INSTALLATION, OPERATING AND SERVICE INSTRUCTIONS FOR

SOLARIS Gas-Fired Boiler

For service or repairs to boiler, call your heating contractor. When seeking information on boiler, provide Boiler Model Number and Serial Number as shown on Rating Label.		
Boiler Model Number SOL__ __ __ __ - __ __ __	Boiler Serial Number 6 __ __ __ __ __ __ __	Installation Date
Heating Contractor		Phone Number
Address		

THERMAL SOLUTIONS
Innovative Equipment for Hot Water Systems

814SOL0010R3-3/15

Price - $5.00

IMPORTANT INFORMATION - READ CAREFULLY

NOTE: The equipment shall be installed in accordance with those installation regulations enforced in the area where the installation is to be made. These regulations shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made.

All wiring on boilers installed in the USA shall be made in accordance with the National Electrical Code and/or local regulations.

All wiring on boilers installed in Canada shall be made in accordance with the Canadian Electrical Code and/or local regulations.

The Commonwealth of Massachusetts requires this product to be installed by a licensed Plumber or Gas Fitter.

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

DANGER

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

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury or property damage.

WARNING

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

NOTICE

Indicates specific instructions on installation, operation, or maintenance 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 vapors, DO NOT try to operate any appliance - DO NOT touch any electrical switch or use any phone in the building. Immediately, call the gas supplier from a remotely located phone, Follow the gas supplier's instructions or if the supplier is unavailable, contact the fire department.

Manufacturer's Contact Information:
Thermal Solutions
1175 Manheim Pike
Lancaster, PA 17601
717-239-7642
www.thermalsolutions.com

WARNING
This boiler requires regular maintenance and service to operate safely. Follow the instructions contained in this manual.
Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Read and understand the entire manual before attempting installation, start-up operation, or service. Installation and service must be performed only by an experienced, skilled, and knowledgeable installer or service agency.
This boiler must be properly vented.
This boiler needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
The interior of the venting system must be inspected and cleaned before the start of the heating season and should be inspected periodically throughout the heating season for any obstructions. A clean and unobstructed venting system is 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.
Installation is not complete unless a pressure relief valve is installed into the tapping located on top of appliance. - See the Water Piping and Trim Section of this manual for details.
This boiler is supplied with safety devices which may cause the boiler to shut down and not restart 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 contains 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.
Boiler 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.
Failure to follow all instructions in the proper order can cause personal injury or death. Read all instructions, including all those contained in component manufacturers manuals which are provided with the boiler before installing, starting up, operating, maintaining or servicing.
Keep boiler area clear and free from combustible materials, gasoline and other flammable vapors or liquids.
All cover plates, enclosures and guards must be in place at all times.
This product must be installed by a licensed plumber or gas fitter when installed within the Commonwealth of Massachusetts.

NOTICE
This boiler has a limited warranty, a copy of which is printed on the back of this manual. It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when the installation is complete.

Table of Contents

Minimum Clearance to Combustible Materials					
Left Side	Right Side	Front	Rear	Top	Flue Connector
1”	1”	24”	3”	1”	6”

Recommended Clearance for Service				
Model	Left Side or Right Side	Front	Rear	Top
SOL-500	24”	24”	36”	16”
SOL-750	24”	24”	36”	16”
SOL-1000	24”	24”	36”	19”
SOL-1250	24”	24”	36”	31”
SOL-1500	24”	24”	36”	31”

Note: Verify clearance with jurisdiction having authority and local codes.

Net AHRI Ratings

1. The Net AHRI Water Ratings shown are based on a piping and pickup allowance of 1.15.
2. The manufacturer should be consulted before selecting a boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc.
3. The ratings have been determined under the provisions governing forced draft boiler-burner units.

Boiler Model Number	AHRI CERTIFIED® www.ahridirectory.org			CAPACITIES					
	INPUT (MBH)	GROSS OUTPUT (MBH)	NET AHRI RATING (MBH)[1]	WATER VOLUME (Gallons)	DRY WEIGHT (lbs.)	WET WEIGHT (lbs.)	ELECTRICAL SUPPLY (Voltz/Hertz/Phase)	RATED MOTOR HORSE POWER (HP)	RATED BLOWER AMP DRAW (Amps)
SOL-500	500	407	354	1.3	316.0	326.8	120/60/1	3/4	8.5
SOL-750	750	626	544	2.4	508.5	528.5		3/4	8.0
SOL-1000	1,000	821	714	2.6	548.5	570.2		3/4	8.0
SOL-1250	1,250	1,039	903	2.9	620.0	644.2		1-1/8	12
SOL-1500	1,500	1,261	1,097	3.3	713.0	740.5		1-1/8	12

1. See notes concerning Net AHRI Ratings on page 4.

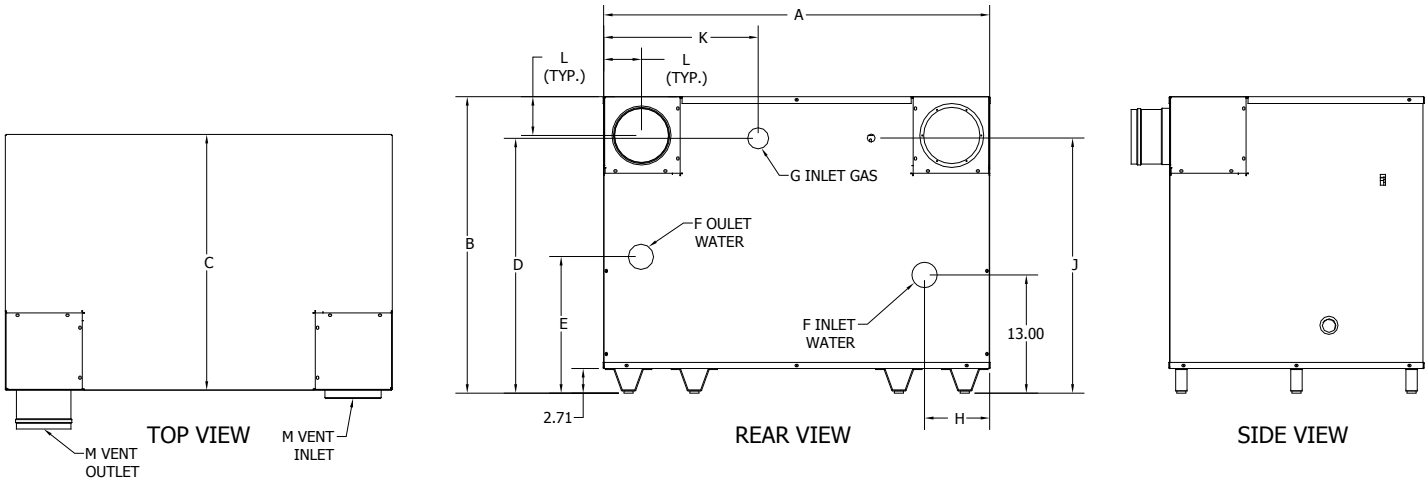


Figure 1: Dimensions

Boiler Model	Dimensions (inches)											
	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'J'	'K'	'L'	'M'
SOL-500	42.6	32.6	28.1	28.0	15.0	2.0	1.00	7.2	27.8	17.0	4.1	6.0
SOL-750	41.4	36.9	31.8	32.4	13.0	3.0	1.00	3.5	32.1	23.6	6.2	8.0
SOL-1000	49.4	36.9	31.8	32.4	13.0	3.0	1.25	3.5	32.1	21.6	6.2	8.0
SOL-1250	61.6	36.9	31.8	32.4	13.0	3.0	1.25	3.5	32.1	26.5	6.2	10.0
SOL-1500	73.9	36.9	31.8	32.4	13.0	3.0	1.50	3.5	32.1	25.6	6.2	10.0

I. Pre-Installation

WARNING

If you do not follow these instructions exactly, a fire or explosion may result causing property damage or personal injury.

DANGER

Do not install boiler where gasoline or other flammable vapors or liquids, or sources of hydrocarbons (i.e. bleaches, cleaners, chemicals, sprays, paint removers, fabric softeners, etc.) are used or stored.

NOTICE

Due to the low water content of the boiler, mis-sizing of the boiler with regard to the heating system load will result in excessive boiler cycling and accelerated component failure. Thermal Solutions DOES NOT warrant failures caused by mis-sized boiler applications. DO NOT oversize the boiler to the system. Modular boiler installations greatly reduce the likelihood of boiler oversizing.

A. Installation must conform to the requirements of the authority having jurisdiction. In the absence of such requirements, installation must conform to the *National Fuel Gas Code*, NFPA 54/ANSI Z223.1, and/or CAN/CGA B149 Installation Codes. Where required the installation must conform to the standard for controls and safety devices for automatically fired boilers, ANSI/ASME CSD-1.

B. Appliance is design certified for installation on combustible flooring. Do not install boiler on carpeting.

C. Provide clearance between boiler jacket and combustible material in accordance with local fire ordinance. Refer to Figure 1 for minimum listed clearance from combustible material. Recommended service clearance is 24 inches from left side, right side and front. Recommended service clearance is 36" at rear of unit. Service clearances may be reduced to minimum clearances to combustible materials.

D. Install on level floor. Floor must be able to support weight of boiler, water and all additional system components.

E. Protect gas ignition system components from water (dripping, spraying, rain, etc.) during boiler operation and service (circulator replacement, condensate trap, control replacement, etc.).

F. Provide combustion and ventilation air in accordance with sections 5.3 of the National Fuel Gas code, ANSI Z223.1/NFPA 54, or sections 7.2, 7.3, or 7.4 of CAN/CSA B149.1, Natural Gas and Propane Installation code, or applicable provisions of the local building codes.

WARNING

Adequate combustion and ventilation air must be provided to assure proper combustion.

The following guideline is based on the *National Fuel Gas Code*, NFPA 54/ANSI Z223.1.

1. Determine volume of space (boiler room). Rooms communicating directly with space (through openings not furnished with doors) are considered part of space.

   Volume [ft³] = Length [ft] x Width [ft] x Height [ft]

2. Determine Total Input of all appliances in space. Round result to nearest 1,000 Btu per hour (Btuh).

3. Determine type of space. Divide Volume by Total Input.

   a. If result is greater than or equal to 50 ft³ per 1,000 Btuh, space is considered an *unconfined space*.

   b. If result is less than 50 ft³ per 1,000 Btuh, space is considered a *confined space*.

4. Determine building type. A building of *unusually tight construction* has the following characteristics:

   a. Walls and ceiling exposed to outside atmosphere have a continuous water vapor retarder with a rating of 1 perm or less with openings gasketed and sealed, and;

   b. Weather-stripping has been added on openable windows and doors, and;

   c. Caulking or sealants applied in joints around window and door frames, between sill plates and floors, between wall-ceiling joints, between wall panels, at plumbing and electrical penetrations, and at other openings.

5. For boiler located in an *unconfined space in a building of other than unusually tight construction*, adequate combustion and ventilation air is normally provided by fresh air infiltration through cracks around windows and doors.

6. For boiler located within *unconfined space in building of unusually tight construction*, or within equate *confined space,* provide outdoor air through two permanent openings which communicate directly or by duct with the outdoors or spaces (crawl or attic) freely communicating with the outdoors. Locate one opening within twelve (12) inches of top of space. Locate remaining opening within twelve (12) inches of bottom of space. Minimum dimension of air opening is three (3) inches. Size each opening per following:

   a. Direct communication with outdoors. Minimum free area of one (1) square inch per 4,000 Btu per hour input of all equipment in space.

   b. Vertical ducts. Minimum free area of one (1) square inch per 4,000 Btu per hour input of all equipment in space. Duct cross-sectional area shall be same as opening free area.

   c. Horizontal ducts. Minimum free area of one (1) square inch per 2,000 Btu per hour input of all equipment in space. Duct cross-sectional area shall be same as opening free area.

   Alternate method for boiler located within confined space: Use indoor air if two permanent openings communicate directly with additional space(s) of sufficient volume such that combined volume of all spaces meet criteria for unconfined space. Size each opening for minimum free area of one (1) square inch per 1,000 Btu per hour input of all equipment in spaces, but not less than 100 square inches.

7. Combustion Air/Ventilation Duct Louvers and Grilles. Equip outside openings with louvers to prevent entrance of rain and snow, and screens to prevent entrance of insects and rodents. Louvers and grilles must be fixed in open position or interlocked with equipment to open automatically before burner operation. Screens must not be smaller than ¼ inch mesh.

   Consider the blocking effect of louvers, grilles and screens when calculating the opening size to provide the required free area. If free area of louver or grille is not known, assume wood louvers have 20-25 percent free area and metal louvers and grilles have 60-75 percent free area.

CAUTION

Avoid operating this boiler in an environment where saw dust, loose insulation fibers, dry wall dust, etc. are present. If boiler is operated under these conditions, the burner interior and ports must be cleaned and inspected daily to ensure proper operation.

II. Unpack Boiler

CAUTION

Do not drop boiler. Do not bump boiler jacket against the floor.

A. Move boiler to approximate installed position.

B. Remove all crate fasteners.

C. Lift and remove outside container. Save two of the wooden slats from the container sleeve for use in Steps E and F.

D. Remove all boiler hold-down fasteners.

WARNING

Installation of this boiler should be undertaken only by trained and skilled personnel from a qualified service agency.

E. Tilt the boiler to its front side or back side and slide a wooden slat under the raised feet.

F. Tilt the boiler in the opposite direction and slide another wooden slat under the raised feet.

G. Slide the boiler left or right off the skid using the two wooden slats as runners.

H. Move boiler to its permanent location.

III. Venting / Air Intake Piping

WARNING
Do not use this boiler with galvanized, non metallic or any other venting material that is not designed for condensing flue gas applications.
Do not use a drafthood with this appliance.
Do not use vent dampers with this boiler.
Moisture and ice may form on surfaces around termination. To prevent deterioration, surfaces should be in good repair (sealed, painted, etc.).
This appliance needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
Do not reduce size of air intake pipe.
Read, understand and follow combustion air instruction restrictions contained in the Pre-Installation instructions of this manual.
Do not operate appliance where gasoline or other flammable vapors or liquids, or sources of hydrocarbons (i.e. bleaches, cleaners, chemicals, sprays, paint removers, fabric softeners, etc.) are used, stored and/or present in the air.
When installing vent pipe through chimney, no other appliance can be vented into the chimney.
Do not exceed maximum vent/air intake lengths. Refer to Table 0.
Use of cellular core PVC (ASTM F891), cellular core CPVC, or Radel® (polyphenolsulfone) in venting systems is prohibited.

A. Vent Guidelines Due to Removal of an Existing Boiler

For installations not involving the replacement of an existing boiler, proceed to Step B.

When an existing boiler is removed from a common venting system, the common venting system is likely to be too large for proper venting of the remaining appliances. At the time of removal of an existing boiler, the following steps shall be followed with each appliance remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common venting system are not in operation:

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, and other deficiencies which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected to the common venting system. Turn on any exhaust fans, such as range-hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Place in operation the appliance being inspected. Follow the Lighting (or Operating) Instructions. Adjust thermostat so appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after five (5) minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fire place dampers and any other gas burning appliance to their previous conditions of use.
7. Any improper operation of the common venting system should be corrected so the installation conforms with the *National Fuel Gas Code*, NFPA 54/ANSI Z223.1 and/or CAN/CSA B149.1 Natural Gas and Propane Installation Code. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Part 11 of the *National Fuel Gas Code*, ANSI Z223.1/NFPA 54 and/or CAN/CSA B149.1 Natural Gas and Propane Installation Code.

B. General Guidelines

1. Vent system installation must be in accordance with Part 7, Venting of Equipment of the National Fuel Gas Code, ANSI Z223.1/NFPA 54, or Section 7, Venting Systems and Air Supply for Appliances of the CAN/CSA B149.1, Natural Gas and Propane Installation Code, or applicable provisions of the local building codes.

2. Contact local building or fire officials about restrictions and installation inspection in your area.

3. Refer to the appropriate drawings in this section of this manual to determine the proper configuration of venting system (Figures 2 thru 11). The vent system shall be installed in accordance with the instructions listed in this manual.

4. This appliance requires a Special Gas Vent. The product is designed to use AL 29-4C® Stainless Steel or other Stainless Steel material approved for condensing flue gas applications. The boilers are shipped with an AL 29-4C® vent adapter to directly connect to Heat Fab Saf-T-Vent. The use of alternate manufacturer's venting systems will require adapters. These adapters are not supplied with this unit and should be obtained from the supplier of the alternate venting system.

5. The venting system must be installed so as to prevent accumulation of condensate. Horizontal vent pipe must maintain a minimum ¼ inch per foot slope down towards boiler.

   a. Do not manifold condensate drains.

   b. A common condensate sump/pump may be used. Run separate condensate piping from each vent drain to the sump. A common drain may be used to discharge condensate from the sump.

      Consult sump/pump manufacturer for compatibility of materials of construction with flue gas condensate. If a common sump/pump is used, individual vent drain lines must be connected such that one drain pipe cannot back feed into another vent drain.

   c. Consult local authorities regarding disposal of flue gas condensate into public waste water system. Some jurisdictions require that the condensate be buffered before discharge. This buffering is commonly achieved by draining the condensate through a limestone bed. Consult chemical treatment company for buffering systems.

6. Use noncombustible ¾ inch pipe strap to support horizontal runs and maintain vent location and slope while preventing sags in pipe. Do not restrict thermal expansion or movement of vent system. Maximum support spacing is five (5) feet. Do not penetrate any part of the vent system with fasteners.

7. Vent length restrictions are based on equivalent length of vent/air pipe (total length of straight pipe plus equivalent length of fittings). Maximum vent/air lengths are listed in Table 0. Do not exceed maximum vent/air intake lengths. Refer to vent manufacturer's recommendations for the equivalent length of fittings.

Table 0: Vent & Air Intake Length

	Vent/Air Intake		
	Min	Max	Pipe Dia.
Boiler Model	ft.	ft.	In.
SOL-500	5	78	6
SOL-750	5	50	8
SOL-1000	5	50	8
SOL-1250	5	50	10
SOL-1500	5	50	10

8. Provide and maintain vent pipe minimum clearances to combustible materials. Vent pipe minimum clearance to combustible material is four (4) inches when vent is installed in a fully enclosed (chase) application or three (3) inches when vent is installed with at least one side open, similar to a joist bay application. Use double wall thimble when penetrating a combustible wall. Some examples of Wall thimble manufactures are American Metal Products, Hart & Cooley, and Metal Fab.

9. Do not install venting system components on the exterior of the building except as specifically required by these instructions. The vent termination location is restricted as follows:

   a. The minimum distance from adjacent public walkways, adjacent buildings, openable windows and building openings shall not be less than those values specified in the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CAN/CSA B149.1, Natural Gas and Propane Installation Code.

   b. Minimum twelve (12) inches above grade plus normally expected snow accumulation level, or seven (7) feet above grade if located adjacent to public walkway. Do not install over public walkway where local experience indicates appliance flue gas vapor or condensate creates a nuisance or hazard.

   c. Minimum three (3) feet above any forced air inlet located within ten (10) feet.

   d. Power Vent - Minimum four (4) feet below, four (4) feet horizontally from, or four (4) feet above any door, window, or gravity air inlet.

e. Minimum of four (4) feet horizontally from, and in no case above or below, unless a 4 foot horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment. This distance may be reduced if equipment is protected from damage due to condensation or vapor by enclosure, overhangs, etc.

f. Minimum twelve (12) inches from overhang or corner of building.

g. The vent termination shall be located such that no damage to building materials will occur from flue gasses degradation.

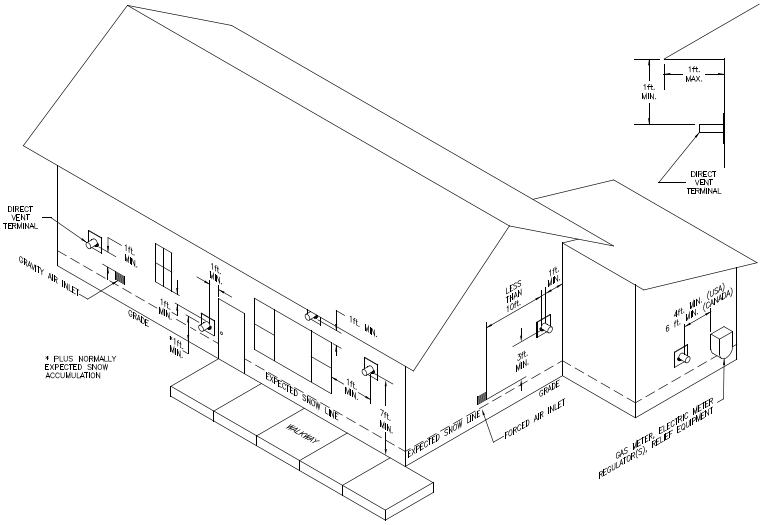


Figure 2: Vent Terminal Location

NOTICE

Cut must be square with pipe and filed or sanded smooth before joining. Carefully ensure roundness of cut pipe by hand with gloves before installing. Seal joint with RTV specified in this manual.

10. Enclose vent passing through occupied or unoccupied spaces above the boiler with material having a fire resistance rating of at least equal to the rating of the adjoining floor or ceiling. Maintain minimum clearances to combustible materials. See page 4.

11. Plan venting system to avoid possible contact with plumbing or electrical wires. Start at vent connector at rear of boiler and work towards vent terminal.

12. Once a vent pipe manufacturer and system is chosen never mix and match vent systems.

13. Field Supplied Vent Terminations (One per boiler)
    a. Horizontal - Use Saf-T Vent mitered termination with screen or equivalent

    b. Vertical - Use Saf-T Vent rain cap or equivalent

C. Supplemental Instructions (Massachusetts Code Only)

The Commonwealth of Massachusetts requires compliance with regulation 248 CMR 4.00 and 5.00 for installation of side-wall vented gas appliances as follows:

a. For all side wall horizontally vented gas fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. INSTALLATION OF CARBON MONOXIDE DETECTORS. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building, or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.
   a. In the even that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
   b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.
2. APPROVED CARBON MONOXIDE DETECTORS. Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.
3. SIGNAGE. A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, **"GAS VENT DIRECTLY BELOW, KEEP CLEAR OF ALL OBSTRUCTIONS".**
4. INSPECTION. The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection,

the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

b. EXEMPTIONS: The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:
1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the board; and
2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

c. MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED. When the manufacturer of Product Approved side wall horizontally vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:
1. Detailed instructions for the installation of the venting system design or the venting system components; and
2. A complete parts list for the venting system design or venting system.

d. MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED. When the manufacturer of a Product Approved side wall horizontally vented gas fueled equipment does not provide the parts for venting the flue gasses, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:
1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

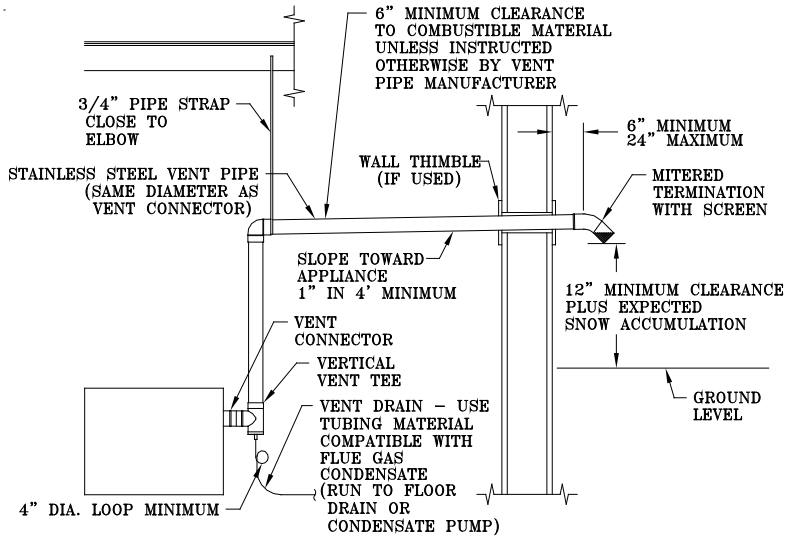


Figure 3: Side Top Vent

e. A copy of all installation instructions for all Product Approved side wall horizontally vented gas fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

D. Separate Horizontal Venting System. See Figures 3, 4 and 5.

1. Vent Piping –
   a. Do not exceed maximum vent/air intake lengths. Refer to Table 0.
   b. Recommended horizontal installation consists of vent being sloped down ¼ inch per foot toward boiler.
   c. Use appropriately designed thimbles when passing through combustible walls (thimble use optional for noncombustible walls). Insert thimble through wall from outside. Secure outside flange to wall with nails or screws, and seal ID, OD and vent holes with sealant material. Install inside flange to inside wall, secure with nails or screws, and seal with sealant material.
   d. For noncombustible wall application when thimble is not used, size opening such that bell with locking band attached cannot pass through.
   e. Join vent terminal to vent pipe. Locate vent pipe such that vent terminal is between six (6) inches and twenty-four (24) inches from wall when joined to inside vent piping. See Figure 3 or 4.
   f. Insert vent pipe through thimble/opening from outside and join to vent system. Apply sealant between vent pipe and opening/thimble to provide weathertight seal.
2. Side Vent Installation. See Figure 5.
   a. Horizontal vent/air intake runs with no vertical rise in piping allowed.
   b. Do not exceed maximum vent/air intake lengths. Refer to Table 0.
   c. Recommended Horizontal Installation only consists of vent/air intake sloped down 1/4 inch per foot toward termination.
   d. Refer to items c, d, e, and f above in section D.1

