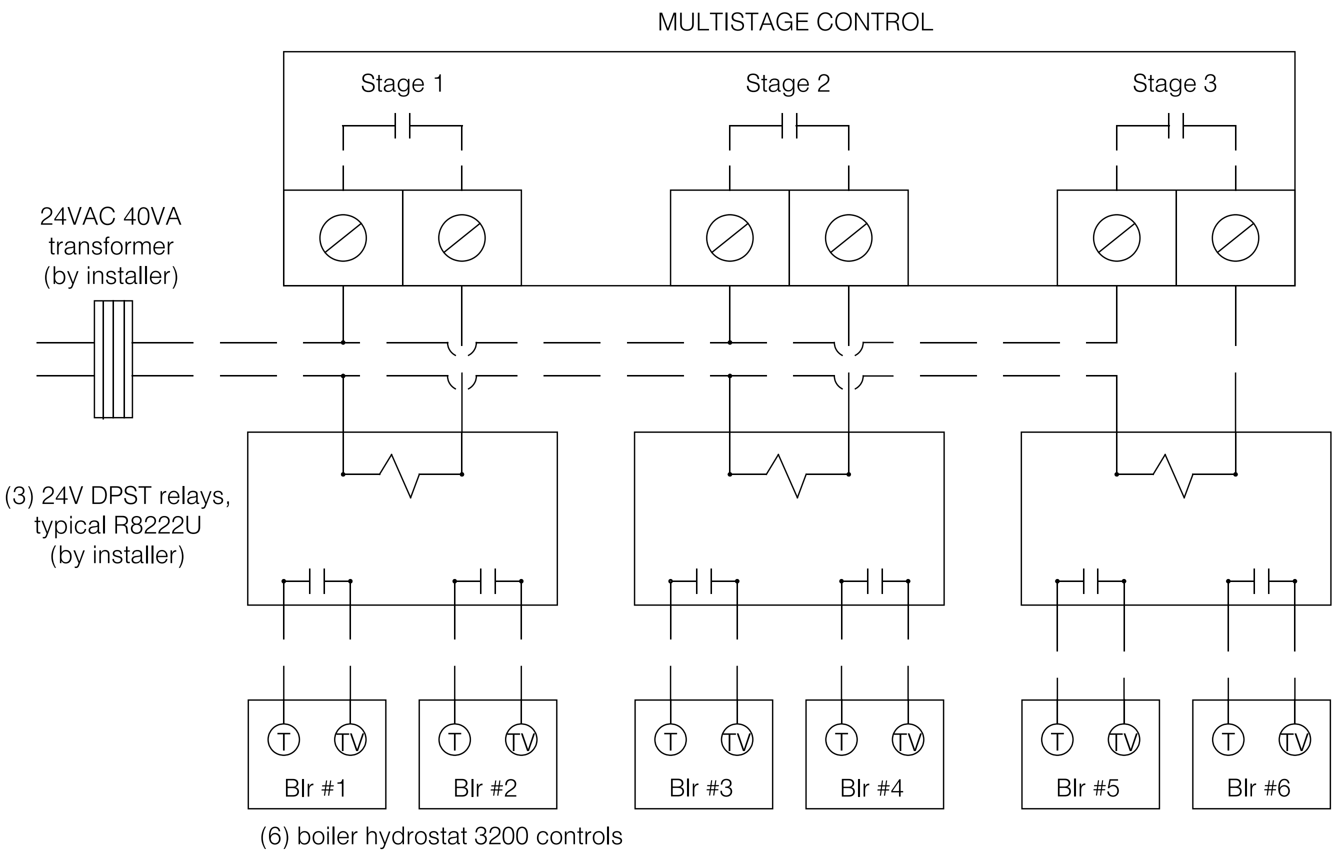


Figure 5-1: Example - Using 24V Relays to Pair Boilers