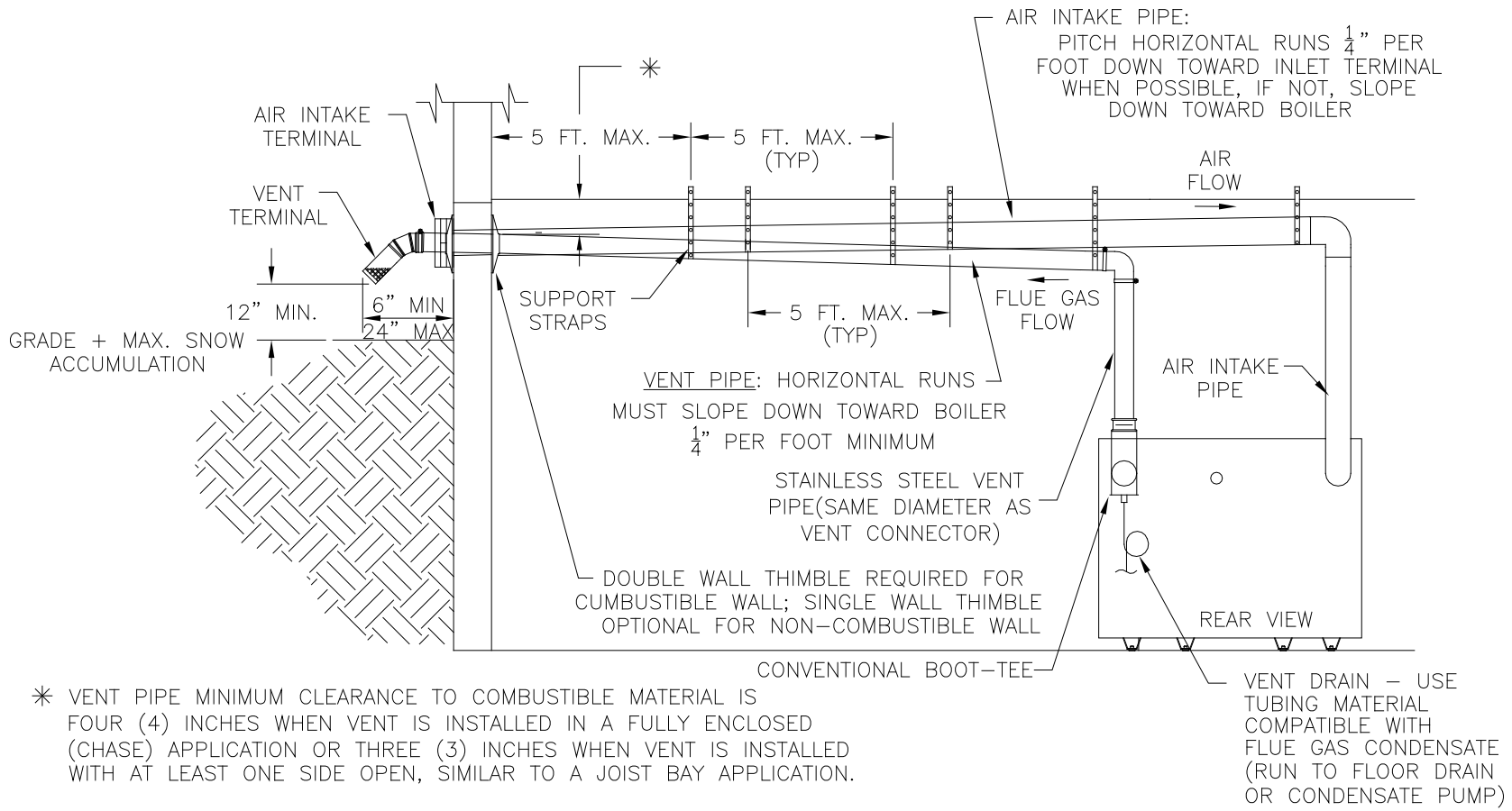


Figure 4: Recommended Separate Horizontal - Vent/Air Intake Installation

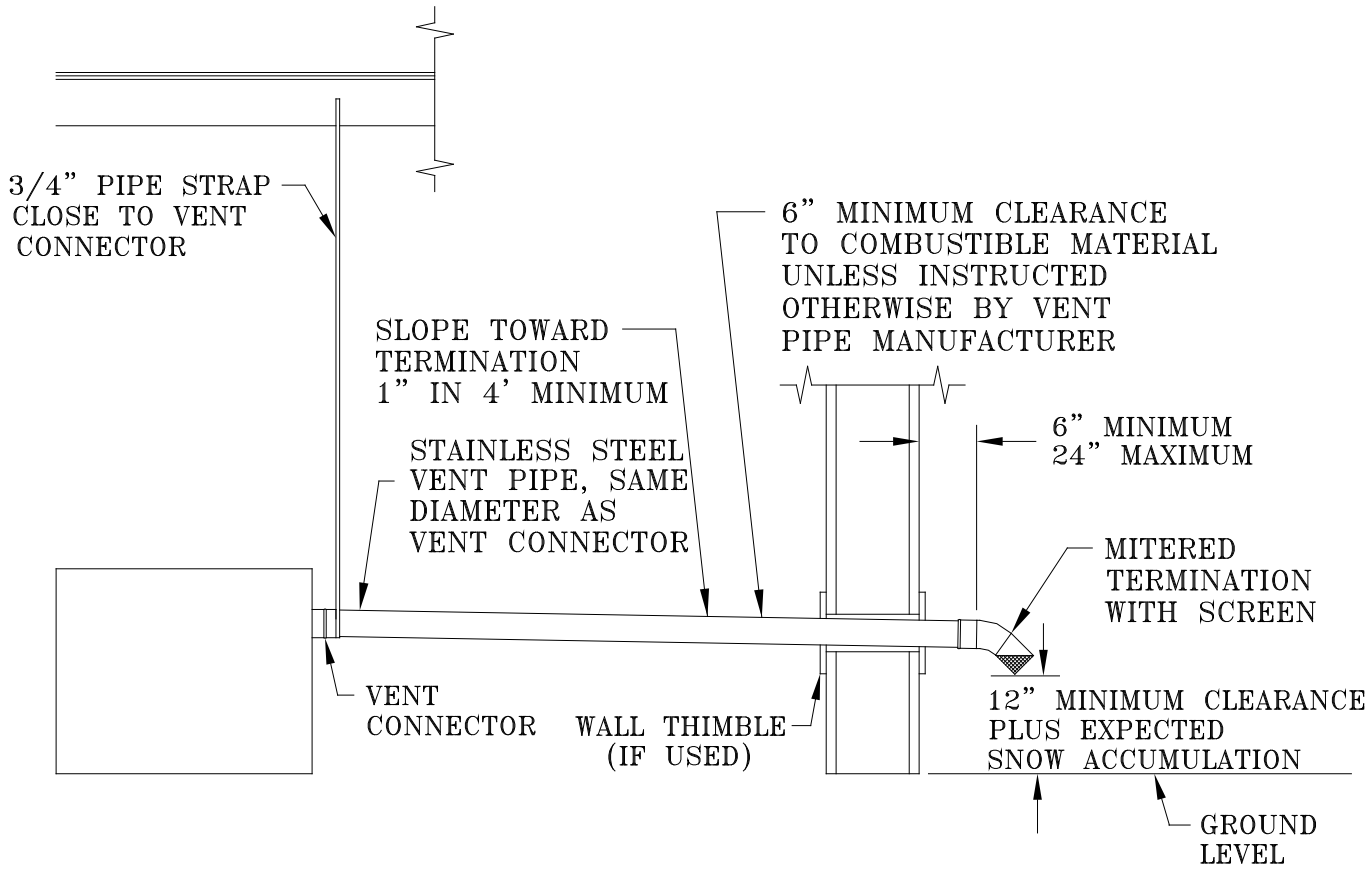


Figure 5: Side Vent

E. Optional Separate Horizontal Vent Terminal Mounting – See Figure 6

1. Do not exceed maximum vent/air intake lengths. Refer to Table 0.
2. This installation will allow a maximum of five (5) feet vertical exterior run of the vent/air intake piping to be installed on separate horizontal venting and indoor air horizontal venting.

Note: Exterior run to be included in equivalent vent/air intake lengths.

3. Install vent piping.
   a. Install vent piping for desired venting system. Refer to specific section for details for vent pipe installation.
   b. After penetrating wall/thimble, install a 90° elbow so that elbow leg is in the up direction.
   c. Install maximum of five (5) feet of vent pipe. Refer to Sections C through E for proper procedures for joining vent pipe and fittings.
   d. At top of vent pipe length install a 90° elbow so that elbow leg is opposite the building's exterior surface.
   e. Install 45° elbow to upper 90° elbow so that leg of 45° is in down direction (see Figure 6). If not using indoor air, proceed to Step f.
   f. Install horizontal vent terminal.
   g. Brace piping if required.
4. Air Intake Piping (not required for indoor air).
   a. Install air intake piping for desired venting system. Refer to specific section for details for air intake installation.
   b. After penetrating wall, install a corrosion resistant 90° elbow so that elbow leg is in the up direction.
   c. Install maximum of five (5) feet of corrosion resistant air intake pipe.
   d. At top of air intake pipe install air intake terminal (provided with boiler).
   e. Brace piping if required.

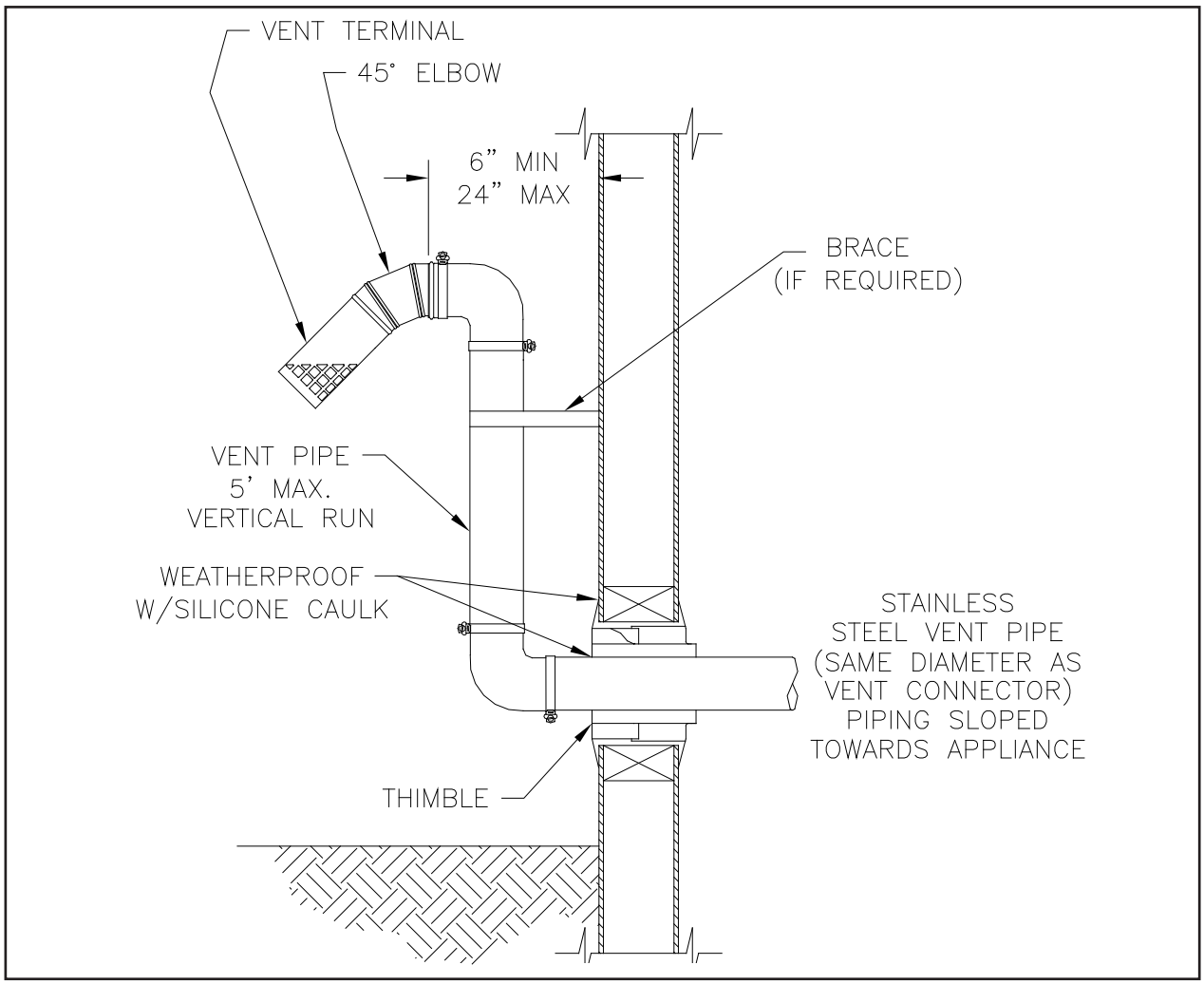


Figure 6: Optional Indoor Air – Vent Terminal Installation

F. Conventional Venting (Negative Draft) – See Figure 7

1. The minimum chimney height is 15 feet.
2. The chimney must be protected from down drafts, rain and debris by using a chimney cap or star.
3. Start installing vent at vent cap and continue installation toward the boiler.
4. The flue connector and chimney flue diameter may need to be increased or decreased depending on the dimensions of the boiler. Consult the National Fuel Gas Code or Local Codes for sizing. Boiler input, flue connector lateral distance and chimney height affect the flue connector or chimney flue diameters.
5. A double acting barometric damper with integral flue spillage interlock switch must be used when the boiler is vented conventionally.
6. The chimney and flue connector must be sized and configured to provide a minimum - 0.04 inch w.c. draft at the vent outlet of the boiler.
7. Maintain a minimum vertical pitch of one (1) inch in four (4) feet of vent connector run.

G. Air Intake Piping - See Figure 4 & 8

1. Locate air intake termination on the same wall as the vent termination if possible, to prevent nuisance boiler shutdowns. However, boiler may be installed with vertical venting and sidewall combustion air inlet or vice versa, if installation conditions do not allow alternate arrangement.
2. Do not exceed maximum air intake length. See Table 0.
3. Use single wall metal pipe and fittings or thin wall PVC available at most heating distributors.
4. Horizontal air intake termination must be located at least twelve (12) inches above grade plus the expected snow accumulation.
5. Start at collar on burner enclosure (inside boiler jacket) and work towards the air intake terminal.
6. Maintain minimum of 1/4 inch per foot slope on horizontal runs. Slope towards air inlet terminal when possible. If not, slope towards boiler.
7. The air intake pipe must be adequately supported with straps or supports no less than five (5) feet apart on horizontal runs. The complete air intake piping system must be rigid and able to withstand minor impacts without collapse.
8. Inlet air pipe penetration: Horizontal - Size wall penetration to allow easy insertion of air inlet piping. Seal around pipe with sealant to form weathertight exterior joint.
9. Seal all joints airtight, using silicone caulk or self-adhesive aluminum tape.
10. Install Air Intake Terminal.

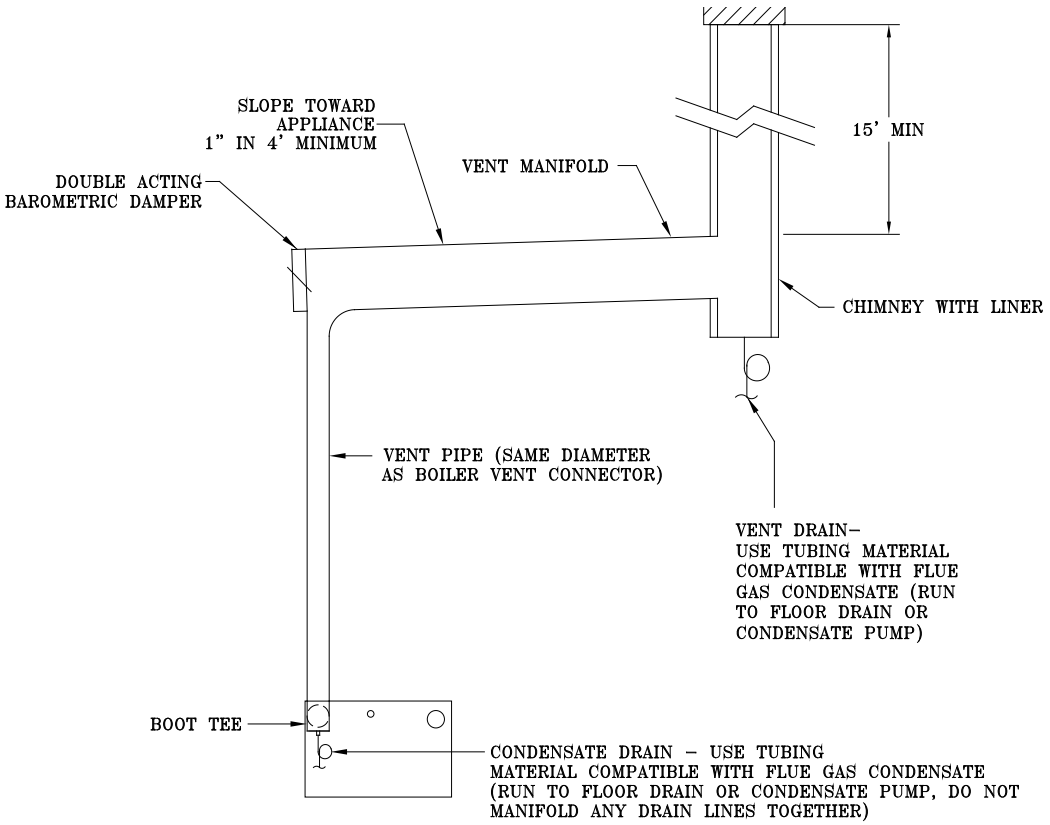


Figure 7: Conventional Venting (Negative Draft)

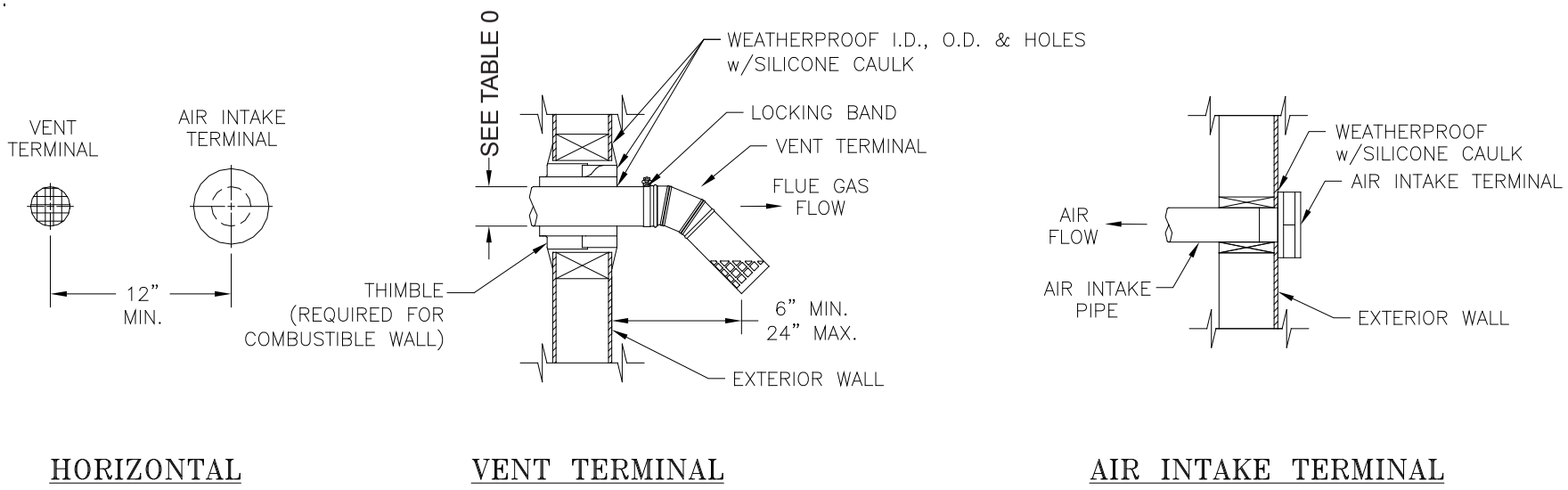


Figure 8: Separate Horizontal – Vent/Air Intake Terminal Configuration

H. Separate Vertical Venting System - See Figures 9, 10, and 11.

Vertical Venting –

1. Do not exceed maximum vent lengths. Refer to Table 0.
2. Slope horizontal runs minimum ¼ inch per foot down towards boiler.
3. Install fire stops where vent passes through floors, ceilings or framed walls. The fire stop must close the opening between the vent pipe and the structure. Fire stop manufacturers are Air-Jet, American Metal Products, Metal-Fab, and Simpson Dura-Vent.
4. Whenever possible, install vent straight through the roof. Refer to Figure 9 if offset is necessary. Maintain minimum clearance to combustible materials.
5. Install Vent Terminal.
   a. Size roof opening to maintain minimum clearance from combustible materials.
   b. Extend vent pipe to maintain minimum vertical and horizontal distance of twelve (12) inches from roof surface. Allow additional vertical distance for expected snow accumulation. Provide brace as required. Refer to Figure 11.
   c. Vertical venting requires use of the roof flashing and storm collar to prevent moisture from entering the structure.
   d. Install storm collar on vent pipe immediately above flashing. Apply Dow Corning Silastic 732 RTV Sealant between vent pipe and storm collar to provide weathertight seal.
   e. Attach vent terminal.

Vertical Air Intake Piping –

1. Do not exceed maximum air intake length. Refer to Table 0.
2. Locate air intake termination on the same roof location as the vent termination if possible, to prevent nuisance boiler shutdowns. However, boiler may be installed with vertical venting and sidewall combustion air inlet or vice versa, if installation conditions do not allow alternate arrangement.
3 Use single wall metal pipe and fittings or thin wall PVC available at most heating distributors.
4. Air intake termination must be located:
   Vertical - At least twelve (12) inches above the roof surface plus the expected snow accumulation.
5. Start at collar on burner enclosure (inside boiler jacket) and work towards the air intake terminal.
6. Maintain minimum of 1/4 inch per foot slope on horizontal runs. Slope down towards boiler.
7. The air intake pipe must be adequately supported with straps or supports no less than five (5) feet apart on horizontal runs. The complete air intake piping system must be rigid and able to withstand minor impacts without collapse.
8. Inlet air pipe penetration:
   Vertical - Size roof opening to allow easy insertion of inlet piping and allow proper installation of flashing and storm collar.
   a. Use appropriately designed vent flashing when passing through roofs. Follow flashing manufacturers' instructions for installation procedures. Flashing manufacturers are Air-Jet, American Metal Products, Metal Fab, and Simpson Dura-Vent.
   b. Extend air intake pipe to maintain minimum vertical and horizontal distance of twelve (12) inches from roof surface. Allow additional vertical distance for expected snow accumulation. Provide brace as required. Refer to Figure 11.
   c. Vertical air intake requires flashing and a storm collar to prevent moisture from entering the structure.
   d. Install storm collar on air intake pipe immediately above flashing. Apply Dow Corning Silastic 732 RTV Sealant between air intake pipe and storm collar to provide weathertight seal.
9. Seal all joints airtight, using silicone caulk or self - adhesive aluminum tape.
10. Install Air Intake Terminal:
    Vertical - Insert intake piping into intake terminal collar. Secure terminal to intake piping and seal joint with silicone caulk.

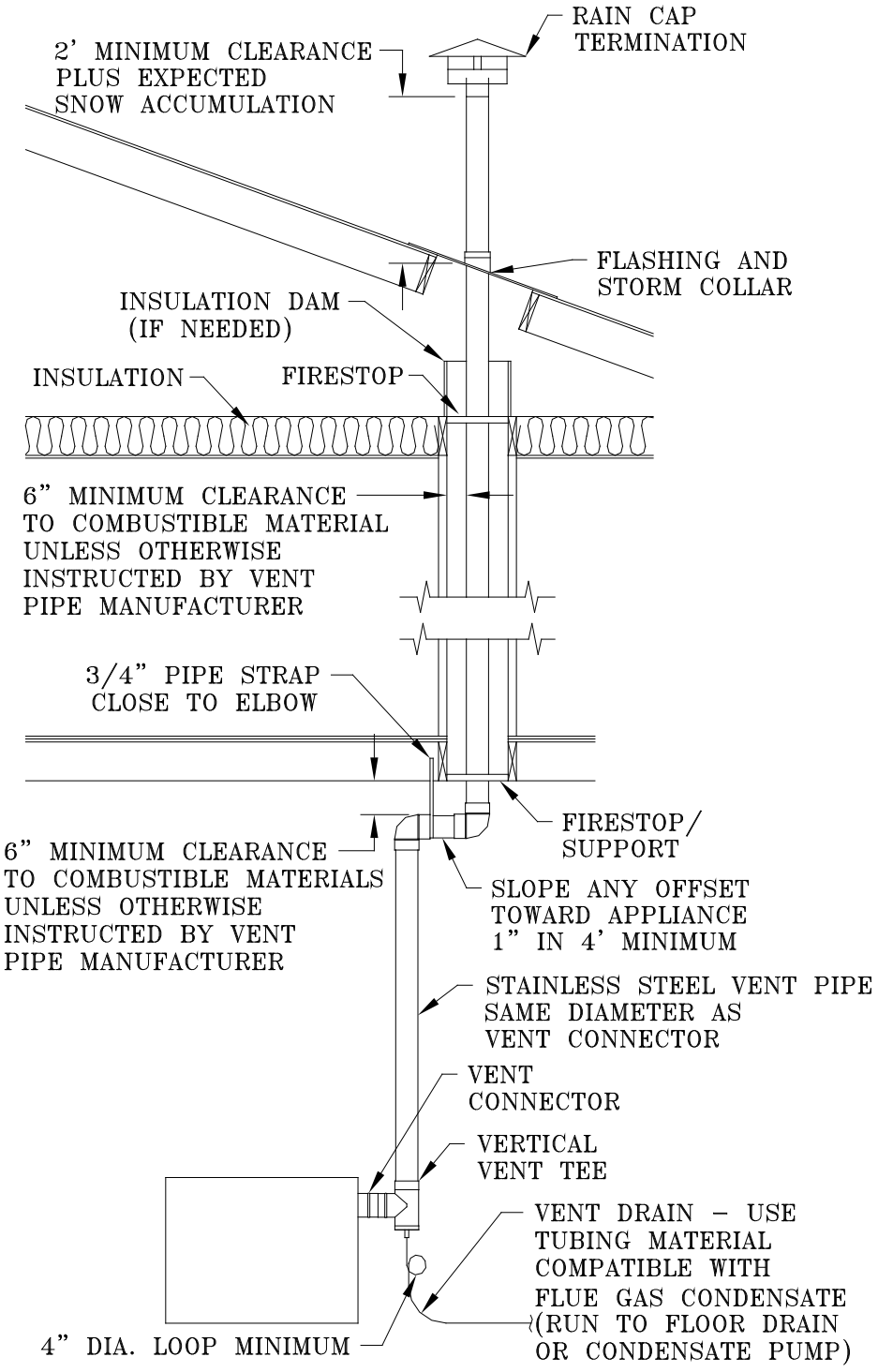
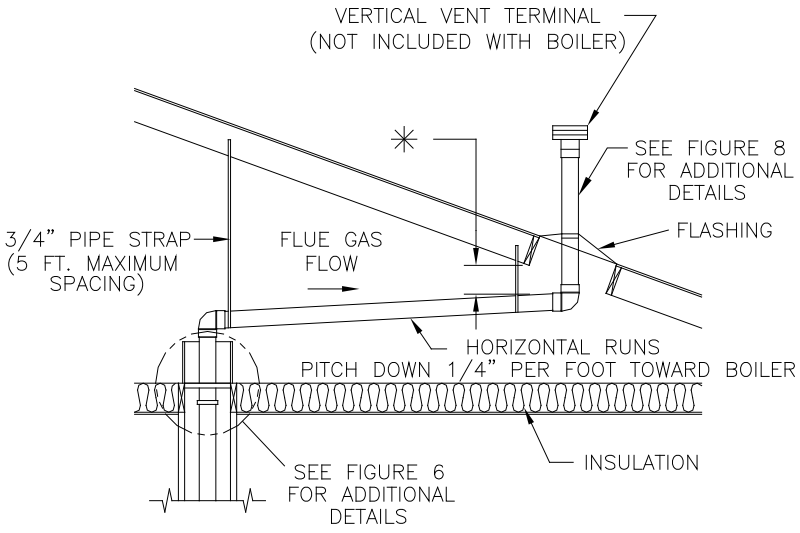
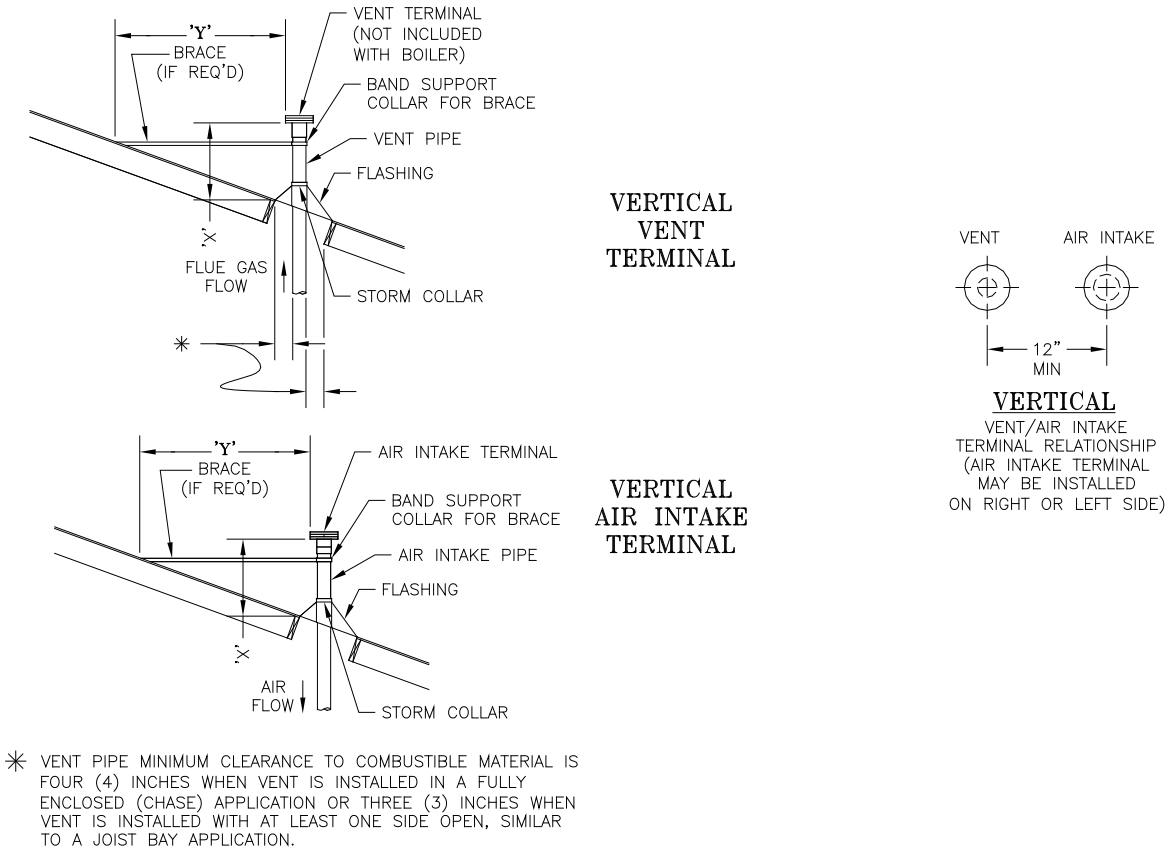


Figure 9: Vertical Vent Installation



✳ VENT PIPE MINIMUM CLEARANCE TO COMBUSTIBLE MATERIAL IS FOUR (4) INCHES WHEN VENT IS INSTALLED IN A FULLY ENCLOSED (CHASE) APPLICATION OR THREE (3) INCHES WHEN VENT IS INSTALLED WITH AT LEAST ONE SIDE OPEN, SIMILAR TO A JOIST BAY APPLICATION.

Figure 10: Attic Offset



✳ VENT PIPE MINIMUM CLEARANCE TO COMBUSTIBLE MATERIAL IS FOUR (4) INCHES WHEN VENT IS INSTALLED IN A FULLY ENCLOSED (CHASE) APPLICATION OR THREE (3) INCHES WHEN VENT IS INSTALLED WITH AT LEAST ONE SIDE OPEN, SIMILAR TO A JOIST BAY APPLICATION.

Figure 11: Indoor Air - Horizontal / Vertical Vent Terminal Installation

Extend Vent/Air Intake Piping to maintain minimum vertical ("X") and minimum horizontal ("Y") distance of twelve (12) inches from roof surface. Allow additional vertical ("X") distance for expected snow accumulation.

IV. Water Piping and Trim

1. WATER TREATMENT: The quality of water used in the heating system is essential for the successful operation and longevity of the system components. A successful water treatment plan will help to maintain efficiency, reduce the regularity of repair and/or replacement, and extend the working life of the boiler and other system equipment. If left untreated, poor water quality could cause a number of problems including, but not limited to, oxidation, scaling, corrosion, and fouling. See Table 1 for examples of typical chemical agents found in untreated water along with their potential effects.

Table 1: Chemical Agents and Effects

Compound	Effect
Calcium Carbonate ($CaCO_3$)	Soft Scale
Calcium Bicarbonate ($CaHCO_3$)	Soft Scale, CO_2
Calcium Sulphate ($CaSO_4$)	Hard Scale
Calcium Choloride ($CaCl_2$)	Corrosion
Magnesium Carbonate ($MgCO_3$)	Soft Scale
Magnesium Bicarbonate ($MgHCO_3$)	Corrosion, Scale
Magnesium Sulphate ($MgSO_4$)	Corrosion
Silicon Dioxide (SiO_2)	Hard Scale

Since the condition of water varies from location to location, it is impossible to prescribe a one-size-fits-all treatment plan for the system water. In order to develop an effective water treatment plan, it will be necessary to gain knowledge of the impurities dissolved in the water. Once all the impurities are identified, the proper treatment plan can be established. Therefore, it will be essential to obtain the expertise of a qualified industrial water treatment professional for establishing a treatment plan.

In addition, a periodic testing/sampling plan should be developed. The intent of the plan should be to: (1) ensure the protection of the boiler and system equipment, (2) prevent an unforeseen system failure, (3) provide information for use in addressing the water quality, and (4) to confirm the proper concentration of chemicals in use.

CAUTION

The water shall have a maximum water hardness of 8.5 grains or 150 ppm. The recommended pH range is 8.8 to 9.2. However, other aspects of water quality can affect boiler operation and longevity. A qualified water treatment expert should be consulted to develop a complete water treatment plan.

Oxygen contamination of boiler water will cause corrosion of iron and steel boiler components, and can lead to boiler failure. Thermal Solutions Standard Warranty does not cover problems caused by oxygen contamination of boiler water.

Proper water treatment and boiler maintenance is required to avoid scale build-up on the inside of the boiler. Thermal Solutions Standard Warranty does not cover problems caused by scale build-up.

When using Glycol products, all Glycol manufacturers' requirements, including rust inhibitors, must be adhered. Max 50% Glycol.

CAUTION

Failure to properly pipe boiler may result in improper operation and damage to boiler or structure.

CAUTION

All piping either new or existing must be cleaned with a tri sodium phosphate (TSP) solution to remove mill scale and oils from the system. Failure to do so could result in premature failure of the heat exchanger (not covered by Thermal Solutions warranty.)

CAUTION

On an existing or retrofit system, a filter or strainer must be installed on the system return prior to the boilers.

2. Design and install boiler and system piping to prevent oxygen contamination of boiler water and frequent water additions.
   a. There are many possible causes of oxygen contamination such as:
      i. Addition of excessive make-up water as a result of system leaks.

ii. Absorption through open tanks and fittings.

iii. Oxygen permeable materials in the distribution system.

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

i. Repairing system leaks to eliminate the need for addition of make-up water.

ii. Eliminating and/or repairing fittings which allow oxygen absorption.

iii. Using non-permeable materials in the distribution system.

iv. Isolating the boiler from the system water by installing a heat exchanger.

vi. Using properly designed and operating air elimination devices in water piping.

3. Design and install system piping to prevent return water temperatures below 130°F. Refer to Table 2 for boiler flow and pressure drop requirements.

4. Connect system supply and return piping to boiler. Refer to Figure 12. Also consult I=B=R Installation and Piping Guides. Maintain ½" minimum distance between water piping and combustible material. Consult Thermal Solutions for unusual system requirements.

CAUTION

Return water temperature below 130°F will cause flue gas condensation inside the boiler. Flue gas condensate can lead to boiler failure. Thermal Solutions Standard Warranty does not cover problems caused by flue gas condensation.

WARNING

Supply and return water temperature differences greater than 40°F can lead to boiler failure. Thermal Solutions Standard Warranty does not cover problems caused by temperature differences greater than 40°F.

5. A pressure relief valve is supplied with each appliance. No valve is to be placed between the relief valve and appliance. No reducing coupling or other restriction shall be installed in the discharge line. See Figure 13A.

   a. Pipe the safety relief discharge to a suitable place for disposal when relief occurs.

   b. Do not install reducing couplings for other restrictive devices in the safety relief discharge line.

   c. The safety relief discharge line must allow for complete drainage of both the valve and line.

6. If the relief valve discharges periodically, this may be due to thermal expansion in a closed water supply system. Contact the water supplier or local plumbing inspector on how to correct this situation. DO NOT PLUG THE RELIEF VALVE.

7. Install the drain valve provided with the appliance at the lowest elevation. See Figure 13A.

8. If this boiler is used in connection with refrigeration systems, the boiler must be installed so that the chilled medium is piped in parallel with the boiler using appropriate valves to prevent the chilled medium from entering the boiler, see figure 13B. Also consult I=B=R Installation and Piping Guides. If this boiler is connected to heating coils located in air handling units where they may be exposed to refrigerated air circulation, the boiler piping must be equipped with flow control valves or other automatic means to prevent gravity circulation of boiler water during operation of the cooling system.

9. Install water flow switch. Water flow switch must be located such that water flow disruptions do not affect switch operation. Maintain maximum practical straight piping before and after flow switch to minimize water disruptions. Refer to manufacturer's instructions for proper paddle length.

10. A low water cutoff is required to protect a hot water boiler when any connected heat distributor (radiation) is installed below the top of the hot water boiler (i.e. baseboard on the same floor level as the boiler). In addition, some jurisdictions require the use of a LWCO with a hot water boiler. If a low water cutoff is required, it must be mounted in the system piping above the boiler. The minimum safe water level of a hot water boiler is just above the highest water containing cavity of the boiler; that is, a hot water boiler must be full of water to operate safely.

11. Oil, grease, and other foreign materials which accumulate in new hot water boilers and a new or reworked system should be boiled out, and then thoroughly flushed. A local qualified water

treatment chemical specialist is a suggested source for recommendations regarding appropriate chemical compounds and concentrations which are compatible with local environmental regulations.

12. After the boiler and system have been cleaned and flushed, and before refilling the entire system add appropriate water treatment chemicals, if necessary, to bring the pH between 8.8 and 9.2.

13. If it is required to perform a long term pressure test of the hydronic system, the boiler should first be isolated to avoid a pressure loss due to the escape of air trapped in the boiler.

    To perform a long term pressure test including the boiler, ALL trapped air must first be removed from the boiler.

    A loss of pressure during such a test, with no visible water leakage, is an indication that the boiler contained trapped air.

WARNING
Failure to operate the unit with the proper water flow rate can lead to appliance failure. Always install water flow switch so that the unit stops operating if improper water flow is present.
Safety 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. Consult Local Codes for proper discharge piping arrangement.
Do not operate boiler with flow rates in excess of the maximum flow rates listed in Table 2. Boiler tube erosion and pitting will occur. Thermal Solutions Standard Warranty does not cover problems caused by excessive water flow rates.
If a high head system pump is installed, assure that the boiler relief valve and system piping are capable of operating properly at the combined pressure of the system fill pressure plus the pump static head pressure.

Table 2 - Solaris Boiler Flow and Pressure Drop					
Boiler Model	20° ΔT (max)		40° ΔT (min)		Supply/Return Pipe (in. dia.)
	Δ P (ft)	Flow (GPM)	Δ P (ft)	Flow (GPM)	
SOL-500	6.9	41	1.4	20	2
SOL-750	6.5	63	1.5	31	3
SOL-1000	16.1	82	3.7	41	3
SOL-1250	23.5	104	6.9	52	3
SOL-1500	29.1	126	10.6	63	3

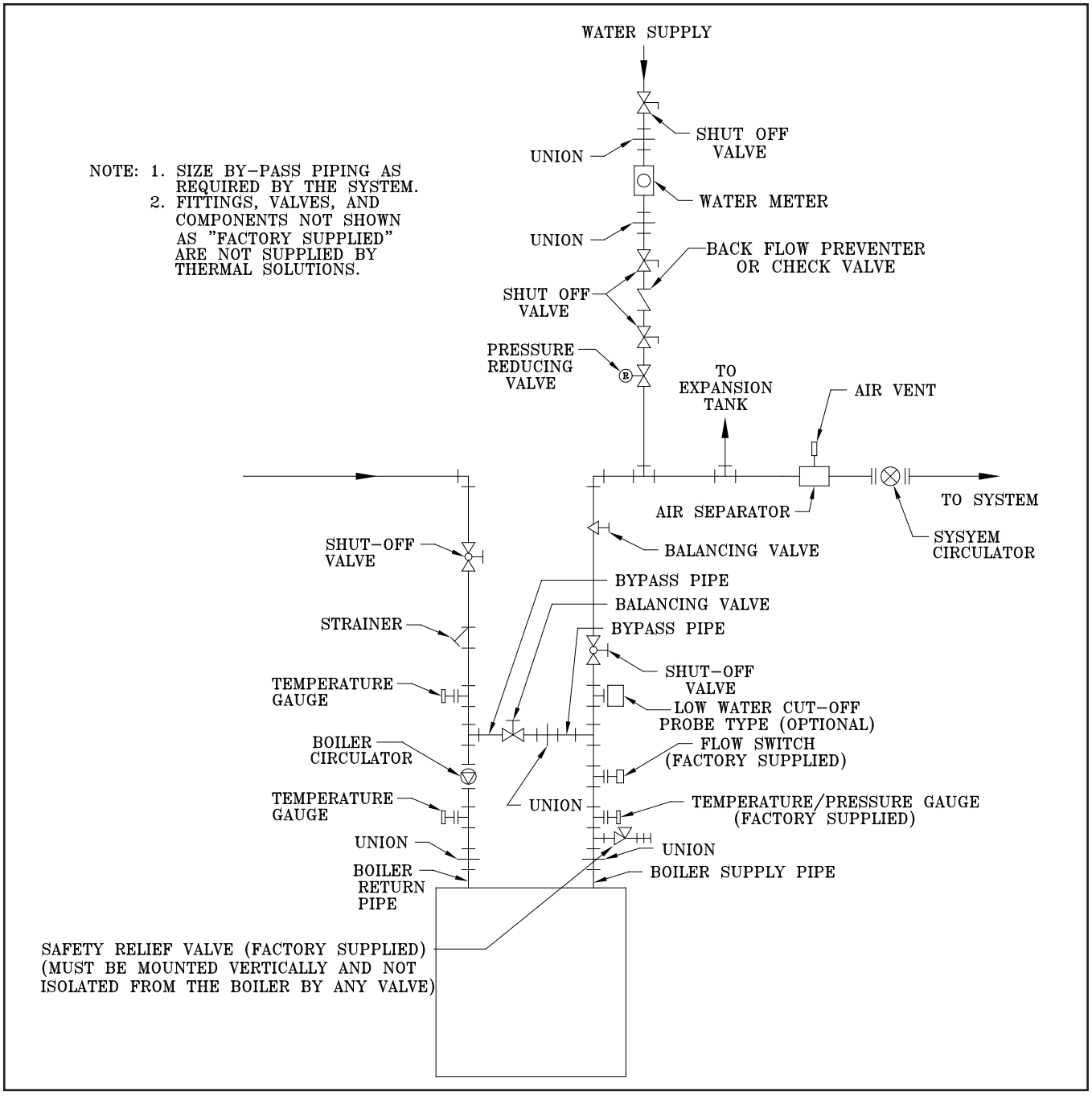


Figure 12: Water Piping (Single Boiler)

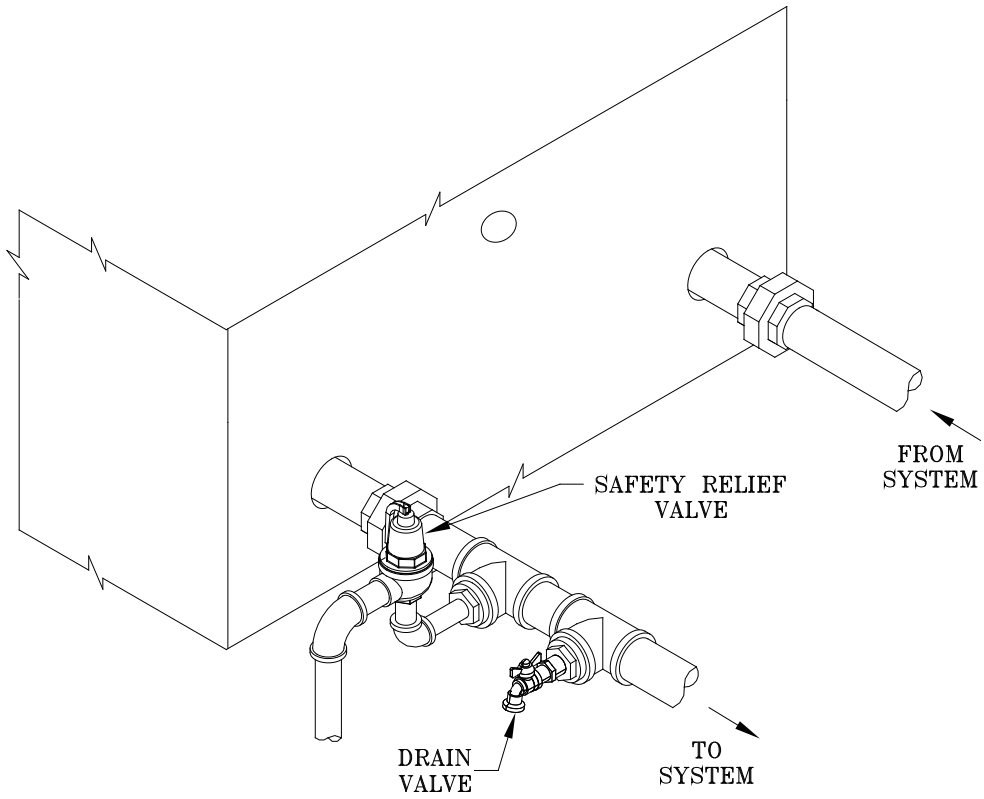


Figure 13A: Safety & Drain Valve Installation

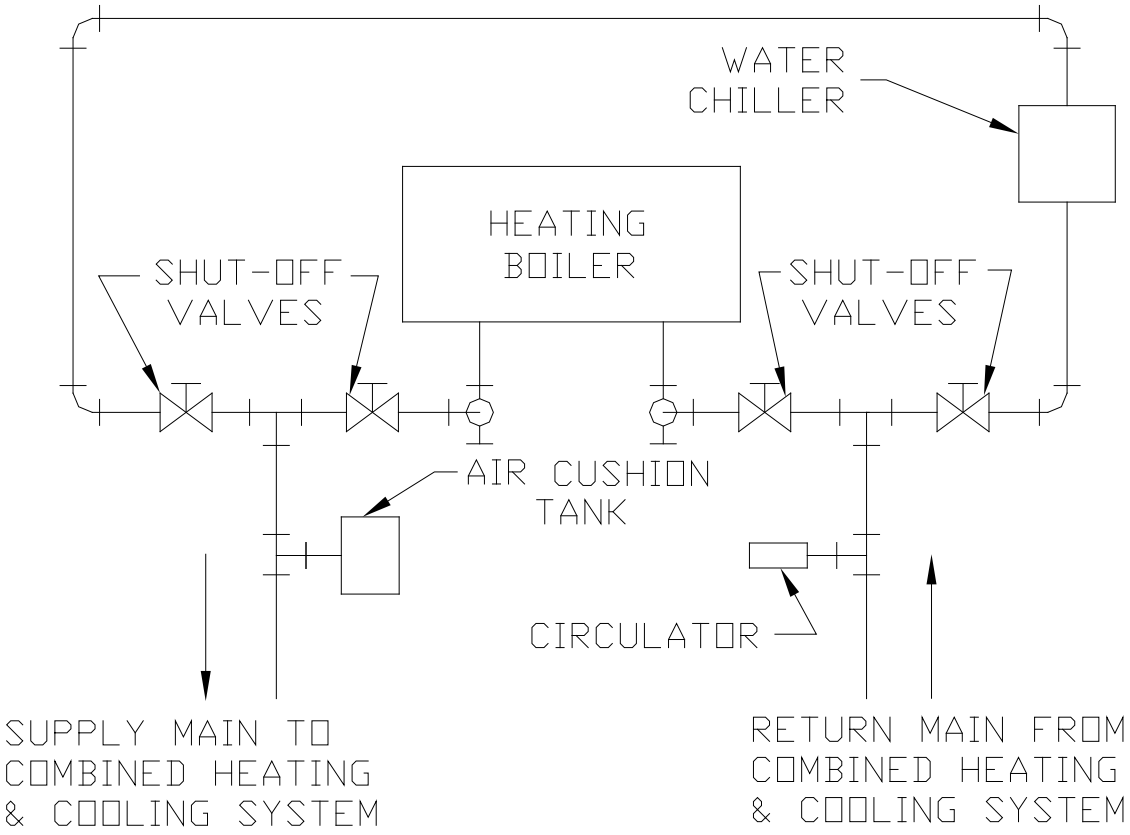


Figure 13 B: Recommended Piping for Combination Heating & Cooling (Refrigeration) System

V. 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 of the proper size and type for the connected load. An additional gas pressure regulator may be needed. Consult gas supplier.

A. Size gas piping. Design system to provide adequate gas supply to boiler. Consider these factors:

1. Allowable pressure drop from point of delivery to boiler. Maximum allowable system pressure is ½ psig. Actual point of delivery pressure may be less; contact gas supplier for additional information. The minimum and maximum gas valve inlet pressure is stamped on the rating label and can be found in table 3.

2. Maximum gas demand. Refer to the boiler's input found in Figure 1 or as printed on it's rating label. Also consider existing and expected future gas utilization equipment (i.e. water heater, cooking equipment).

3. Length of piping and number of fittings. Refer to Table 5 for maximum capacity of Schedule 40 pipe. Table 6 lists equivalent pipe length for standard fittings.

Table 3: Gas Ratings

Boiler Model	Maximum Gas Pressure (in. w.c.)	Minimum Gas Pressure (in. w.c.)	Manifold Pressure (in. w.c.)
SOL-500	14	4.5	1.3
SOL-750	14	4.5	2.3
SOL-1000	14	4.5	1.9
SOL-1250	14	4.5	1.5
SOL-1500	14	4.5	1.3

4. Specific gravity of gas. Gas piping systems for gas with a specific gravity of 0.70 or less can be sized directly from Table 5, unless authority having jurisdiction specifies a gravity factor be applied. For specific gravity greater than 0.70, apply gravity factor from Table 4. If exact specific gravity is not shown choose next higher value.

Table 4: Specific Gravity Correction Factors

Specific Gravity	Correction Factor	Specific Gravity	Correction Factor
0.50	1.10	1.10	0.74
0.55	1.04	1.20	0.71
0.60	1.00	1.30	0.68
0.65	0.96	1.40	0.66
0.70	0.93	1.50	0.63
0.75	0.90	1.60	0.61
0.80	0.87	1.70	0.59
0.85	0.84	1.80	0.58
0.90	0.82	1.90	0.56
1.00	0.78	2.00	0.55

For materials or conditions other than those listed above, refer to *National Fuel Gas Code*, NFPA54/ANSI Z223.1, or size system using standard engineering methods acceptable to authority having jurisdiction.

B. Connect boiler gas valve to gas supply system.

1. Use methods and materials in accordance with local plumbing codes and requirements of gas supplier. In absence of such requirements, follow *National Fuel Gas Code*, NFPA 54/ANSI Z223.1.

2. Use thread (joint) compounds (pipe dope) resistant to action of liquefied petroleum gas.

3. Install sediment trap, ground-joint union and manual shut-off valve upstream of boiler gas control valve and outside jacket. See Figure 14.

4. All above ground gas piping upstream from manual shut-off valve must be electrically continuous and bonded to a grounding electrode. Do not use gas piping as grounding electrode. Refer to *National Electrical Code*, NFPA 70.

C. Pressure test. The boiler and its gas connection must be

WARNING

Boilers installed between 0 and 2,000 feet above sea level use fuel inputs listed in the General Ratings and Capacities table found at the beginning of this manual. For boilers installed above 2,000 feet, reduce gas input by 4% for each additional 1,000 feet above sea level, as per NFPA54.

Table 5: Maximum Capacity of Schedule 40 Pipe in CFH* for Gas Pressures of 0.5 psig or Less								
	0.3 inch w.c. Pressure Drop				0.5 inch w.c. Pressure Drop			
Length (Feet)	3/4	1	1-1/4	1-1/2	3/4	1	1-1/4	1-1/2
10	273	514	1060	1580	360	678	1390	2090
20	188	353	726	1090	247	466	957	1430
30	151	284	583	873	199	374	768	1150
40	129	243	499	747	170	320	657	985
50	114	215	442	662	151	284	583	873
60	104	195	400	600	137	257	528	791
70	95	179	368	552	126	237	486	728
80	89	167	343	514	117	220	452	677
90	83	157	322	482	110	207	424	635
100	79	148	304	455	104	195	400	600

*** 1 CFH of Natural Gas is approximately equal to 1 MBH.**

leak tested before placing boiler in operation.

1. Protect boiler gas control valve. For all testing over ½ psig, boiler and its individual shutoff valve must be disconnected from gas supply piping. For testing at ½ psig or less, isolate boiler from gas supply piping by closing boiler's individual manual shutoff valve.
2. Locate leaks using approved combustible gas detector, soap and water, or similar nonflammable solution.

WARNING

Failure to use proper thread compounds on all gas connectors may result in leaks of flammable gas.

WARNING

Gas supply to boiler and system must be absolutely shut off prior to installing or servicing boiler gas piping.

DANGER

Do not use matches, candles, open flames or other ignition source to check for leaks.

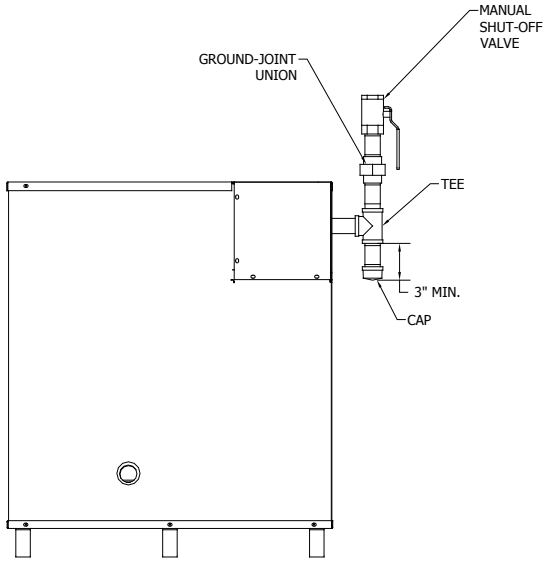


Figure 14: Recommended Gas Piping

Table 6: Equivalent Lengths of Standard Pipe Fittings & Valves									
VALVES FULLY OPEN									
Pipe Size	I.D. Inches	Gate	Globe	Angle	Swing Check	90° Elbow	45° Elbow	90° Tee, Flow Through Run	90° Tee, Flow Through Branch
1/2"	0.622	0.35	18.6	9.3	4.3	1.6	0.78	1.0	3.1
3/4"	0.824	0.44	23.1	11.5	5.3	2.1	0.97	1.4	4.1
1"	1.049	0.56	29.4	14.7	6.8	2.6	1.23	1.8	5.3
1-1/4"	1.380	0.74	38.6	19.3	8.9	3.5	1.60	2.3	6.9

VI. Electrical

DANGER

Positively assure all electrical connections are unpowered before attempting installation or service of electrical components or connections of the boiler or building. Lock out all electrical boxes with padlock once power is turned off.

WARNING

Failure to properly wire electrical connections to the boiler may result in serious physical harm.

Electrical power may be from more than one source. Make sure all power is off before attempting any electrical work.

Each boiler must be protected with a properly sized over-current device.

Never jump out or make inoperative any safety or operating controls.

The wiring diagrams contained in this manual are for reference purposes only. Each boiler is shipped with a wiring diagram attached to the front door. Refer to this diagram and the wiring diagram of any controls used with the boiler. Read, understand and follow all wiring instructions supplied with the controls.

A. **General.** Install wiring and electrically ground boiler in accordance with authority having jurisdiction or, in the absence of such requirements, follow the *National Electrical Code*, NFPA 70, and/or CSA C22.1 Electrical Code.

B. A separate electrical circuit must be run from the main electrical service with an over-current device/disconnect in the circuit. A service switch is recommended and may be required by some local jurisdictions. Install the service switch in the line voltage "Hot" leg of the power supply. Locate the service switch such that the boiler can be shut-off without exposing personnel to danger in the event of an emergency. Connect the main power supply and ground to the three (3) boiler wires (black, white and green) located in the junction box at the back of the boiler jacket.

C. Refer to Figures 15 and 16 for details on the internal boiler wiring.

D. When installed, the boiler must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the National Electric Code, ANSI/NFPA70 and/or the Canadian Electrical Code Part 1, CSA C22.1, Electrical Code.

NOTICE

This boiler is equipped with a high water temperature limit located inside the internal wiring of the boiler. This limit provides boiler shutdown in the event the boiler water temperature exceeds the set point of the limit control. Certain Local Codes require an additional water temperature limit. In addition, certain types of systems may operate at temperatures below the minimum set point of the limit contained in the boiler.

If this occurs, install an additional water temperature limit (Honeywell L4006 Aquastat) located in the system piping as shown in the Water Piping and Trim Section of this manual. Wire as indicated in the Electrical Section of this manual.

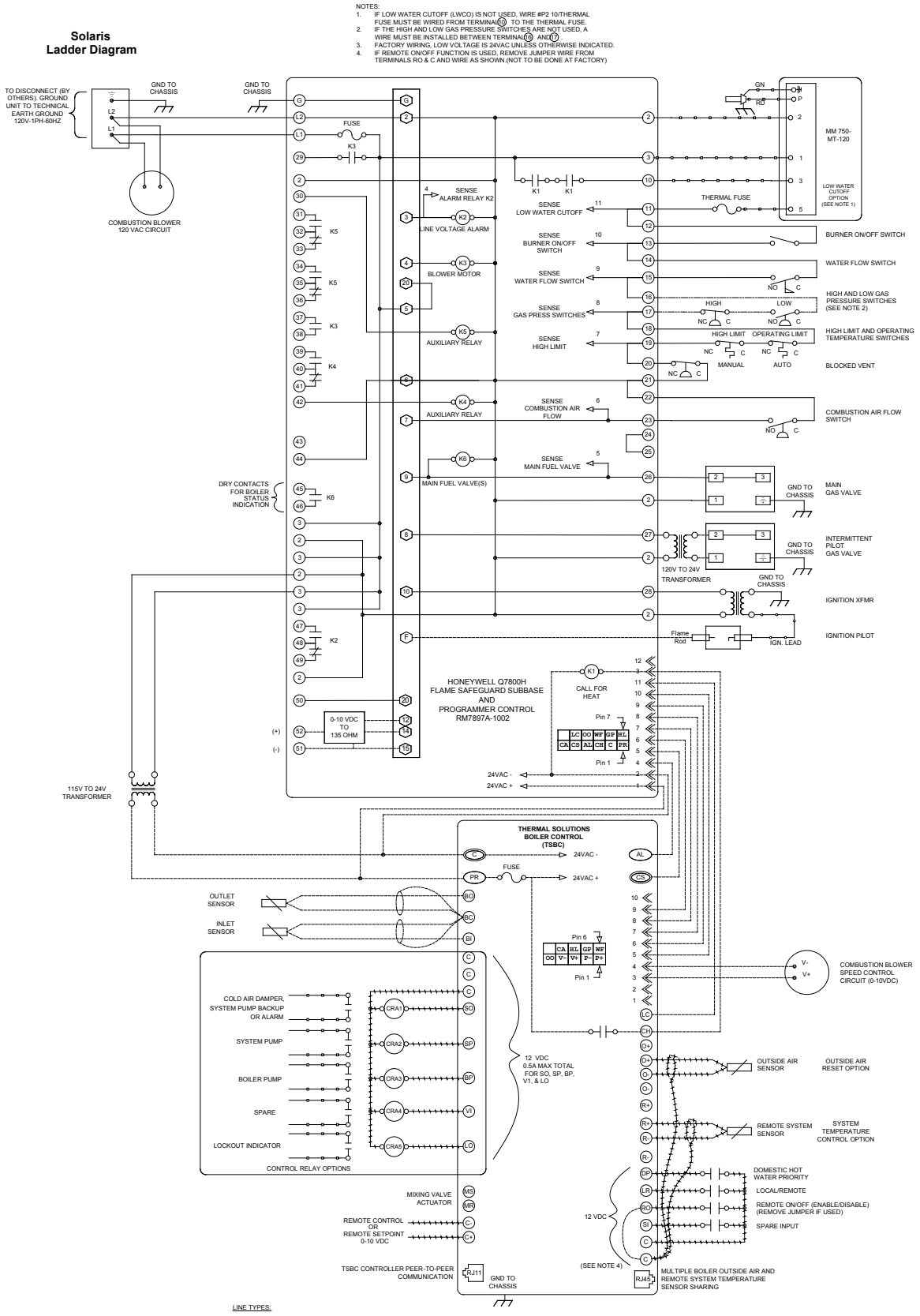


Figure 15: Internal Boiler Wiring Ladder Diagram

E. System Controls and Wiring

1. Refer to National Electric Code or Local Electric Codes for proper size and type of wire required. Follow Code.
2. Use anti-short bushings on all wiring passing through boiler jacket, junction boxes and/or control boxes.
3. Use armored cable (BX) over all exposed line voltage wiring.

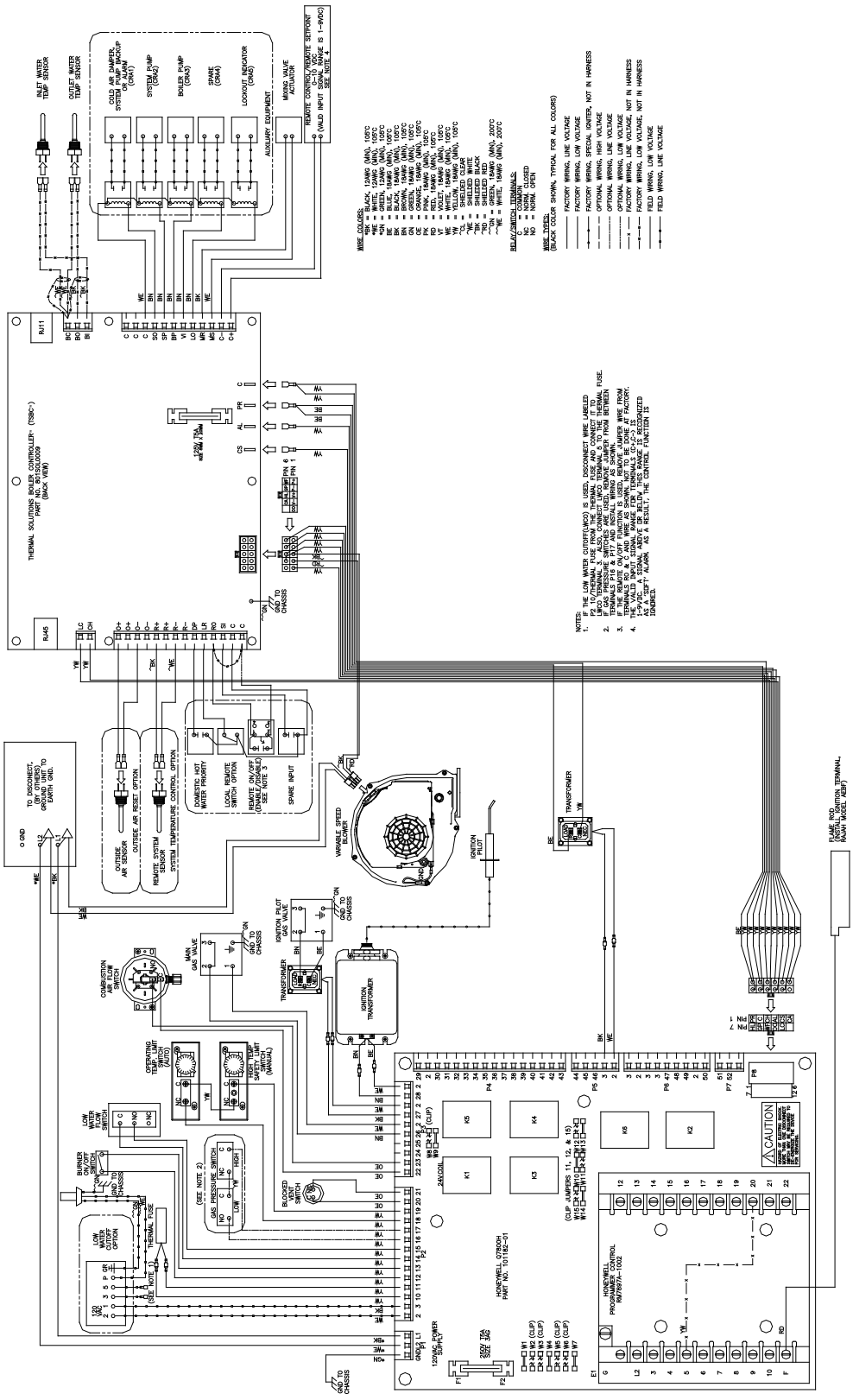


Figure 16: Schematic Diagram

VII. Modular Installation

A. General Guidelines

1. Read and follow all venting, combustion air, water piping, gas piping and electrical instructions contained in this manual unless otherwise instructed in this section.
2. Consult Local Building Codes or National Fuel Gas Code, NFPA 54/ANSI Z222.3 for restrictions and instructions on modular boiler installations.
3. Modular systems are complex. Design and installation of modular systems should only be undertaken by skilled and knowledgable engineers and contractors.
4. Use stainless steel vent material approved for condensing flue gas applications.

B. Module Sizing

Thermal Solutions recommends sizing each boiler in a modular system to provide 20 % of the combined heating load where ever possible. If the combined load exceeds the output of five (5) boilers, install the minimum number of boilers to meet the load requirements.

C. Venting

1. Horizontal/Vertical Venting
   a. Use Stainless Steel vent material approved for condensing flue gas applications.

WARNING

Do not manifold vent components of a boiler without correcting to negative draft.

   b. See Table 0 for the maximum vent length of each size boiler.
   c. Refer to Section III of this manual for guidelines on venting of modular boilers individually. Each boiler requires an individual vent pipe.
   d. The minimum horizontal distance between vent terminations is one (1) foot. Additional horizontal distance is desirable to avoid frost damage to the building. Vent terminations must be at least twelve (12) inches above the ground plus the expected snow accumulation.
   e. Multiple vertical vent pipes may be piped through a common conduit or chase so that one roof penetration may be made. Each vent termination must be one (1) foot from other terminations. A minimum of at least six (6) inches from the common conduit to combustible material must be maintained unless otherwise instructed by the conduit manufacturer.

CAUTION

Installing multiple vent terminations close together promotes frost buildup on buildings. To minimize this possibility, extend the distance from the building to the end of the vent termination and increase the horizontal distance between terminations.

   f. Refer to the cautions, notices, and warnings in Section III.

2. Conventional Venting (Negative Draft)
   a. Refer to Figure 17 for conventional venting guidelines for modular boilers.
   b. Refer to National Fuel Gas Code to determine required chimney diameter and common venting diameter. Note that combined input, lateral length and chimney height affect vent diameter.
   c. A single double acting barometric damper can be utilized on the common venting when venting according to Figure 17.
   d. Slope common venting a minimum of one (1) inch in four feet of run towards boilers.
   e. Locate boiler(s) with lowest input closest to chimney.
   f. Refer to cautions, notices, and warnings in Section III.

D. Air Intake Piping

1. Locate air intake termination on the same wall as the vent termination if possible, to prevent nuisance boiler shutdowns. However, boiler may be installed with vertical venting and sidewall combustion air inlet (or visa versa) if installation conditions do not allow alternate arrangement.
2. Refer to Figures 18 and 19 for common air intake guidelines for modular water heaters.
3. Individual air intake pipes may be used in lieu of common air intake piping. If so desired, refer to Figures 4 and 8.
4. Refer to Table 0 for the maximum air intake length. Common air intake straight lengths and fittings should be assumed to have the equivalent length the same as an individual air intake pipe used for a given boiler intake pipe diameter.
5. Position horizontal air intake termination center line below horizontal vent termination's center line.
6. Vertical air intake pipe must terminate at least two (2) feet above the closest portion of the roof.
7. Refer to the cautions, notices, and warnings in the Combustion Air Section of this manual.

E. Water Piping

1. Refer to Figures 20 through 25 for typical water piping installation details for modular boilers.
2. Installing a low water cutoff in the system is highly recomended and may be required by code.
3. Refer to Table 2 for pressure drop and flow requirements for each boiler.
4. Refer to the instructions, cautions, notices, and warnings in Section IV.

F. Gas Piping

1. Refer to National Fuel Gas Code, Local Codes and Tables 5 and 6 for gas pipe sizing.
2. Each boiler must be piped as shown in Figure 14.
3. Refer to the instructions, catuions, notices, and warnings in Section V.

G. Electrical

WARNING

If gas pressure in the building is above 1/2 psig, an additional gas pressure regulator is required. Using one additional regulator for multiple boilers may result in unsafe boiler operation. The additional regulator must be able to properly regulate gas pressure at the input of the smallest boiler. If the regulator cannot do this, two or more additional regulators are required. Consult regulator manufacturer and/or local gas supplier for instructions and equipment ratings.

1. Each boiler must be provided with a fused disconnect and service switch.
2. Install wiring in accordance with requirements of authority having jurisdiction. In the absence of such requirements, follow the National Electric Code, NFPA 70 and/or CSA C22.1 Electric Code.
3. Refer to Figure 1 for electrical data for each boiler size.
4. Refer to the instructions, cautions, notices, and warnings found in Section VI.

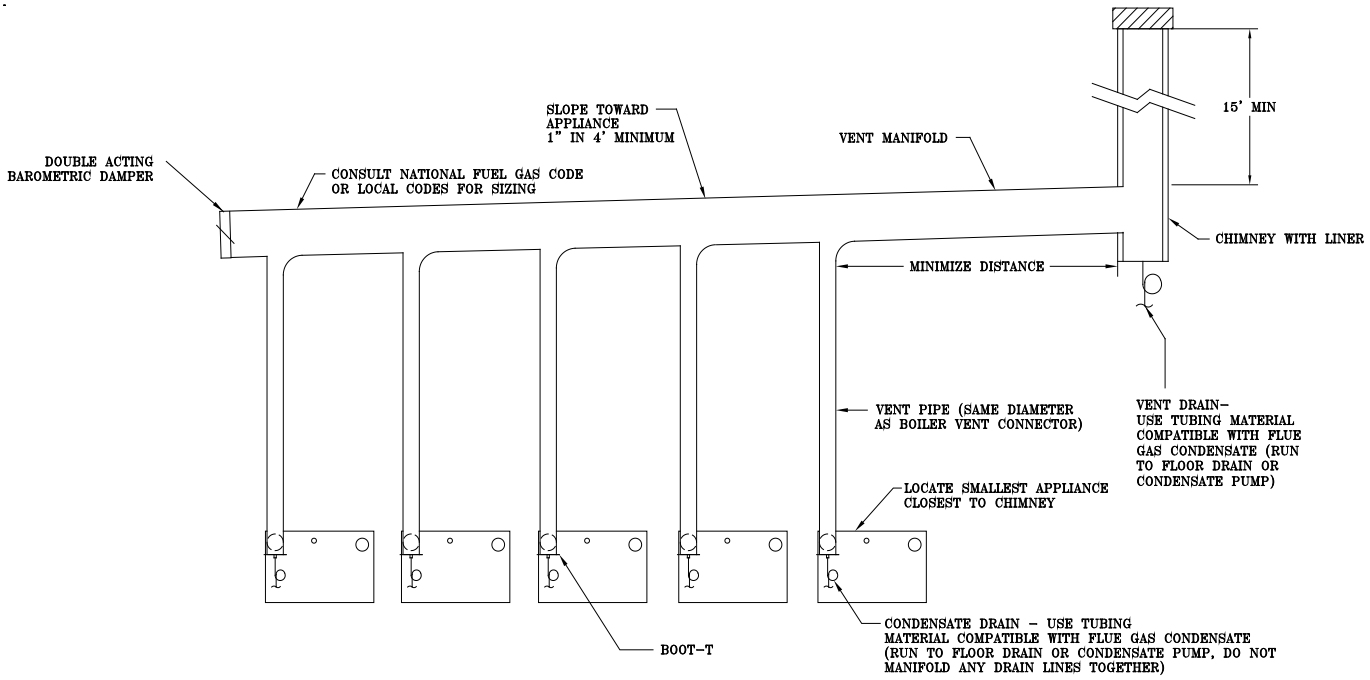


Figure 17: Modular Boiler Conventional Venting

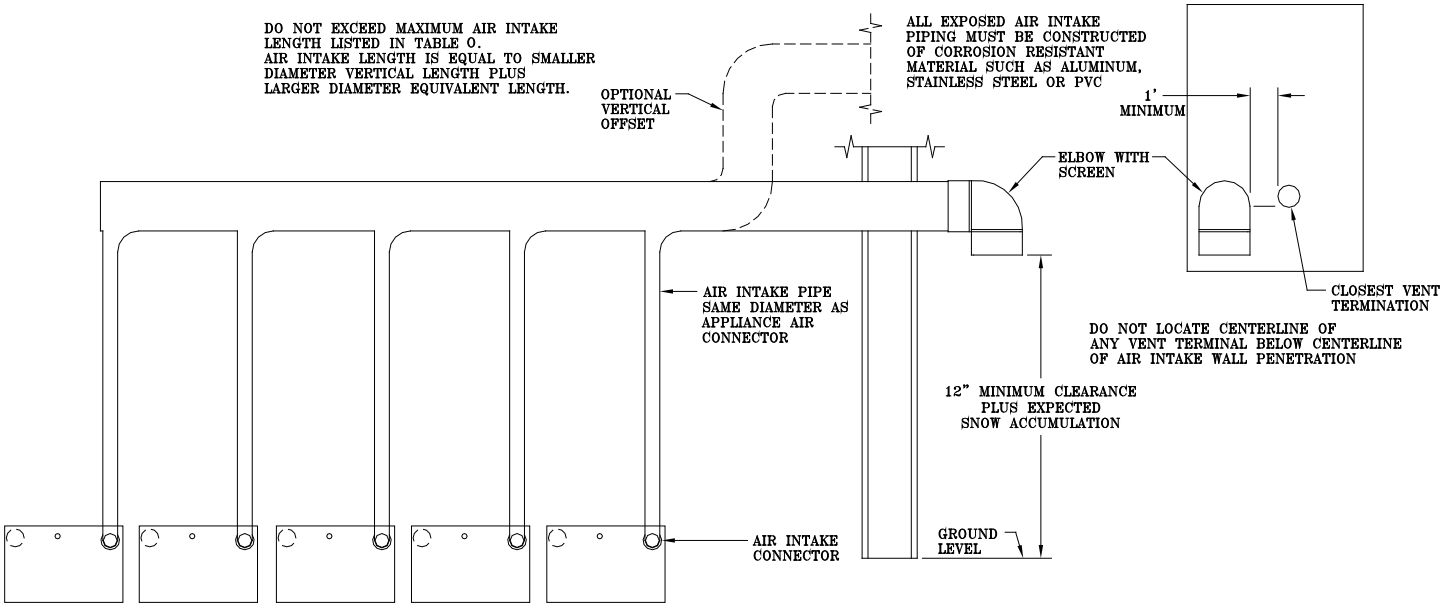


Figure 18: Modular Boiler Horizontal Air Intake Piping

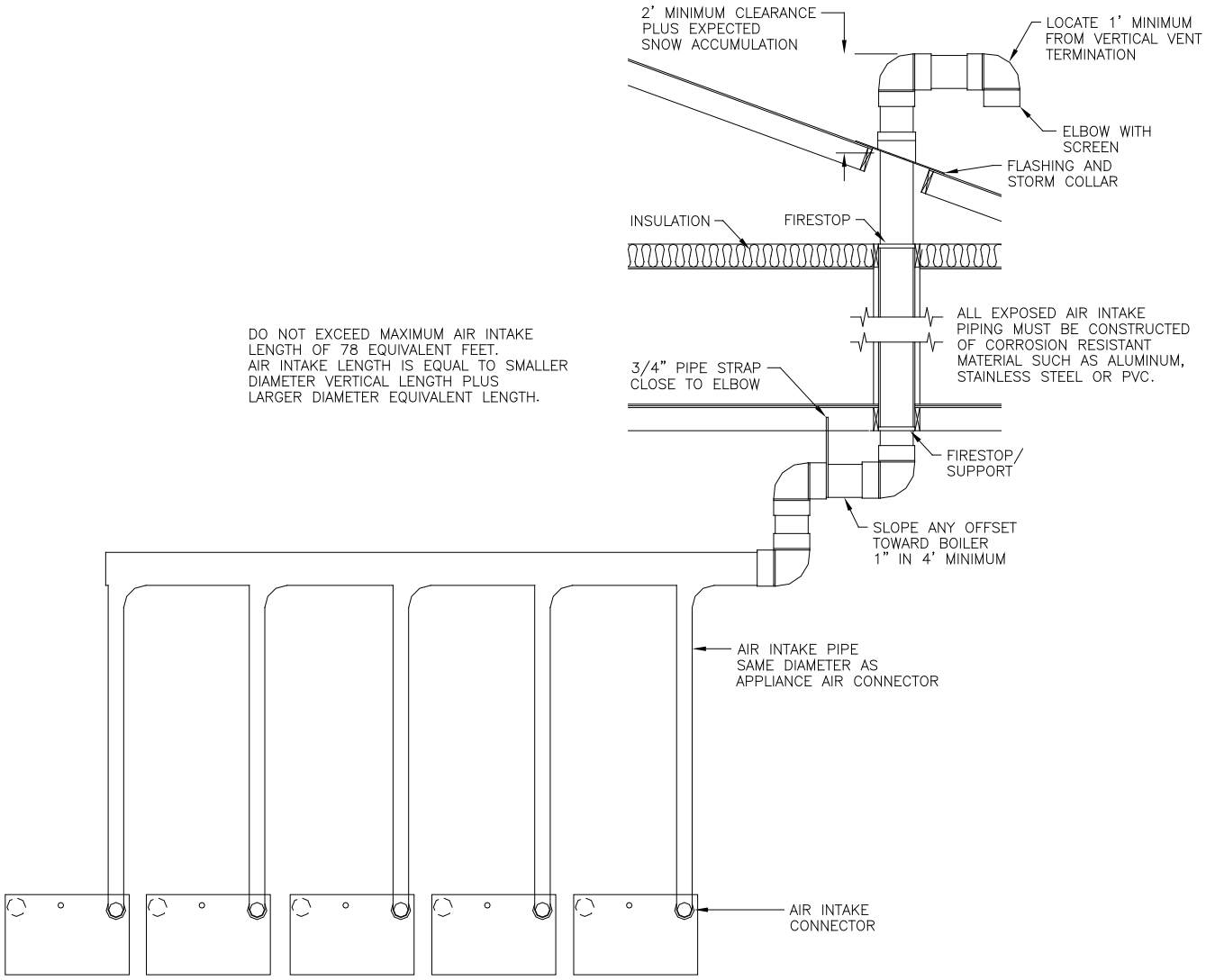


Figure 19: Modular Boiler Vertical Air Intake Piping

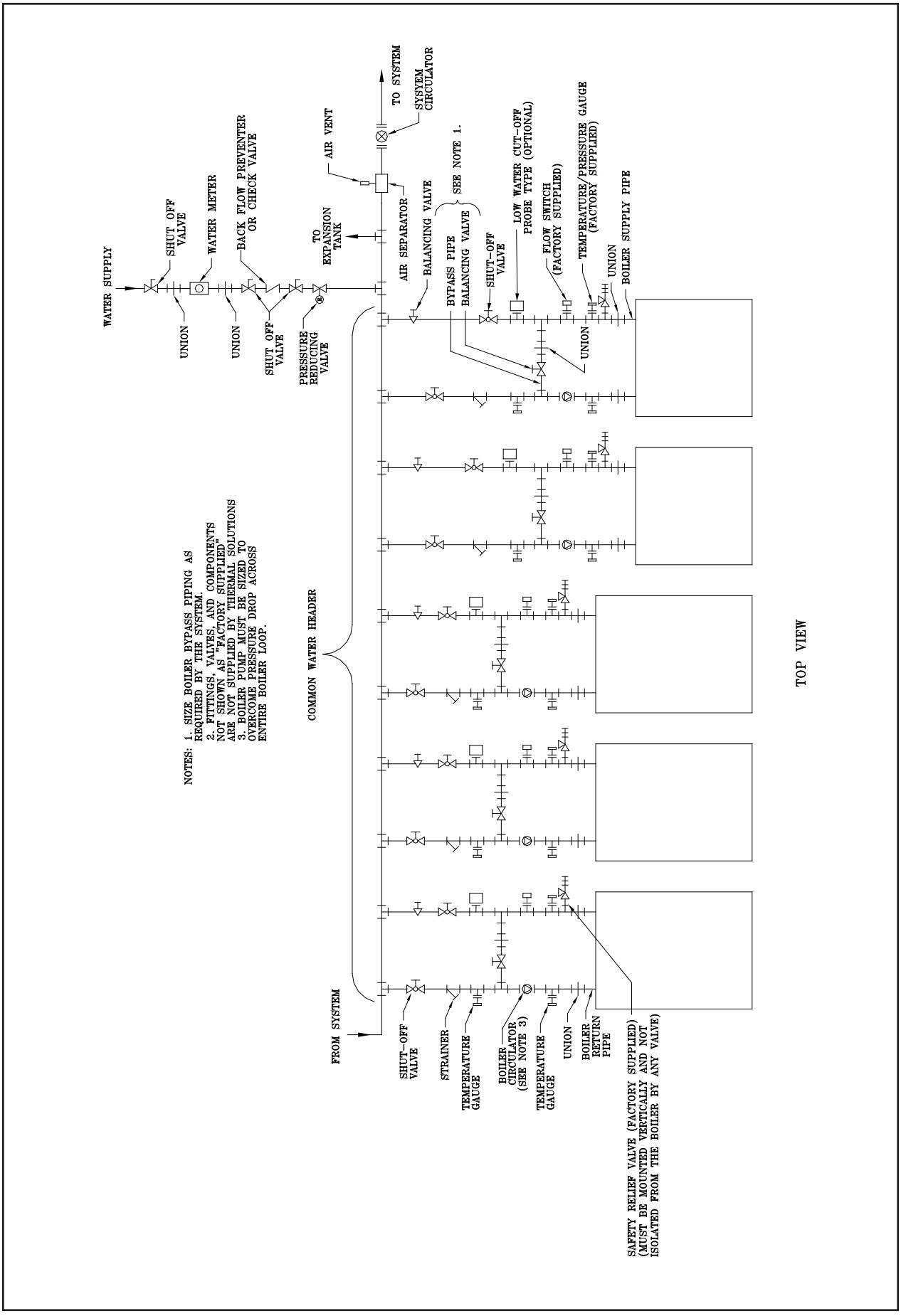
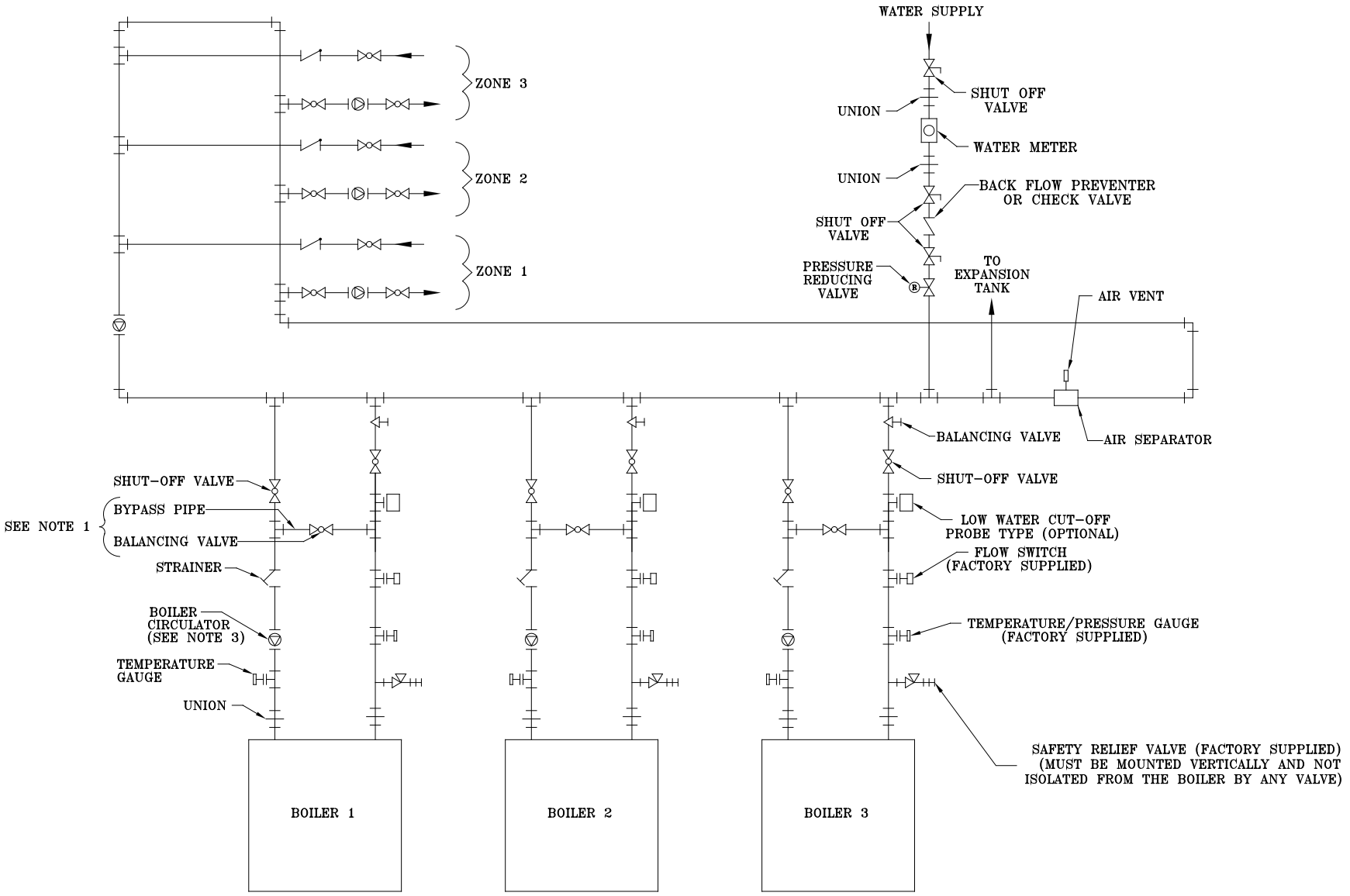
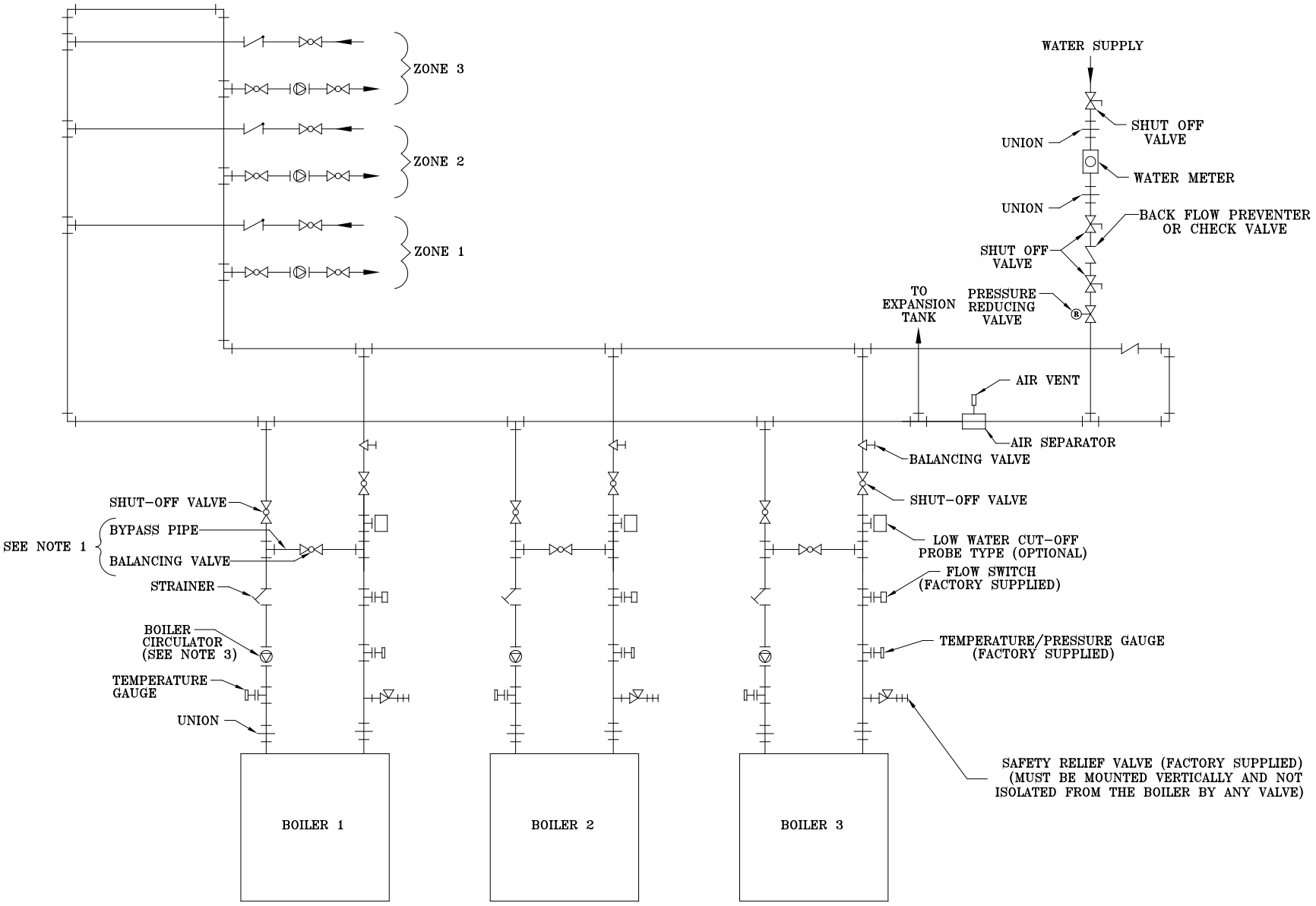


Figure 20: Modular System: Typical One Pipe Water Piping



NOTES: 1. SIZE BYPASS PIPING AS REQUIRED BY THE SYSTEM.
2. FITTINGS, VALVES, AND COMPONENTS NOT SHOWN AS "FACTORY SUPPLIED" ARE NOT SUPPLIED BY THERMAL SOLUTIONS.
3. BOILER PUMP MUST BE SIZED TO OVERCOME PRESSURE DROP ACROSS ENTIRE BOILER LOOP.

Figure 21: Modular System: Typical Primary/Secondary Water Piping



NOTES: 1. SIZE BYPASS PIPING AS REQUIRED BY THE SYSTEM.
2. FITTINGS, VALVES, AND COMPONENTS NOT SHOWN AS "FACTORY SUPPLIED" ARE NOT SUPPLIED BY THERMAL SOLUTIONS.
3. BOILER PUMP MUST BE SIZED TO OVERCOME PRESSURE DROP ACROSS ENTIRE BOILER LOOP.

Figure 22: Modular System: Typical Primary/Secondary without System Pump

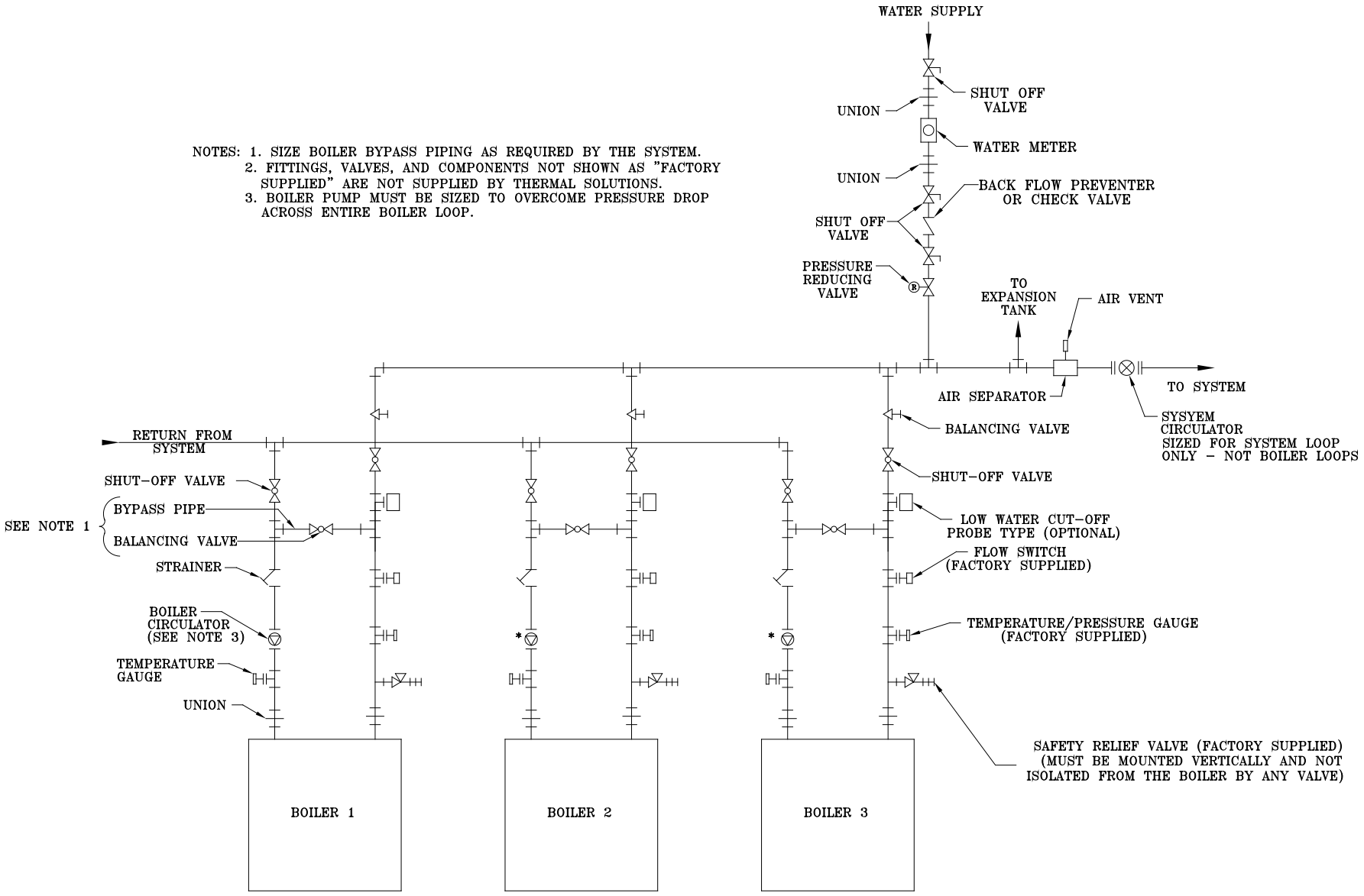


Figure 23: Modular System: Typical Reverse - Return Water Piping

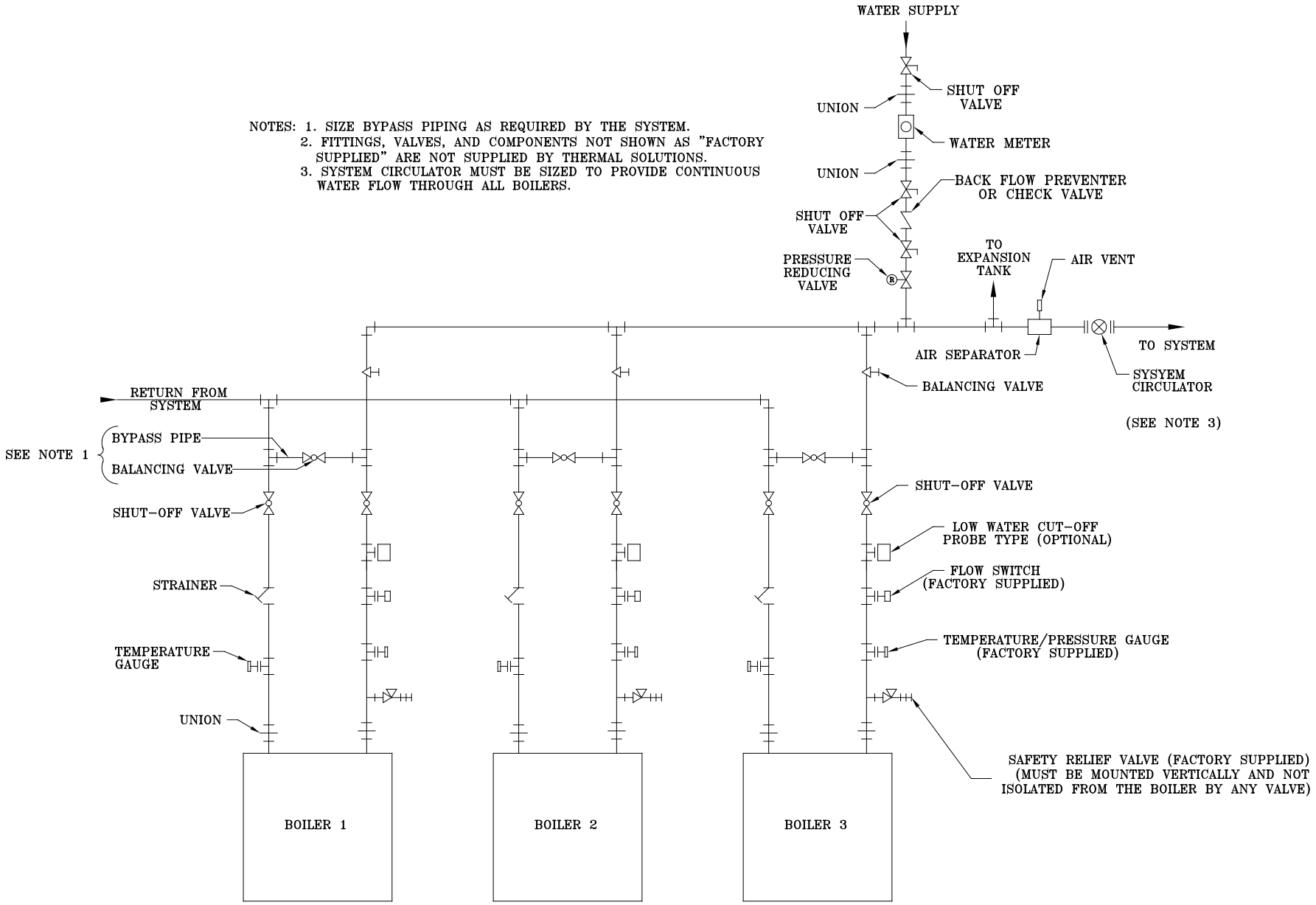
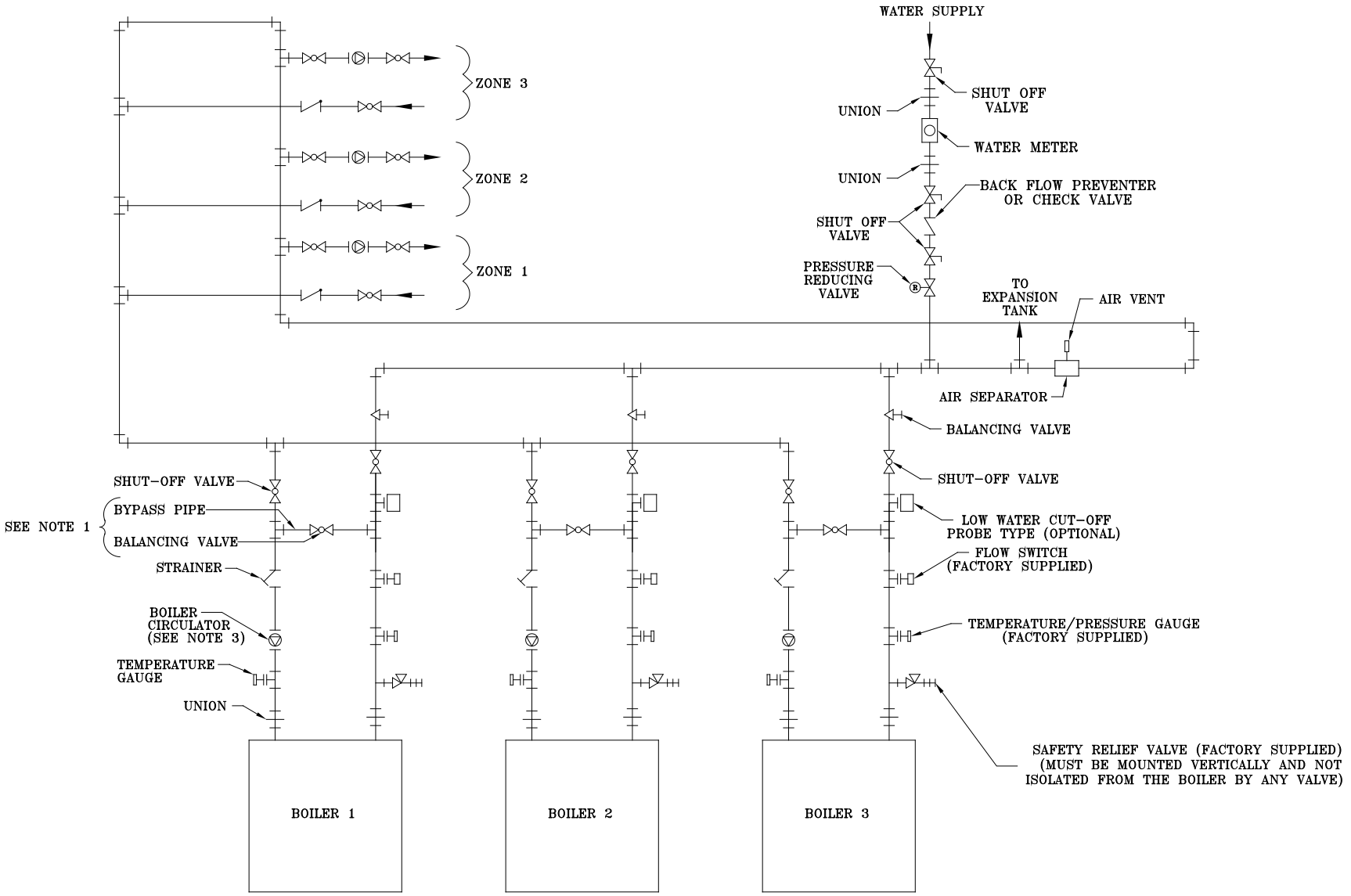


Figure 24: Modular System Reverse - Return with System Pump Only



NOTES: 1. SIZE BYPASS PIPING AS REQUIRED BY THE SYSTEM.
2. FITTINGS, VALVES, AND COMPONENTS NOT SHOWN AS "FACTORY SUPPLIED" ARE NOT SUPPLIED BY THERMAL SOLUTIONS.
3. BOILER PUMP MUST BE SIZED TO OVERCOME PRESSURE DROP ACROSS ENTIRE BOILER LOOP.

Figure 25: Modular System: Typ Primary/Secondary with Reverse-Return

VIII. System Start-up

A. **Safe operation** and other performance criteria were met with gas manifold and control assembly provided on boiler when boiler underwent tests specified in *American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers,* ANSI Z21.13.

B. Verify that the venting, water piping, gas piping and electrical system are installed properly. Refer to installation instructions contained in this manual.

C. Confirm all electrical, water and gas supplies are turned off at the source and that vent is clear of obstructions.

D. Confirm that all manual shut-off gas valves between the boiler and gas source are closed.

WARNING

Completely read, understand and follow all instructions in this manual before attempting start up.

E. FILL ENTIRE HEATING SYSTEM WITH WATER and vent air from system. Use the following procedure on a Series Loop or multi-zoned system installed to remove air from the system while filling.

WARNING

The maximum operating pressure of this boiler is 150 psig. Never exceed this pressure. Do not plug or change pressure relief valve.

NOTICE

If it is required to perform a long term pressure test of the hydronic system, the boiler should first be isolated to avoid a pressure loss due to the escape of air trapped in the boiler.
To perform a long term pressure test including the boiler, ALL trapped air must first be removed from the boiler.
A loss of pressure during such a test, with no viable water leakage, is an indication that the boiler contained trapped air.

1. Close full port ball valve in boiler supply piping.
2. Isolate all zones by closing zone valves or shut-off valves in supply and return of each zone(s).
3. Attach a hose to the vertical hose bib located prior to the full port ball valve in the system supply piping. (Note - Terminate hose in five gallon bucket at a suitable floor drain or outdoor area).
4. Starting with one circuit at a time, open zone valve or shut-off valve in system supply and return piping.
5. Open hose bib.
6. Open fill valve (Make-up water line should be located directly after full port ball valve in system supply piping between air scoop and expansion tank).
7. Allow water to overflow from bucket until discharge from hose is bubble free for 30 seconds.
8. Close the opened zone valve or shut-off valve for the zone being purged of air, then open the zone valve or shut-off valve for the next zone to be purged. Repeat this step until all zones have been purged. At completion, open all zone valves or shut-off valves.
9. Close hose bib, continue filling the system until the pressure gauge indicates required system operating pressure. Close fill valve.

   (Note - If make-up water line is equipped with pressure reducing valve, system will automatically fill to set pressure. Follow fill valve manufacturer's instructions).
10. Open isolation valve in boiler supply piping.
11. Remove hose from hose bib.

F. Confirm that the water flow switch is operating properly.

G. Turn on the electrical supply to the boiler and circulation system at the fused disconnect.

H. Prepare to check operation.

1. Obtain the gas heating value (in Btu per cubic feet) from the gas supplier.
2. Connect a manometer to the pressure tapping upstream V1 on the main gas valve. Use the G 1/8 test nipple provided. Reference item 7 on Figure 28.
3. Temporarily turn off all other gas-fired appliances.
4. Turn on gas supply to the boiler gas piping.
5. Purge the gas line of air.
6. Reset the low gas pressure switch.
7. Confirm that the supply pressure to the gas valve is 14 in. w.c. or less. Refer to Table 3 for the minimum supply pressure.
8. Open the field installed manual gas shut-off valve

DANGER

Do not use matches, candles, open flames or other ignition source to check for leaks.

located upstream of the gas valve on the boiler.

9. Check that boiler gas piping, valves, and all other components are leak free using a soap solution or a similar non-combustible solution, electronic leak detector or other approved method. Eliminate any leaks.

I. Follow the operating instructions to place the boiler into operation. Reference Figure 27.

J. Sequence of operation. See Figure 29. If boiler fails to operate properly, see Trouble shooting Guide in Section IX.

K. Select Desired Operating Mode. Refer to the Thermal Solutions Boiler Control ™ (TSBC ™) instructional manual supplied with the boiler.

L. Set operating limits. Refer to the TSBC ™ instructional manual supplied with the boiler.

M. Check Ignition control module shut-off.

1. Rotate the manual gas shut-off valves clockwise from “ON” to “OFF” position.
2. Turn on the boiler-operating switch located on the left side of the unit.
3. Allow boiler to complete prepurge and pilot trial for ignition (PTFI) sequence. Confirm that the flame control locks out on pilot flame failure.
4. Rotate the manual shut off valve for the pilot to allow gas flow to the pilot valve.
5. Allow the boiler to complete the pre-purge, PTFI, and main trial for ignition (MTFI). Confirm that the flam control locks out on main flame failure.
6. Rotate the manual shut off valves for the main gas valve to allow gas flow to the main gas valve. Confirm that the main flams ingnite smoothly. Test five times to confirm operation.
7. Disconnect the pilot lead wires from the pilot gas valve. If the burners do not shut down, determine the cause of the malfunction. Replace necessary items and check operation.

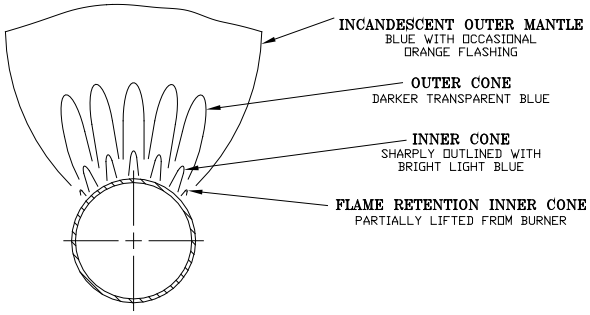


Figure 26: Pilot Burner/Main Burner Flame

FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: **If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury, or loss of life.**

A. This appliance is equipped with an ignition device, which automatically lights the pilot. Do not try to light the pilot by hand.

B. BEFORE OPERATING smell all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.

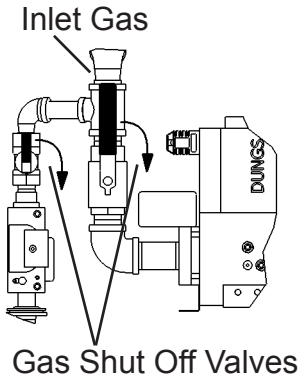
WHAT TO DO IF YOU SMELL GAS
• Do not try to light any appliance.
• Do not touch any electric switch; do not use any phone in your building.
• Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
• If you cannot reach your gas supplier, call the fire department.

C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.

D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

OPERATING INSTRUCTIONS

1. **STOP! Read the safety information above on this label.**
2. **Set the thermostat to lowest setting.**
3. **Turn off all electric power to the appliance.**
4. **This appliance is equipped with an ignition device, which automatically lights the pilot. Do not try to light the pilot by hand.**
5. **Remove front door.**
6. **Locate the gas pilot & main shutoff valves at the end of the gas supply pipe inside the boiler.**



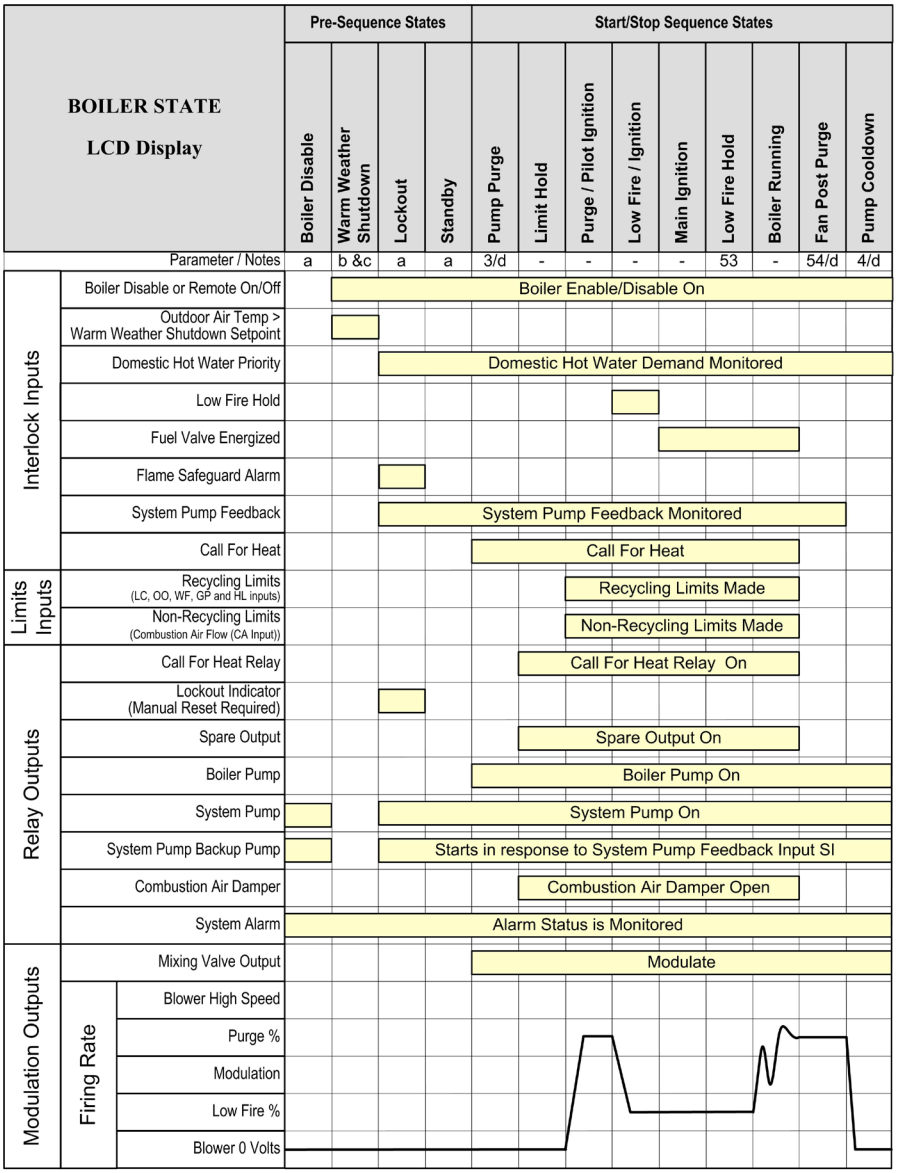
7. **Rotate gas shutoff valves clockwise from "ON" position to "OFF". Make sure handle rests against stop.**
8. **Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas, STOP! Follow "B" in the safety information above on this label. If you do not smell gas, go to the next step.**
9. **Rotate gas shutoff valves counterclockwise from "OFF" to "ON". Make sure handle rest against stop. Do not force.**
10. **Replace front door.**
11. **Turn on all electric power to the appliance.**
12. **Set thermostat to desired setting.**
13. **If the appliance will not operate, follow the instructions "TO TURN OFF GAS TO APPLIANCE" and call your service technician or gas supplier.**

TO TURN OFF GAS TO APPLIANCE

1. **Set the thermostat to lowest setting.**
2. **Turn off all electric power to the appliance if service is to be performed.**
3. **Remove front door.**
4. **Rotate gas shutoff valves clockwise from "ON" position to "OFF". Make sure handle rests against stop.**
5. **Replace front door.**

814SOL0001

Figure 27: Operating Instructions



Notes
a. Boiler Pump is “On” when the Boiler Pump is set to “On Always” or (the boiler is lead boiler and Boiler Pump is set to “On Lead”)
b. Boiler Pump is "On" when the Boiler Pump is set to "On Always" and WWSD is set to "WWSD of System Pump" or “Off”
c. System Pump is "On" when the System Pump is set to “yes” and WWSD is set to either "WWSD of Boiler" or "Off"
d. Boiler pump is "On" during Prepurge and Post Purge when Boiler Pump is set to "Purge" or (the boiler is lead boiler and Boiler Pump is set to “On Lead”)
e. Combustion Air Damper Spare Output is maintained “On” for 2 minutes after the Call For Heat is removed.
f. Firing rate held at purge % when low fire input not provided.

Figure 28: Sequence of Operation

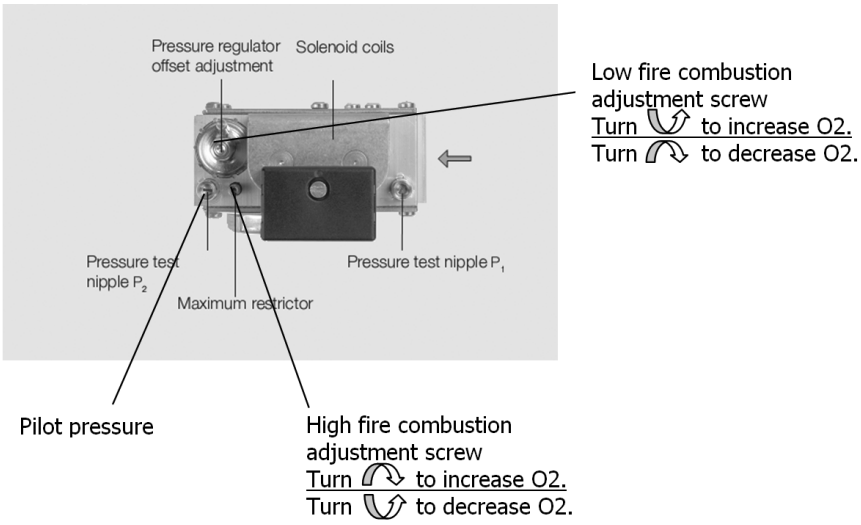
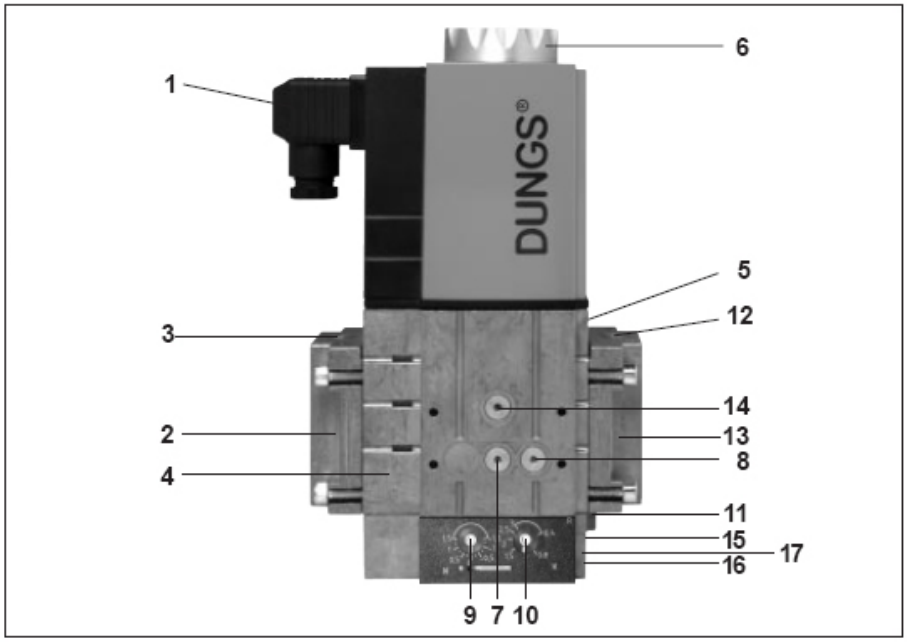


Figure 29A: SOL500-1500 Pilot Valve



1	Electrical connection for valves (DIN EN 175 301-803)	10	Setting screw Ratio V
2	Input flange	11	Vent nozzle G 1/8
3	Pressure connection G 1/8 upstream of filter	12	G 1/8 pressure connection Burner pressure p_{Br}
4	Filter	13	Output flange
5	Type plate	14	Test point connection G 1/8 upstream of V1, possible both sides
6	Cover	15	G 1/8 pressure connection blower pressure p_L
7	Test point connection G 1/8 upstream of V1, possible on both sides	16	G 1/8 pressure connection for p_F furnace pressure
8	Test point connection G 1/8 downstream of V2 possible on both sides	17	Optional: Pulse line p_Br
9	Setting screw Zero point adjustment N	*	G 1/8: 1/8” Iso Parallel Threads

Figure 29B: Main Gas Valve

O. Check the pilot and main burner flames. Allow the boiler to complete pre-purge, PTFI, and MTFI. Look through the boiler sight glass and check the pilot and main burner flames. Reference Figure 26 for flame appearance. The flames should have a clearly defined inner cone with no yellow tipping. Orange-yellow streaks should not be confused with true yellow tipping. If the flames do not meet the criteria in Figure 26, adjust the gas valve settings as described in step R.

P. Check low water cut-off (if so equipped).

1. Adjust setpoint to highest setting.

2. With boiler operating, open the drain valve and slowly drain the boiler.

3. Main burners and pilot burner will extinguish and blower will stop when the water level drops below the low water cutoff probe. Verify limit, thermostat or other controls have not shut off the boiler.

4. Adjust the setpoint to the desired value and refill the boiler.

Q. Verify that all safety and operating limits are operating properly. These controls and limits include differential air switch, water temperature operating control, manual reset water temperature safety limit, and the high and low gas pressure switches (if provided). Refer to the individual manuals, provided with the boiler, for these components to obtain proper start-up and operating instructions. Follow all instructions contained in these manuals. Refer to section IX to view a description of the safety and operating controls.

R. Adjust the gas input rate to the boiler.

1. Administer a call for heat and allow the boiler to operate.

2. Check the manifold pressure at high fire and low fire. See table 3 or the rating label located in the boiler's vestibule compartment.

a. Connect manometer to pressure tapping downstream V1 on main gas valve. See item 8 on Figure 28.

b. Use the V setting (Item 10 on Figure 28) on the main gas valve to adjust the gas manifold pressure at high fire. Turn the screw setting clockwise to increase and counterclockwise to decrease the manifold pressure.

c. Use the N setting (Item 9 on Figure 28) on the main gas valve to adjust the gas manifold pressure at low fire. Turn the screw setting clockwise to increase counterclockwise to decrease the manifold pressure.

3. Clock the gas meter for at least 30 seconds. Use Table 7 to determine the gas flow rate in cubic feet per hour.

4. Determine the input rate. Multiply the gas flow rate by the gas heating value.

5. Compare the measured input rate to the input rate stated on the rating plate.

a. The boiler must not be over fired. Reduce the input rate by decreasing the manifold pressure as described in step R. Do not reduce more than 0.3 inch w.c. If the boiler is still over fired, contact your Thermal Solutions representative.

WARNING

Failure to properly adjust gas input will result in over firing or under firing of the appliance. Improper and unsafe operation may result.

b. If the measured value is less than 98% of the rating plate input, increase the input rate by increasing the manifold gas pressure described in step R. Do not increase the manifold pressure more than 0.3 inch w.c. Contact your Thermal Solutions representative if the measured rate is still less than 98% of the rated input.

WARNING

Failure to properly adjust excess air will result in unsafe levels of carbon monoxide. Variations in venting or combustion air pressure and temperature will change excess air. Adjust excess air levels so that variation in venting or combustion air pressures and temperatures caused by change of seasons, wind conditions, opening or closing of boiler room doors or windows do not cause the boiler to operate with carbon monoxide concentrations above 400 parts per million.

6. Measure the percent oxygen (%O2), the carbon monoxide concentrations in the flue gas (CO ppm), and the flue gas temperature. Compare the results with the values given on the factory fire test report supplied with the boiler.

7. Return gas fired appliances to previous conditions of use.

S. Review user's information manual and system operation with owner or operator.

Table 7: Gas Flow Rate in Cubic Feet Per Hour			
Seconds for One Revolution	Size of Gas Meter Dial (Measured Volume per Revolution)		
	½ Cu. Ft.	1 Cu. Ft.	2 Cu. Ft.
	CFH	CFH	CFH
30	60	120	240
32	56	113	225
34	53	106	212
36	50	100	200
38	47	95	189
40	45	90	180
42	43	86	171
44	41	82	164
46	39	78	157
48	38	75	150
50	36	72	144
52	35	69	138
54	33	67	133
56	32	64	129
58	31	62	124
60	30	60	120

T. After boiler and system water has cooled to less than 80°F, turn boiler on and observe the return water temperature from the system. If the return water temperature rises to above 120°F in less than five (5) minutes, leave the bypass balancing valve fully closed. If return water temperature is not above 120°F or it takes a longer period than five (5) minutes to rise above 120°F, slowly open bypass balancing valve. Continue to open bypass balancing valve so that return water temperature is above 140°F. Note that if the temperature does not rise above 140°F with the bypass valve fully open, slowly begin to close balancing valve in the system and return piping until appliance return water temperature is above 140°F. Turn off and allow boiler and system water to cool to less than 80°F. Turn on and note return water temperature to the boiler. Confirm that water temperature rises above 120°F in less than five (5) minutes. If not, continue to open bypass balancing valve.

U. When water adjustment is complete, allow boiler to operate and confirm proper operation. Place system control back in normal operation.

IX. Service and Maintenance

DANGER
This boiler uses flammable gas, high voltage electricity, moving parts, and very hot water under high pressure. Assure that all gas and electric power supplies are off and that the water temperature is cool before attempting any disassembly or service.
Do not attempt any service work if gas is present in the air in the vicinity of the boiler. Never modify, remove or tamper with any control device.

WARNING
This boiler must only be serviced and repaired by skilled and experienced service technicians.
If any controls are replaced, they must be replaced with identical models.
Read, understand and follow all the instructions and warnings contained in all the sections of this manual.
If any electrical wires are disconnected during service, clearly label the wires and assure that the wires are reconnected properly.
Never jump out or bypass any safety or operating control or component of this boiler.
Read, understand and follow all the instructions and warnings contained in ALL of the component instruction manuals.
Assure that all safety and operating controls and components are operating properly before placing the boiler back in service.

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

ATTENTION
Au moment de l'entretien des commandes, étiqueteztous les fils avant de les débrancher. Des erreurs de câblage peuvent entraîner un fonetionnement inadéquat et dangereux.
S'assurer que l'appariel fonctionne adéquatement une fois l'entretien terminé.

A. Periodic Maintenance. Inspection and service should be conducted periodically. Turn off electrical power and gas supply while conducting service or maintenance. Follow instructions TO TURN OFF GAS TO APPLIANCE. See Figure 27.

1. **General**

a. Keep the area around the boiler free from combustible materials, gasoline and other flammable vapors and liquids.

b. Keep the area around the combustion air inlet terminal free from contaminants.

c. Keep the boiler room ventilation openings open and unobstructed.

2. Low water cutoff (LWCO, if so equipped).

a. Probe Type (Annual Service). Probe type LWCO should be removed once a year, examined and cleaned of any dirt accumulations to assure proper operations. Do not attempt to repair mechanisms in the field. Complete replacement mechanisms, including necessary gaskets and installation instructions, are available from the manufacturer.

3. Vent/Air Intake System. Inspect for obstructions, soot accumulation, proper support, deterioration of pipe, fittings, and joints.

a. Clean terminal screens. Terminals must be free of obstruction, undamaged, with screens securely in place.

b. Inspect and clean the air filter as needed. The filter can be cleaned using water. See Figure 39, Item 11, for location.

c. Terminal Wall thimbles (if used) must be weathertight.

d. Pipe must be full round shape, and show no damage from impact or excessive temperature.

e. Ensure that there is nothing obstructing the flow of combustion air and/or flue gas.

f. Inspect and clean piping with soft bristle brush and vacuum to remove any lint, soot, or other dirt.

g. Replace immediately if any signs of deterioration or corrosion are present.

h. Pipe must be supported at minimum five (5) foot intervals and must not sag.

i. All vent joints must be secure and watertight.

j. All air intake joints must be secure and airtight.

k. Horizontal vent tee drain or vertical vent tee drain (if used) must have minimum 6 inch trap and allow condensate to flow freely. To Clean:

   i. Disconnect drain tube from drain fitting.

   ii. Flush drain tube with water. Fill trap with water.

   iii. Securely fasten drain tube to drain fitting, providing gas-tight and watertight seal.

l. If pipe must be disassembled for removal of obstructions or resealing of joint, see Section III, Paragraph B.

4. Inspect Condensate Drain Trap and Drain Line (Monthly)

a. Inspect condensate trap water level. If low, add water to bring level to trap discharge.

b. Ensure condensate can flow freely to drain.

5. Inspect Pilot and Main Burner Flames (Monthly).

a. Remove jacket front panel.

b. View flames through Flame Observation Port.

c. Adjust thermostat to highest setting.

d. Check pilot flame. See Figure 26. The pilot produces three (3) flames. The center flame should be steady, medium hard blue enveloping 3/8 to 1/2 inch of sensing probe. If flame is yellow and lazy, follow instructions TO TURN OFF GAS TO APPLIANCE (see Figure 27), and contact qualified agency.

e. Check main burner flames. See Figure 26. Flame should have clearly defined inner cone with no yellow tipping. Orange-yellow streaks caused by dust should not be confused with true yellow tipping. If yellow flames are observed, follow instructions TO TURN OFF GAS TO APPLIANCE (see Figure 27), and contact qualified service agency.

6. Combustion Chamber/Burners . Inspect for blockage or soot accumulation (annually).

a. Remove Main Burners. See Figure 30.

   1. Remove front door.

   2. Remove air box cover.

   3. Disconnect ignition wire, sensor wire, ground wire and gas valve wiring.

   4. Disconnect manifold unions at pilot valve and main gas inlet on right side of air box.

   5. Remove attachment screws holding air box to front of combustion chamber.

   6. Remove burner/fuel train assembly from combustion chamber.

   7. Inspect and clean burners with soft bristle brush and vacuum to remove any dirt and lint.

   8. If burners show signs of deterioration or corrosion, replace immediately.

   9. Check gas orifices for dirt and lint. Clean as necessary.

   10. Inspect heat exchanger and combustion chamber. Clean heat exchanger with straight handle wire brush and vacuum heat exchanger and combustion chamber.
      1. Exercise care during vacuuming to avoid damaging base insulation.

   11. Inspect combustion chamber/burner assembly gaskets and replace if required.

   12. Install burner/fuel train assembly and secure with original fasteners.

   13. Connect manifold unions, ignition wire, sensor wire, ground wire and gas valve wiring.

14. Install air box cover and attachment hardware.

15. Install front door.

7. Check Operation . Follow steps from Section VIII for system start-up.

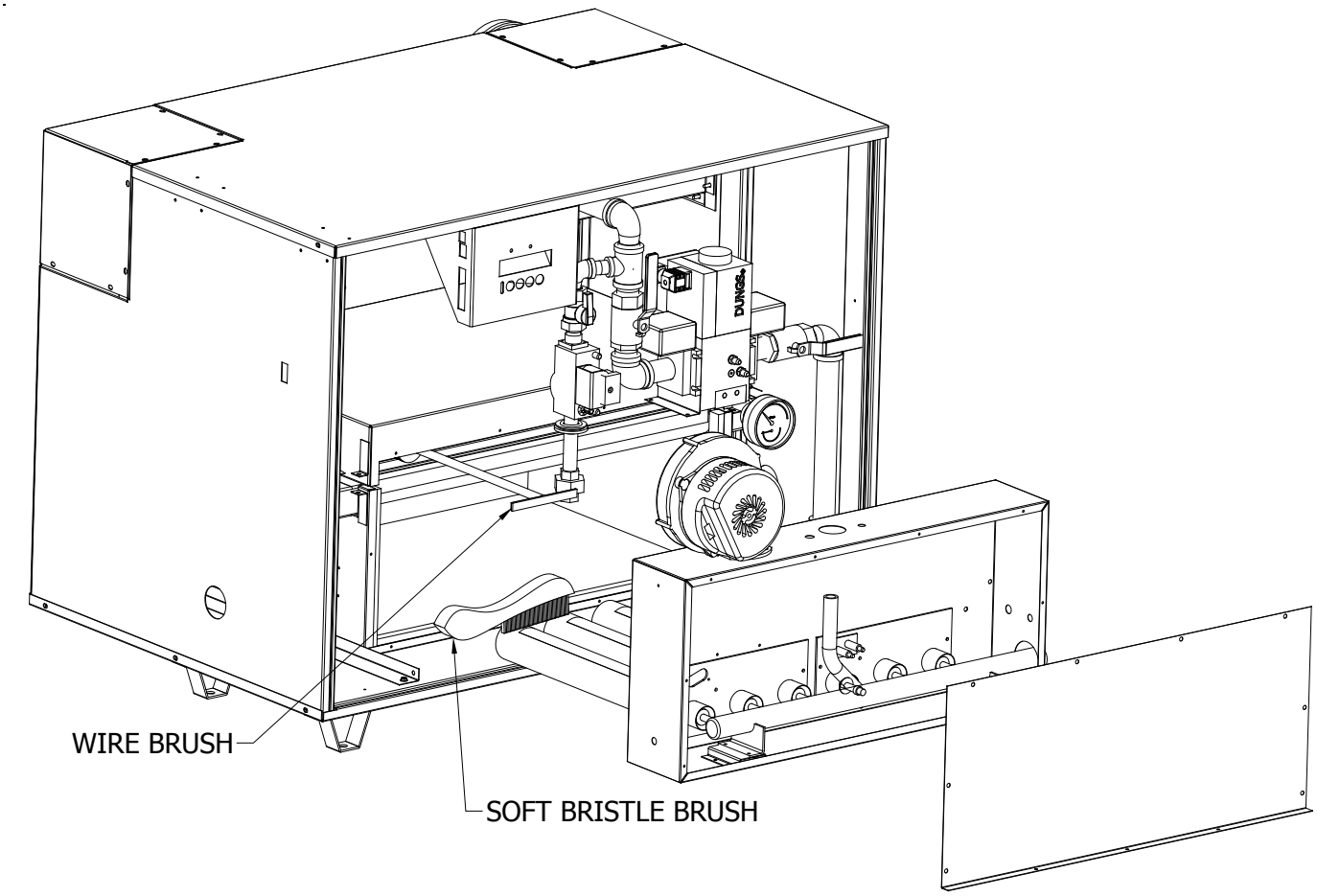


Figure 30: Cleaning Boiler Flue Passages

B. Safety and Operating Controls. Operation and Shut Down

Component	Function
Circuit Board Fuse	If the power draw of the control circuit exceeds approximately 5 amps, the circuit board fuse trips and prevents the boiler from operating until the fuse is replaced.
Power Switch	If this switch is in the off position, power is interrupted to the control circuit of the boiler, which prevents the boiler from operating. If the switch is in the on position, power is supplied to the control circuit.
Operating Aquastat	If the boiler water temperature exceeds the adjustable set point, power is interrupted to the control circuit of the boiler, which prevents the boiler from operating. When the boiler water temperature drops below the set point minus the adjustable differential setting, power is again supplied to the control circuit.
Manual Reset High Limit Aquastat	If the boiler water temperature exceeds the adjustable set point, power is interrupted to the control circuit of the boiler, which prevents the boiler from operating. Power is interrupted until the control is manually reset by pressing the control's reset button. When the button is depressed, power will again be supplied to the control circuit.
Flow Switch	If the water flow through the boiler drops below the fixed flow rate required to move the control's paddle enough to close the control's contacts, power is interrupted to the control circuit, which prevents the boiler from operating. When the water flow rate is increased, the paddle closes the control's contacts and power is supplied to the control circuit.
Pressure (Safety) Relief Valve	If the pressure inside the appliance exceeds the fixed set point, the valve opens mechanically and discharges water. The valve remains open until the pressure inside the appliance drops below the set point.
Vestibule Fuseable Link	If the temperature in the interior of the vestibule enclosure exceeds the fixed set point, the contacts of the switch open and power is interrupted to the control circuit, which prevents the boiler from operating. Power is interrupted until the switch is replaced.
High and Low Gas Pressure Switches	If the gas pressure reaches a point below the adjustable set point, or above the adjustable set point, the contacts of the switch open and power is interrupted to the control circuit, which prevents the boiler from operating. Power is interrupted until gas pressure is between the high and low set points and the control is manually reset by moving the switch to the reset position. The switches will not reset until the gas pressure is within the set point parameters.
Combustion Air Flow Switch	If the differential air pressure drops below the fixed set point, the contacts of the switch open and power is interrupted to the control circuit, which prevents the boiler from operating. Power is interrupted until air flow increases so that the contacts close.
Flame Safeguard Control	Refer to the manual supplied with the boiler.
Thermal Solutions Boiler Control™ (TSBC)™	The Thermal Solutions Boiler Control™ (TSBC™) is a complete boiler monitoring and automation system. It provides advanced boiler modulation control, operating control, diagnostics, multiple boiler lead lag and auxiliary device control. Refer to the TSBC manual shipped with the boiler to learn more about these features and functions.

C. Trouble Shooting Guide

Alarm Messages are shown one at a time in priority order. The message closest to the top of this list is displayed first. Following messages are not show until the higher priority message has cleared. All alarm messages are also stored in the fault history.

LCD Display Alarm Message	Recommended Action	Explanation
Low Water Level	Manually Reset the Low Water Cutoff	**Low Water Cutoff Switch** When this option is configured and an instrument is installed, the manual reset low water safety relay is preventing the boiler from starting. If terminal (LC) does not receive power and the Call For Heat output (CH) is powered the “Low Water Level” Message is displayed.
Off Switch	Turn Burner Switch On	**Burner Switch is Off** Control switch is in the OFF position and is preventing the boiler from starting. If terminal (OO) does not receive power and the Call For Heat output (CH) is powered the “OFF Switch” Message is displayed.
Low Water Flow	Ensure Boiler Pump is Running and Boiler Water Flow is Unobstructed	**Low Water Flow Switch** Low water flow is preventing the boiler from starting. If terminal (WF) does not receive power and the Call For Heat output (CH) is powered the “Low Water Flow” Message is displayed.
Fuel Limit	Manually Reset the Fuel Pressure Switch	**Low or High Gas Pressure Switch** The low or high gas pressure switch is preventing the boiler from starting. If terminal (GP) does not receive power and the Call For Heat output (CH) is powered the “Fuel Limit” Message is displayed.
High Temp Limit	Manually Reset the High Temperature Aquastat	**High Limit Temperature** The high temperature limit (HL) (and operational temperature limit when provided) aquastat is preventing a boiler start. If terminal (HL) does not receive power and the Call For Heat output (CH) is powered the “High Temp Limit” Message is displayed.
Low Air Flow	Check Combustion Air Blower and Air Pressure Switch Settings and Wiring	**Low Air Flow or Blocked Vent Switch Not Made** The air flow (and blocked vent switch when provided) is preventing a boiler start. If terminal (CA) does not receive power and the Call For Heat output (CH) is powered the “Low Air Flow” Message is displayed.
FSG Fault	Manually Reset Required, Refer to Flame Safeguard Manual Corrective Actions	**Flame Safeguard Fault** The Flame Safeguard is preventing a boiler start. If terminal (AL) receives power at any time, the “Flame Failure” Message is displayed.
Outlet Temp Fail	Check Wiring and Sensor	**Boiler Outlet Temperature Sensor Fail** The boiler outlet temperature sensor is not connected or is reading above or below a valid range. When the boiler outlet sensor fails and the Outlet Sensor mode was selected the control will transfer to Lost Sensor Blind Mode.
Inlet Temp Fail	Check Wiring and Sensor	**Boiler Inlet Temperature Sensor Fail** The boiler inlet temperature sensor is not connected or is reading above or below a valid range. When the boiler inlet sensor fails the mixing valve output will drive to 0% and low temperature alarm and maximum water differential (boiler outlet minus boiler inlet) temperature hold are disabled.
OA Temp Fail	Check Wiring and Sensor	**Outside Air Temperature Sensor Fail** The outside air sensor is configured and is not connected or is reading above or below a valid range. When the outside air sensor fails the warm weather shutdown (WWSD) and outside air reset control logics are disabled.
Remote Temp Fail	Check Wiring and Sensor	**Remote System Temperature Sensor Fail** The remote system temperature sensor is configured and is not connected or is reading above or below a valid range. If Remote System Temperature Sensor mode was selected the control will transfer to Boiler Outlet Sensor Mode.

Trouble Shooting Guide (continued)

LCD Display Alarm Message	Recommended Action	Explanation
Remote Input Fail	Check Wiring and Remote System	**Remote Control Input Fail** The Remote Control Input is configured and is not connected or is above or below a valid range. When the remote control input fails the following control mode changes are taken automatically: Selected Modes — Resulting Control Mode Remote Mod — Outlet Sensor and Local Setpoint Remote Mod & Remote Sensor — Remote Sensor and Local Setpoint Remote SP — Outlet Sensor and Local Setpoint Remote SP & Remote Sensor — Remote Sensor and Local Setpoint
Comm Failure	Check Wiring and Remote System Confirm each boiler has a unique address	**Communication Failure** The Modbus or Peer-To-Peer network has failed. When the Modbus network fails the following control mode changes are taken automatically: Selected Modes — Resulting Control Mode Modbus Mod — Outlet Sensor and Local Setpoint Modbus Mod & Remote Sensor — Remote Sensor and Local Setpoint Modbus SP — Outlet Sensor and Local Setpoint Modbus SP & Remote Sensor — Remote Sensor and Local Setpoint After a Modus communication failure, the 'Comm Failure' alarm is not cleared until communication is restored and successfully writes to both the Remote On / Off Modbus Command (00004) and Remote Firing Rate or Remote Setpoint (40006) points have been completed, power is cycled, or the protocol parameter is changed to Peer-To-Peer and then back to Modbus. When a Peer-To-Peer network has failed the boilers begin operation as stand alone boilers using the selected parameters. After a Peer-To-Peer communication failure the 'Comm Failure' alarm is not cleared until communication is restored and the boiler rejoins a network with at least one other boiler, power is cycled, or the protocol parameter is changed to Modbus and then back to Peer-To-Peer.
Low Inlet Temp	Check wiring and sensor Check return water temperature. Consider system or operational changes to avoid low temperature events	**Low Boiler Inlet Temperature** If the boiler inlet temperature is below the low boiler inlet temperature setpoint, the "Low Inlet Temp" Message is displayed and the boiler inlet temperature history is stored. See following page for additional information on low boiler inlet temperature history storage and retrieval.
Memory Failure	Call Factory Reset all memories in System menu: Clr BIT History Clr Alarm Hist Clr Run Time Cnt Clr Cycle Cnt Factory Defaults (Factory Level Password is required)	**Memory Failure** New software has been installed in the TSBC™ or a power interruption has caused a memory failure. The Call For Heat will be prevented until the condition is cleared.

X. Thermal Solutions Boiler Control™ (TSBC™)

A. **INTRODUCTION** - The intent of this section is to briefly summarize the controllers capabilities, familiarize the user with its basic features and to list the factory supplied default settings. Read the additionally supplied Factory Instruction Manual for the TSBC to learn more about the controllers features and capabilities.

1. **Thermal Solutions Boiler Control™ Overview**

   The Thermal Solutions Boiler Control™ (TSBC™) is a complete boiler monitoring and automation system. The TSBC™ provides advanced boiler modulation, operating control, diagnostics, multiple boiler lead-lag and auxiliary device control. The TSBC™ provides advanced control features in an easy to use package.

2. **Flexible, Field Selectable Control**

   Control modes, water system, boiler auxiliary and modulating lead/lag control features are menu selectable without the need for external programmers, lap tops or down loads. Every boiler is shipped with factory defaults that make field menu selections unnecessary unless you are applying additional control features.

3. **Boiler Monitoring and Diagnostic Displays**

   The TSBC™'s two line by sixteen character LCD display may be used for monitoring boiler inlet and outlet, remote system and outside air temperatures, modulation rate setpoint and modulating percent and mixing valve demand percent. Additionally, the display automatically presents boiler sequence messages, alarms, hold and lockout messages. A diagnostic menu is included that provides the last 10 alarm messages and boiler inlet temperature alarm history. Boiler inlet temperature alarm history includes time and date, the lowest inlet temperature reached and the amount of time the water temperature dropped below the alarm setpoint.

4. **Modulation Rate and On/Off Modes**

   The TSBC™ may simply control boiler modulation and on/off output based on the boiler water outlet temperature and an operator adjusted setpoint. However, using parameter selections, the TSBC™ allows the boiler modulation and on/off output to respond to remote system water and outside air temperatures, Domestic Hot Water Priority (DHWP) input or Energy Domestic Hot Water Priority (EMS) modulation rate demand, remote setpoint or remote start/stop commands. Parameter selections of remote system water temperature and remote mode determine the choice of one of six different control modes.

5. **Advanced Availability**

   The above control modes are menu selectable options. However, if a selected sensor fails, the TSBC™ automatically changes to a control mode that will allow continued automatic operation of the boiler. For example, in the event of a remote system temperature sensor failure, the TSBC™ will automatically switch to boiler outlet temperature sensor based control.

6. **Outdoor Air Reset**

   When selected the modulation rate setpoint is automatically adjusted based on outside air temperature. Outdoor air "reset" setpoint saves fuel by adjusting the water temperature of a heating boiler lower as the outside air temperature increases.

7. **Warm Weather Shutdown (WWSD)**

   Some boilers are used primarily for heating buildings, and the boilers can be automatically shutdown when the outdoor air temperature is warm. When outside air temperature is above the WWSD setpoint, this function will prevent the boiler, boiler pump and/or the system pump from starting.

8. **Domestic Hot Water Priority (DHWP)**

   Some boilers are used primarily for building space heating, but also provide heat for the domestic hot water users. When the outdoor temperature is warm, the outdoor reset setpoint may drop lower than a desirable domestic hot water temperature. When enabled and a DHWP contact input is detected, the hot water setpoint is adjusted to be greater than a field adjustable DHWP Setpoint.

9. **Water Side Control Outputs**

   In order to maximize the life and availability of a hot water systems it may be desirable to automate mixing valves, boiler pumps, system pumps, and standby system pumps. The TSBC™ makes this type of automation totally integrated and cost effective. The control of these devices is field selectable through simple yes/no menu selections.

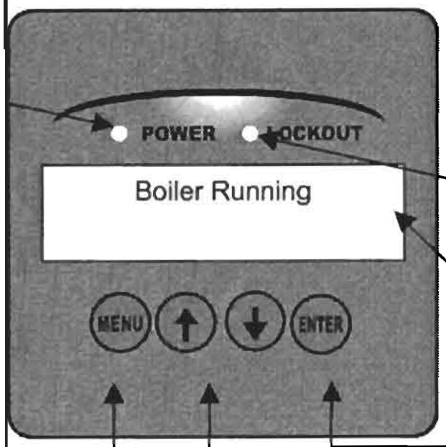
10. **Combustion Air Side Control Outputs**

    Boiler room Combustion air dampers (fresh air dampers) and Vent Inducer control outputs are field selectable options.

11. **Peer-To-Peer Network**

    The TSBC™ includes state-of-the-art modulating lead-lag sequencer for up to eight (8) boilers capable of auto rotation, outdoor reset and peer-to-peer communication. The peer-to-peer network is truly "plug and play". Communication is activated by simply connecting a RJ11 telephone line between boilers. The TSBC™ provides precise boiler coordination by sequencing boilers based on both remote system

FRONT PANEL DISPLAY



POWER LED	[Steady On Green LED] indicates power is available down stream of the Electronic Control Module's on board fuse. [Flashing On Green LED] indicates manual mode operation for boiler modulation, Call For Heat and/or mixing valve modulation
ALARM LED	[Steady On Red LED] indicates an alarm is active. [Flashing On Red LED] indicates a lockout alarm is active and a manual reset may be required
SCREEN	2 line by 16 character display provides operational, alarm, sequence status, configuration and diagnostic user interface
ENTER	The ENTER key has no function in display mode. The ENTER key is used to select menus, menu items and save edited parameters as follows: Select Mode (steady text): Press ENTER to change into Edit Mode or select a menu or menu item Edit Mode (blinking text): Press ENTER to save the current value. Press MENU to cancel the current editing operation
UP, DOWN	Select Mode (steady text): Press UP, DOWN to change the selected display and move up and down menu items. Edit Mode (blinking text): Press UP, DOWN to increases or decreases the value of the number being edited, or scrolls through a list of choices.
MENU	Press and hold MENU to change to the Main Menu screen. When in a sub menu screen, press MENU to move to the next higher menu. When in Edit Mode (blinking text) Press MENU to cancel the current editing operation

B. Thermal Solutions Boiler Control™ (TSBC™) Wiring

When wiring to the Thermal Solutions Boiler Control (TSBC™) terminals, see the terminal layout drawing on the following page or the terminal markings on the control itself. The TSBC™ terminals are removable for easier field wiring connection.

Label 101175-04

Thermal Solutions Boiler Control™ (TSBC™) TERMINAL LAYOUT GUIDE

(Terminal connections as viewed from front of boiler)

RJ-11 (6 pin)

Boiler Peer-To-Peer Communication Network

Alternate Connection For Outside Air Temperature and Remote System Temperature (10k ohm Thermister, 5 Vdc)

RJ-45 (8 pin)

BC — (10k ohm Thermister, 5 Vdc) Common

BO — Boiler Outlet Temperature

BI — Boiler Inlet Temperature

WARNING:
All connections have different inputs and outputs.
Refer to connections on diagrams for individual inputs/outputs.

24 Vac

LC — Low Water Cutoff Switch Input

CH — Call For Heat Output

NOTE:
Valid signal range for terminals C+ and C- is 1-9VDC.
See boiler wiring diagram for details.

C, C, C — 12Vdc Common

SO — Spare Output (Programmable)

SP — System Pump Start/Stop

BP — Boiler Pump Start/Stop

VI — Spare Output Start/Stop

LO — Lockout Indicator

⚠ 12 Vdc, 0.5 A max total for LO, VI, BP, SP and SO

24 Vac

CA - Low Combustion Air Flow

HL - Operating or High Limit

GP - Gas Pressure Switch

WF - Low Water Flow Switch

OO - Burner On/Off Switch

V-, V+ - Firing Rate Demand (0-10 Vdc)

P-, P+ - Firing Rate Demand (0-10 Vdc, PWM)

O+, O+ — Outside Air Temperature (10k ohm Thermister, 5 Vdc)

O-, O- — Remote System Temperature (10k ohm Thermister, 5 Vdc)

R+, R+, R-, R-

MR, MS — Mixing Valve Output (4-20 mAdc)

C-, C+ — Remote Firing Rate or Setpoint Input (0-10 Vdc) (See Note)

C — Power Common (-24 Vac)

PR — Power Supply (+24 Vac)

AL — Flame Safeguard Alarm (24 Vac)

CS — Fuel Valve Energized (24 Vac)

WF	GP	HL	CA	
P+	P-	V+	V-	OO

12 Vdc

DP — Domestic Hot Water Priority

LR — Local / Remote

RO — Remote On / Off (Enable)

SI — Spare Input (Programmable)

C, C — 12 Vdc Common

C. SECURITY MENU

1. Press and hold the MENU button to enter menu mode.
2. Access parameters and set password.
   a. In MENU mode page through to the SECURITY menu and press ENTER.
   b. Page down to the "Enter Password" parameter and press ENTER.
   c. Use the arrow buttons to change the password value to the desired password and **hold** ENTER until the screen flashes.
3. The access level will reset to Basic after one hour if no key is pressed, or if power is removed.

PASSWORD

Access Level	Enter Password	Description
Basic	0 (NONE)	This is the default access level. The user can view many parameters, but is only allowed to edit a small sub-set of the parameters that are visible.
Supervisor	15	This password is set at the factory but can be changed in the field. The user can view and edit most parameters that are visible. Note: Not all parameters will be visible at the Supervisor Access Level.
Factory		All relevant internal parameters in the system will be visible and programmable. Please consult Thermal Solutions for the factory access level password.

Consult Thermal Solutions Boiler Control (TSBC) Instruction manual for operation guidance and a detailed list of parameters and their associated access levels.

D. SETUP MENU

Display	Factory Settings	Range/Choices	Description
			WWSD Specifies Warm Weather Shut-Down (WWSD) control of boiler and/or system pump:
WWSD	Off	Off	Ignores Warm Weather setpoint
		WWSD of Boiler	When Outside Air Temperature (OAT) is higher than the WWSD setpoint, inhibits boiler start
		WWSD of Sys Pump	When OAT is higher than the WWSD setpoint de-energize System Pump output (SO)
		Both	When OAT is higher than the WWSD setpoint, inhibit Call for Heat and de-energized system pump output (SO)
LL Start Trigger	90	50 to 100	LL Start Trigger Specifies the percent of maximum modulation rate the running boiler(s) must reach before calling upon additional boilers for help.
LL Stop Trigger	25	0 to 50	LL Stop Trigger Specifies the percent of modulation rate that the running boiler(s) must be below before shutting down a lag boiler.
Boiler On Delay	120	0 to 900	Boiler On Delay Time Delay after the On Point setpoint before starting the next boiler. Short time delay to prevent nuisance starts due to momentary temperature and modulation rate swings.
Boiler Off Delay	120	0 to 900	Boiler Off Delay Time Delay after the Off Point setpoint before stopping the next boiler. Short time delay to prevent nuisance stops due to momentary temperature and modulation rate swings.
High Fire Limit	100	40 to 100	High Fire Limit High modulation rate limit for all boilers on the peer-to-peer network as long as at least one boiler is still not running. After the last boiler has started the modulation rate is released up to 100%.
Rotation	Disable	Disable Enable	Rotation Specifies number of hours (cumulative) a lead boiler runs before passing the lead to another boiler. Lead rote will be surrendered earlier if the lead boiler is placed into manual mode, is running remotely (mode 6), fails to start, is “blind” (all input sensors failed), or is satisfying a DHWP request.
Rotation After	168	8 to 720	Rotate After Specifies number of hours (cumulative) a lead boiler runs before passing the lead to another boiler.
			Outdoor Sensor Enables the Outside Air Temperature sensor and display and control logic:
Outdoor Sensor	No	No	Outside Air Input (O+O-) is ignored.
		Display Only	Do Not Calculate setpoint based on outdoor temperature, Display Outside Air Temperature
		Outdoor Reset	Calculate the temperature setpoint based on outdoor temperature using a reset curve defined by Outdoor Set Up, Boiler Set Up, Outdoor Design and boiler Design parameters.
Outdoor Set Up	55°F	40°F to 100°F	Outdoor Set Up The Outdoor Set Up temperature is the outdoor temperature at which the Boiler Set Up temperature is supplied. Only visible when Outdoor Sensor is set to Outdoor Reset.
Boiler Set Up	140°F	80°F to 180°F	Boiler Set Up The Boiler Set Up temperature is the starting boiler water temperature of the reset ratio. If the building feels cool during mild outdoor conditions, the Boiler Set Up setting should be increased. Only visible when Outdoor Sensor is set to Outdoor Reset.
Outdoor Design	30°F	-20°F to 50°F	Outdoor Design The Outdoor Design temperature is the outdoor temperature at which the Boiler Design temperature is supplied. Only visible when Outdoor Sensor is set to Outdoor Reset
Boiler Design	180°F	80°F to 220°F	Boiler Design The Boiler Design setting is the water temperature required to satisfy the building heat loss during the Outdoor Design temperature. If the building feels cool during cold outside conditions, the Boiler Design setting should be increased. Only visible when Outdoor Sensor is set to Outdoor Reset.
Local PID P	20	0 to 10000	Local PID P Promotional gain value for boiler outlet temperature sensor control Modes. A larger gain value results in tighter, more active, PID control. Gain is the primary PID modulation rate tuning adjustment and provides the immediate modulation rate response.

D. Setup Menu (Continued)

Display	Factory Settings	Range/Choices	Description
Local PID I	30	0 to 10000	Local PID I Integral Gain value for boiler outlet temperature sensor control Modes. A smaller value makes the Integral ramp in less time (i.e.., faster). Integral is a secondary PID modulation rate tuning adjustment that ramps the output over time (typically minutes).
Local PID D	0	0 to 10000	Local PID D The Derivative Gain value for boiler outlet temperature sensor control Modes. A larger Derivative gain value produces a larger PID output contribution proportional to the rate of change of the error (Setpoint - Boiler Outlet Temperature). When set equal to zero it has no effect on the output.
Remote PID P	20	0 to 10000	Remote PID P Proportional Gain value for Remote System Temperature sensor control Modes. Refer to Local PID P for explanation.
Remote PID I	30	0 to 10000	Remote PID I Integral Gain term for Remote System Temperature sensor control Modes. Refer to Local PID I for explanation.
Remote PID D	0	0 to 10000	Remote PID D Derivative Gain term for Remote System Temperature sensor control Modes. Refer to Local PID D for explanation
Mixing Valve P	15	0 to 10000	Mixing Valve P Proportional Gain value for boiler Inlet Temperature sensor control mode. A larger gain value results in tighter, more active, PID control. Gain is the primary PID modulation rate tuning adjustment and provides the immediate mixing valve modulation response. Only visible when mixing valve = yes.
Mixing Valve I	40	0 to 10000	Mixing Valve I Integral Gain value for boiler inlet Temperature sensor control mode. A smaller value makes the Integral ramp in less time (i.e., faster). Integral is a secondary PID modulation rate tuning adjustment that ramps the output over time (typically minuets).
Mixing Valve D	0	0 to 10000	Mixing Valve D The Derivative Gain value for boiler Inlet Temperature sensor control mode. A larger Derivative gain value produces a larger PID output contribution proportional to the rate of change of the error (Setpoint - Boiler Inlet Temperature) When set equal to zero it has no effect on the output.
Max ΔT P	15	0 to 10000	Max ΔT P Promotional Gain value for boiler differential (boiler outlet minus inlet temperature sensor) temperature control mode. Refer to Local PID P for explanation. Only Visible when mixing valve = yes.
Max ΔT I	40	0 to 10000	Max ΔT I Integral Gain value for boiler differential (boiler outlet minus inlet temperature sensor) temperature control mode. Refer to Local PID I for explanation. Only visible when mixing valve = yes.
Max ΔT D	0	0 to 10000	Max ΔT D Derivative gain term for boiler differential (boiler outlet minus inlet temperature sensor) temperature control mode. Refer to Local PID D for explanation. Only visible when mixing valve = yes.

E. Boiler Configuration Menu

Display	Factory Setting	Range/ Choices	Description
Display Units	°F	°F °C	Display Units Selects how temperature parameter values are displayed.
			Boiler Pump
Boiler Pump	None	None	No Boiler Pump.
		Always On	Pump Runs Continuously.
		Purge	Pump Runs during pump pre/post purge operations and during call for heat and then turns off.
		Lead On	Lead boiler's pump runs continuously when the boiler is the lead boiler and revers to "Purge" operation when it is a lag boiler.
Pump Prepurge	15	0 to 600	Pump Prepurge Sets length of time the boiler pump will be run prior to closing the "Call for Heat" relay (CH). Only visible when Boiler Pump does not equal None.
Postpurge ΔT	5	0 to 20	Postpurge ΔT Defines the temperature above BIT that BOT must be at or below before turning off the boiler pump during pump post purge (Pump Cooldown State). Only visible when Boiler Pump does not equal None.
Inlet Sensor	Yes	No Yes	Inlet Sensor Enables the inlet temperature display and control logic.
Mixing Valve	No	No Yes	Mixing Valve Enables the mixing valve control output and user display.
Set Time/ Date	——	hour : minute Month / day / year	Set Time/Date Sets the time and date of the boiler's real time clock. This item also displays the time and date.
			Spare Input Set the function of the Spare Input Terminal (SL):
Spare Input	Off	Off	Ignore
		Sys Pump FB	Input (SI) should be wired to a flow switch inserted in the flow of the of the primary system pump. Input (SI) indicates the primary system pump is operating. If output (SO) is set to System Backup Pump, system pump output (SO) is energized and System Pump Feedback is de-energized the System Backup Pump output (SO) is energized.
		Low Fire	When the Fuel Valve Energized input (SC) is not energized and input (SI) is energized the modulation rate is set to the "Low Fire Spd" setpoint. When input (SI) is not energized the modulation rate is set to "Fan Purge Spd" setpoint. When the fuel valve energized input (CS) is energized input (SI) is ignored.
Fuel limit	Yes (if applicable)	No Yes	Specifies whether high and low cas pressure switches are connected to input (GP). Enables Fuel Limit Hold and alarm messages. (No)
			Spare Output Sets the function of the Spare Output Terminal (SO):
Spare Output	Off	Off	Never close output (SO).
		CAD	Closes SO relay with a call for heat, Opens SO relay 2 minutes after call for heat has been deactivated.
		System Pump BU	Closes when System Pump output is activated but the System Pump Feedback indicates the Primary System Pump is not operating.
		Soft Alarm	Close when any alarm is active.

F. System Configuration Menu

Display	Factory Setting	Range/Choices	Description
			DHWP Enables Domestic Hot Water Priority (DHWP) control feature. When input (DP) is energized DHWP becomes active as selected:
DHWP	Off	Off	No DHWP.
		Isolated Demand	Boiler that received the input (DP) drops off the Peer-To-Peer network and its temperature setpoint is adjusted above the DHWP setpoint. The PID output is based on boiler outlet temperature and set-point. If Remote SP or Remote System temperature sensor were selected, control is switched to the Boiler Outlet Sensor.
		Shared Demand	If the lead boiler receives the input (DP) the temperature setpoint for all boilers on the peer-to-peer network is adjusted above the DHWP setpoint.
			Remote Control Sets the remote (Energy Management System) control mode as follows:
Remote Control	No	No	Local setpoint and modulation rate is used. Modbus and remote input (C+,C-) are ignored.
Remote 1.0 volt =	140°F	60°F to 170°F	Remote 1.0 Volt = Sets the temperature corresponding to the input (C+,C-) 1 Volt. Voltage below 1V is considered invalid, (failed or miswired sensor.)
Remote 9.0 volt =	220°F	150°F to 220°F	Remote 9.0 Volt = Sets the temperature corresponding to the input (C+,C-) 9 volts. Voltage above 9V is considered invalid (failed or miswired sensor.)
			Remote Sensor Enables the Remote System Temperature sensor display and control logic:
Remote Sensor	No	No	Remote Sensor Input (R+,R-) is ignored.
		Display Only	Remote Sensor Input (R+,R-) is used for display only.
		Control	Control Remote Sensor Input (R+,R-) is compared with the temperature setpoint to establish a modulation rate.
System Pump	No	No Yes	System Pump Enables the System Pump Output (SO)
LWC or CAD	No	No Yes	LWC or CAD Specifies a Low Water Cut-off Switch or Combustion Air Damper (Fresh Air Damper). Open switch is connected to input (LC). Enables Limit Hold and alarm messages.
Alarm Message	16 Text Characters	“Low Water Level”	Alarm Message Limit Hold and alarm message displayed corresponding to sensor connected to input (LC). The “ENTER” key and “up” and “Down” arrow keys are used to change the text message.

G. Setpoints Menu

Display	Factory Setting	Range/Choices	Description
Operational SP	180°F	60°F to 230°F	Operational SP Setpoint used in Local Setpoint Mode when not servicing a Domestic Hot Water Priority (DHWP) request.
On Point	-5°F	0°F to -99°F	On Point The boiler starts when the water temperature drops “On Point” degrees below the setpoint.
Off Point	15°F	0°F to 99°F	Off Point The boiler stops when the water temperature rises “Off Point” degrees above the setpoint.
High Temp Stop	Boilers 230°F Water Heaters 200°F	60°F to 230°F	High Temp Stop The boiler stops when water temperature is above the High Temperature Stop setpoint. This setpoint is active in every control mode.
DHWP Setpoint	180°F	140°F to 230°F	DHWP Setpoint The Domestic How Water Priority (DHWP) Setpoint is active when DHW Input (DP) closes and “DHWP” parameter is set to “yes” and Local SP Mode is selected. When the contact is closed, the boiler outlet is maintained at, or above, the DHW Setpoint.
WWSD Setpoint	70°F	40°F to 90°F	WWSD Setpoint The Warm Weather Shutdown (WWSD) Setpoint used to disable boiler and/or system pump operation when enabled by setting the “WWSD” parameter to “WWSD of Boiler”, “WWSD of Sys Pump” or “Both”
Max SP	Boilers 230°F Water Heaters 200°F	140°F to 230°F	Max SP The Maximum Operational Setpoint for all possible Local and Remote Modes.
Min SP	140°F	60°F to 230°F	Min SP The Minimum Operational Setpoint is the lower limit for all Local and Remote modes.
Min In H_2O Temp	130°F	110°F to 180°F	Min In H_2O Temp. Minimum Inlet Water Temperature Setpoint used as the Mixing Valve inlet temperature setpoint. Only visible when Mixing Valve equals Yes.
Max H_2O Delta T	50°F	20°F to 50°F	Max H_2O Delta T Maximum Water Differential (Boiler Outlet minus Boiler Inlet) temperature setpoint used as the Mixing Valve differential temperature setpoint. Only visible when Mixing Valve equals yes.
Max Delta T Hold	50°F	20°F to 50°F	Max Delta T Hold Maximum Water differential (Boiler Outlet minus Boiler Inlet) Temperature used to hold modulation rate at low fire.

H. Communication Menu

Display	Factory Setting	Range/Choices	Description
Protocol	Peer-To-Peer	Peer-To-Peer Modbus	Protocol Selects between Peer-To-Peer (Multiple boiler lead/lag control network) and a Modbus slave communication.
Modbus Address	1	1 - 247	Modbus Address Each boiler must be given a unique address. Only visible when Protocol equals Modbus.
Baud Rate	19.2	9.6 19.2 38.4	Baud Rate Units are 1000 Bits Per Second (KBPS). Only visible when Protocol Equals Modbus.
Parity	Odd	Odd Even None	Parity Only visible when Protocol equals Modbus.
Timeout	30	1 - 120	Timeout Only visible when Protocol equals Modbus.
Messages Rcvd			Messages Rcvd Diagnostic tool used to confirm wiring and Modbus master configuration. Only visible when Protocol equals Modbus.
Messages Sent			Messages Sent Diagnostic tool used to confirm wiring and Modbus master configuration. Only visible when Protocol equals Modbus.
Boiler Address	1	1 to 8	Boiler Address Each Boiler must be given a unique address. The boiler address assignment determines the boiler sequencing order. A value of 0 disables the network communications. Only visible when Protocol equals Peer-To-Peer.
Online Status		XXXXXXXX	Online Status Each space can be either the boiler address or a “-” depending on whether there is a boiler of that address online. Example: _ _ 6 _ _ 321 indicates that boilers 6, 3,2, and 1 are online. Only visible when Protocol equals Peer-To-Peer

I. Manual Mode Menu

Display	Factory Setting	Range/Choices	Description
101	Auto	Man Auto	Boiler Man/Auto Man: Remain in Manual Mode Auto: Return to Boiler Mode specified by parameter/boiler conditions. Activated only when in Supervisor Mode.
102	Varies	0 to 100	Modulation Rate Sets the modulation rate to be sued for boiler when in Manual Mode. Activated only when in Supervisor Mode and Boiler Man/Auto = Man.
103	Varies	On Off	Boiler On/Off Sets the boiler start/stop status when in Manual Mode. No: Turn of boiler if running, otherwise remain off. Yes: Turn on boiler if off, otherwise remain on. Activated only when in Supervisor Mode and Boiler Man/Auto = Man.
104	Auto	Man Auto	Mixing Valve M/A Man: Remain in Manual Mode Auto: Return to Control Mode specified by parameter/boiler conditions Activated only when in Supervisor Mode.
105	Varies	0 to 100	Mixing Valve Sets the Mixing Valve % Open to be used for valve when in Manual Mode. Activated only when in Supervisor Mode and Mixing Valve M/A equals Man.

XI. Repair Parts

All Solaris® Series Repair Parts may be obtained through your local Thermal Solutions representative. Should you require assistance in locating a Thermal Solutions representative in your area, or have questions regarding the availability of Thermal Solutions products or repair parts, please contact Thermal Solutions Customer Service at (717) 239-7642 or Fax (877) 501-5212.

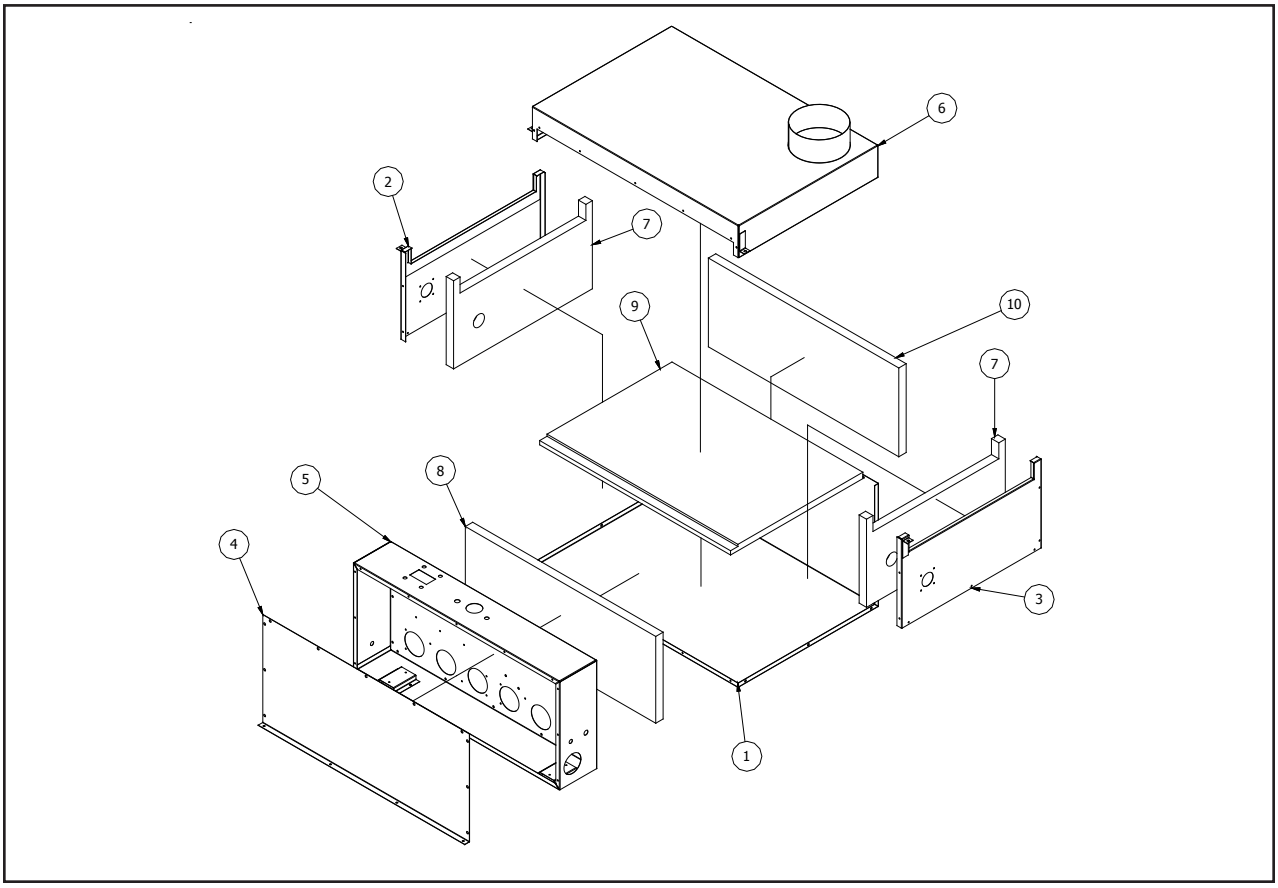


Figure 31: Combustion Chamber

Key No.	Description	Part Number				
1. Combustion Chamber		SOL-500	SOL-750	SOL-1000	SOL-1250	SOL-1500
1	Base/Bottom Panel	618SOL0504	618SOL0704	618SOL1004	618SOL1204	618SOL1504
2	Left Side Panel Assembly	618SOL0021	618SOL00211			
3	Right Side Panel Assembly	618SOL0031	618SOL00311			
4	Air Box Cover	718SOL0503	718SOL0703	718SOL1003	718SOL1203	718SOL1503
5	Air Box Assembly	618SOL05051	618SOL07051	618SOL10051	618SOL12051	618SOL15051
6	Canopy Assembly	618SOL0510	618SOL0710	618SOL1010	618SOL1210	618SOL1510
7	Side Insulation	820SOL0020	820SOL0021			
8	Front Insulation	820SOL0503	820SOL0703	820SOL1003	820SOL1203	820SOL1503
9	Bottom Insulation	820SOL0500	820SOL0700	820SOL1000	820SOL1200	820SOL1500
10	Back Insulation	820SOL0502	820SOL0702	820SOL0112	820SOL1202	820SOL1502

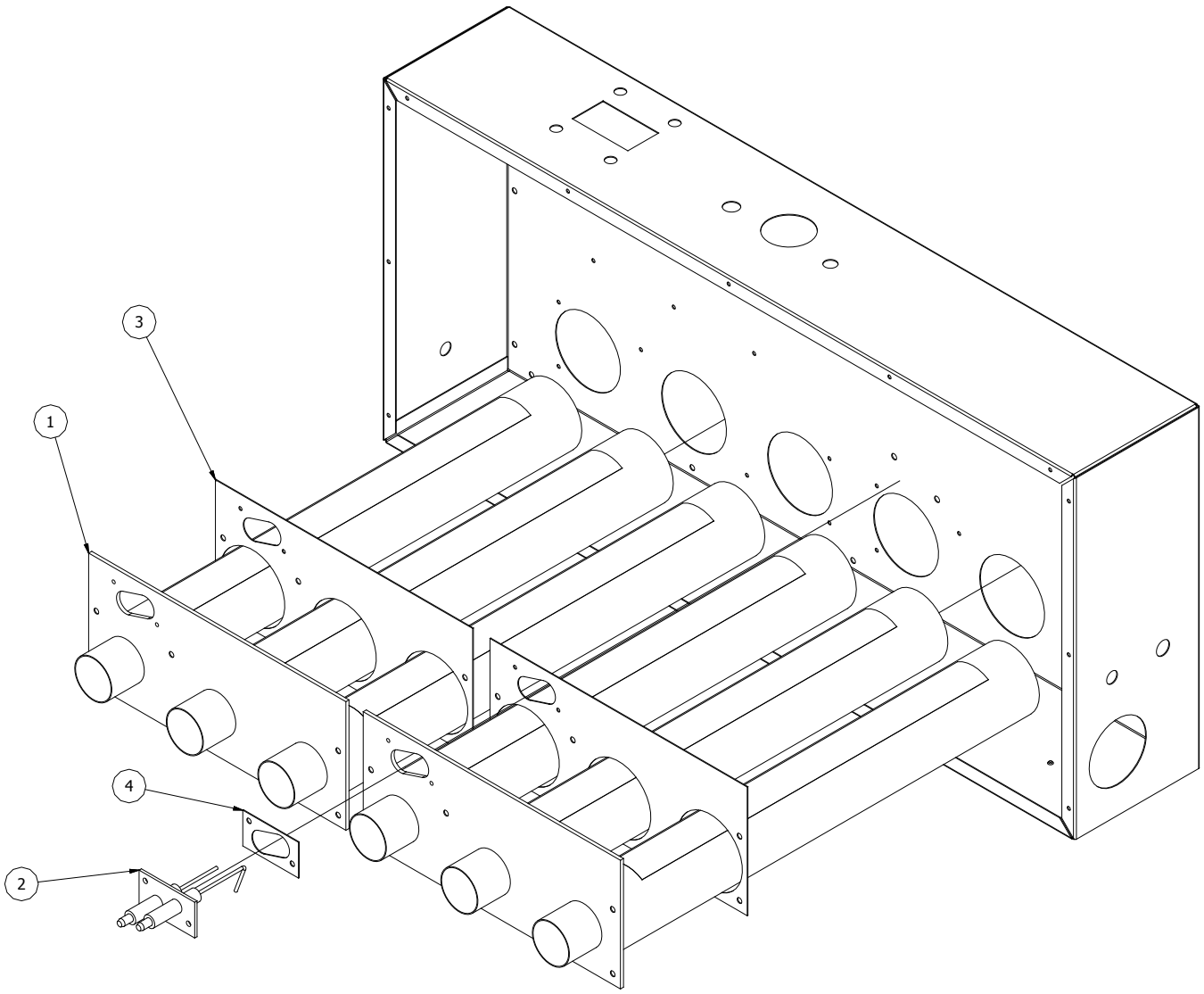


Figure 32: Burner Tray

Key No.	Description	Part Number	Quantity Per Mode				
1. Burner Tray			SOL-500	SOL-750	SOL-1000	SOL-1250	SOL-1500
1	3 Burner Assembly	102017-01	2	2	3	4	5
2	Ignitor Assembly	812SOL0010	1				
3	Gasket, Burner Mounting Plate	820SOL0004	2	2	3	4	5
4	Gasket, Ignitor Assembly	820SOL0005	1				

This page left blank intentionally

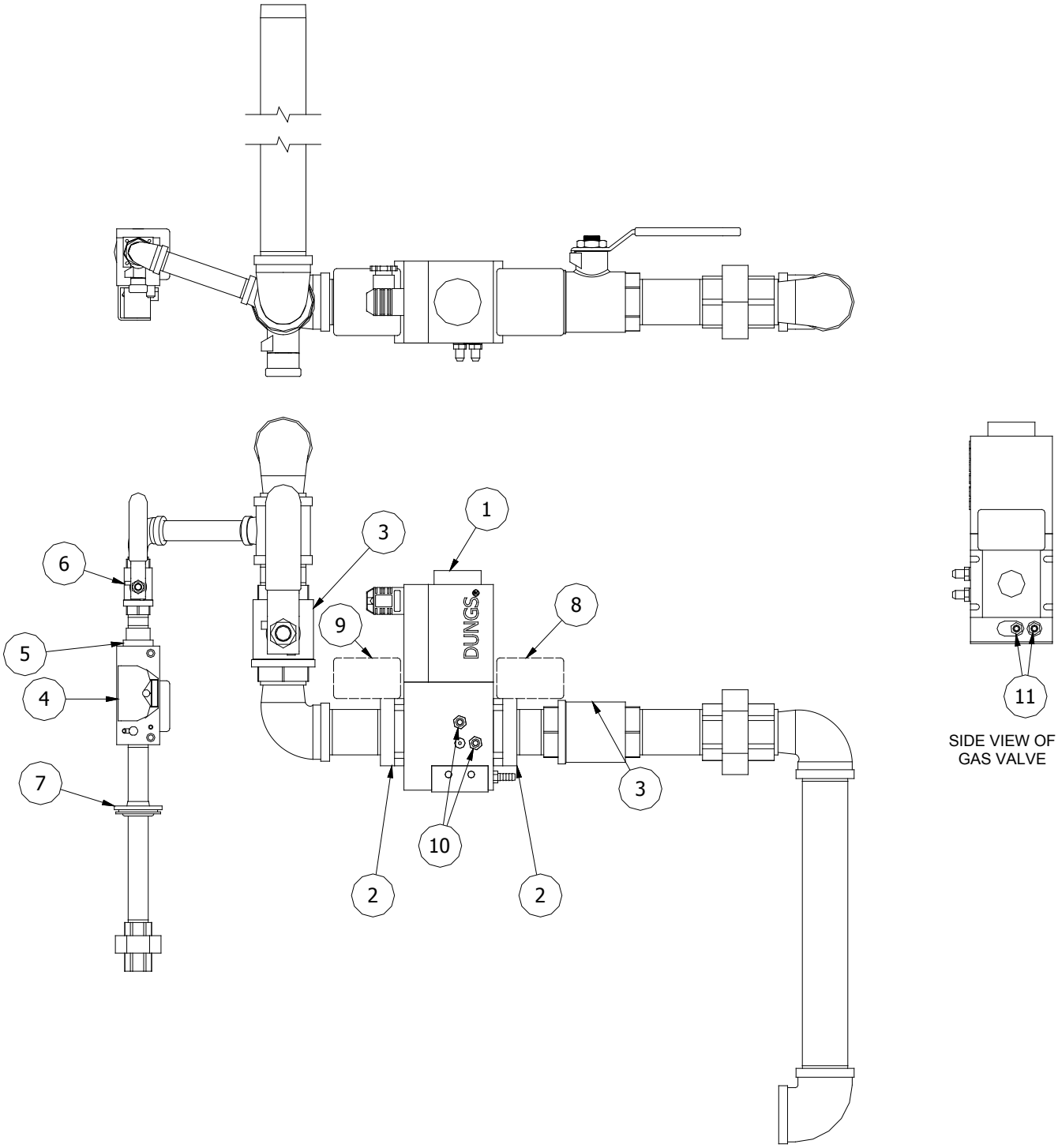
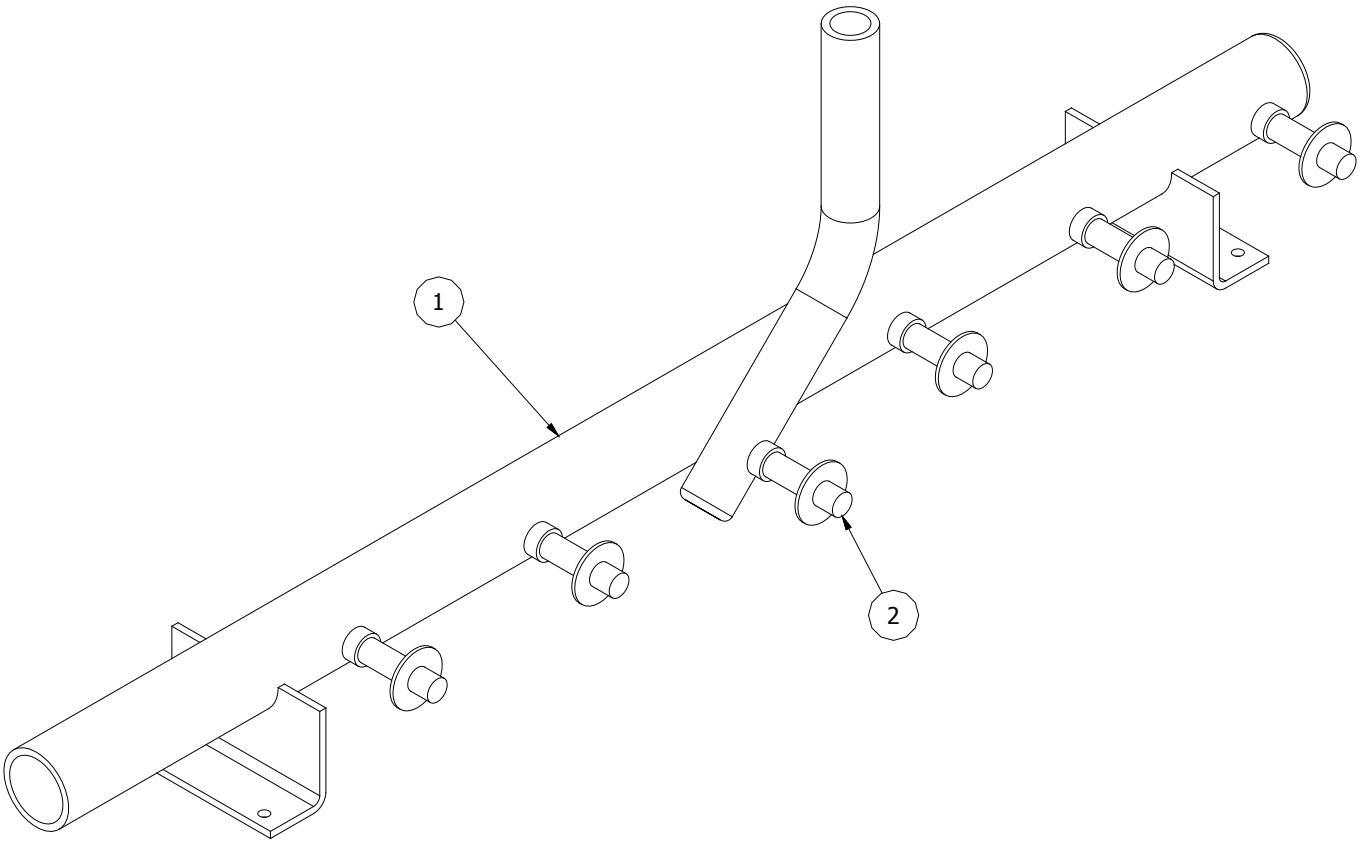


Figure 33: Gas Trains (SOL-500 through SOL-1500)
(Reference Table 8)

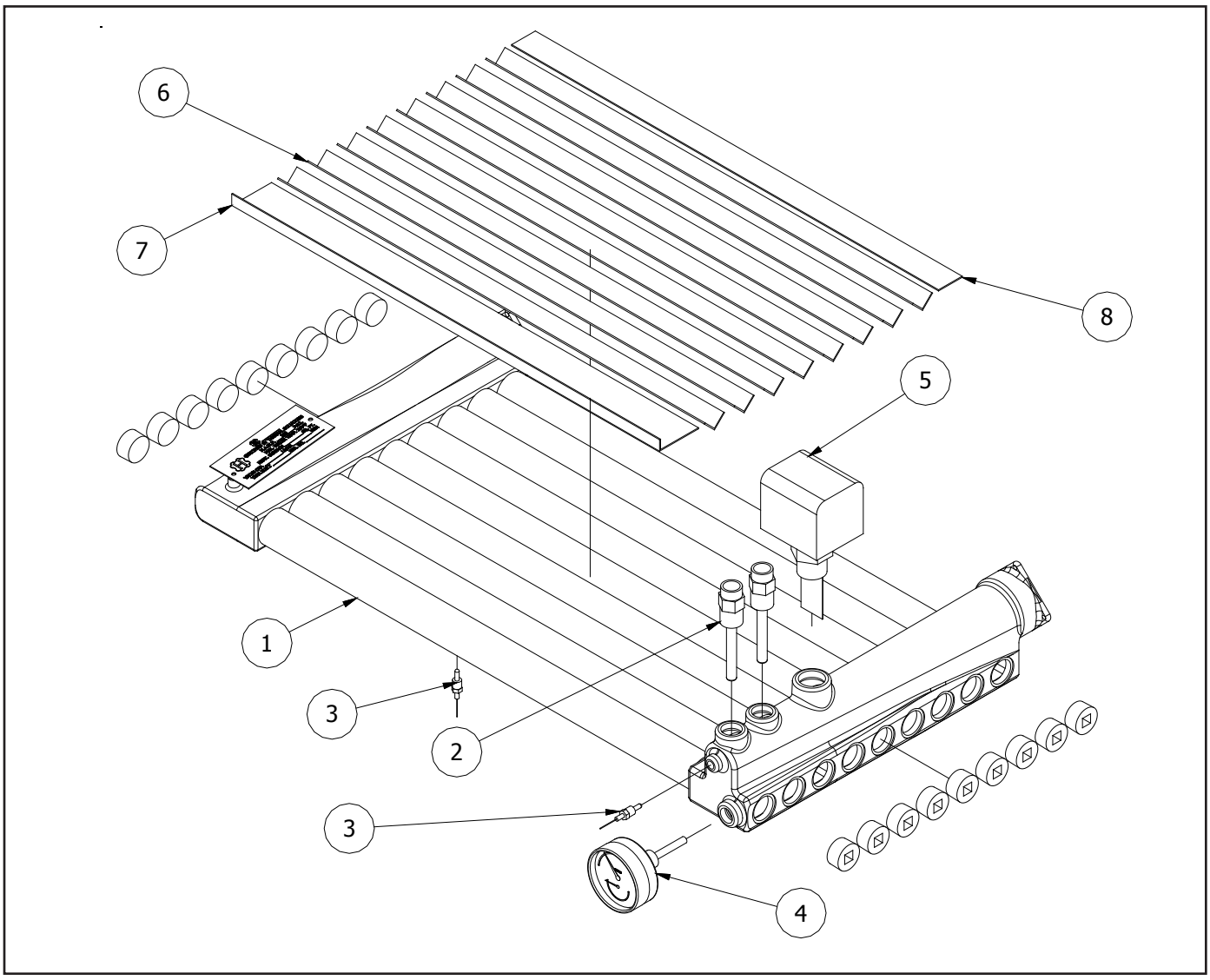
Gas Trains: Reference Figure 33						
Key No.	Description	(Quantity) Part Number				
		SOL-500	SOL-750	SOL-1000	SOL-1250	SOL-1500
1	Main Gas Valve Body	(1)816SOL0500	(1) 102003-01			
2	Main Gas Valve Flange(s) 3/4” NPT	—	—	—	—	—
	Main Gas Valve Flange(s) 1” NPT	(2) 816SOL0503	(2) 102281-02		—	—
	Main Gas Valve Flange(s) 1-1/4” NPT	—	—	—	(2) 102281-03	—
	Main Gas Valve Flange(s) 1-1/2” NPT	—	—	—	—	(2) 102281-04
3	Manual Gas Valve 1” NPT	(2) 816SOL0015			—	—
	Manual Gas Valve 1-1/4” NPT	—	—	—	(2) 816SOL0016	—
	Manual Gas Valve 1-1/2” NPT	—	—	—	—	(2) 816SOL0017
4	Pilot Gas Valve	(1) 106026-01				
5	Pilot Gas Valve Flange 1/2” NPT	(1) 816SOL0502				
6	Manual Gas Valve 1/2” NPT	(1) 816SOL0010				
7	Insulation Grommet	(1) 820SOL0001				
8	High Gas Pressure Switch (Optional)	(1) 801SOL0006				
9	Low Gas Pressure Switch (Optional)	(1) 801SOL0005				
10	G18 Test Nipple	(2) 816SOL0001				
11	Hose Barb	(2) 816SOL0002				

Table 8: Gas Train Components



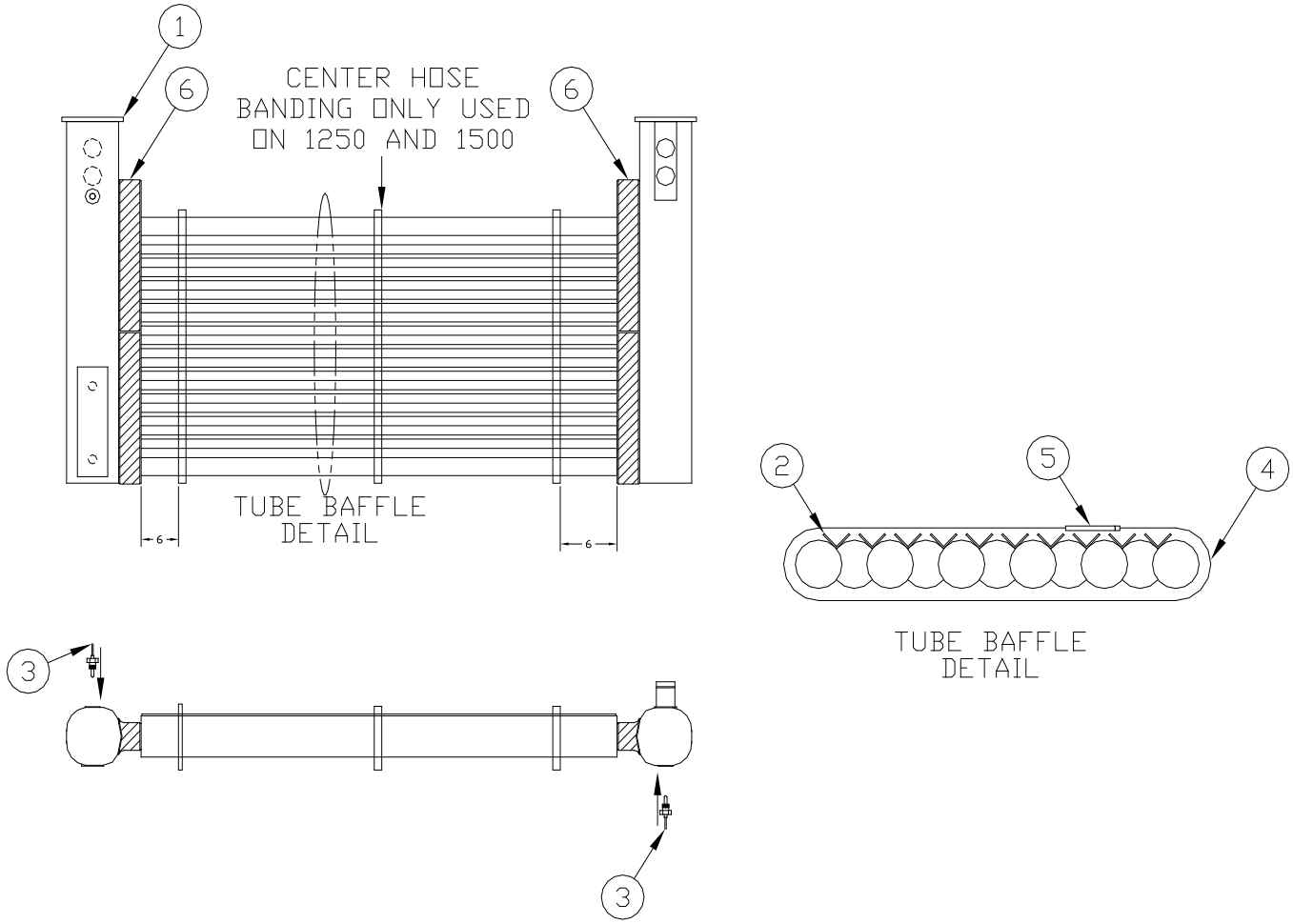
Manifold Orifice Assembly						
Key No.	Description	Boiler Model				
		SOL-500	SOL-750	SOL-1000	SOL-1250	SOL-1500
1	Manifold Orifice Assembly	812SOL0500	812SOL0700	812SOL1000	812SOL1200	812SOL1500
2a	Natural Gas Prejet	812SOL0034				
2b	Liquid Propane (LP) Gas Prejet	812SOL0001				

Figure 34: Manifold Orifice Assembly



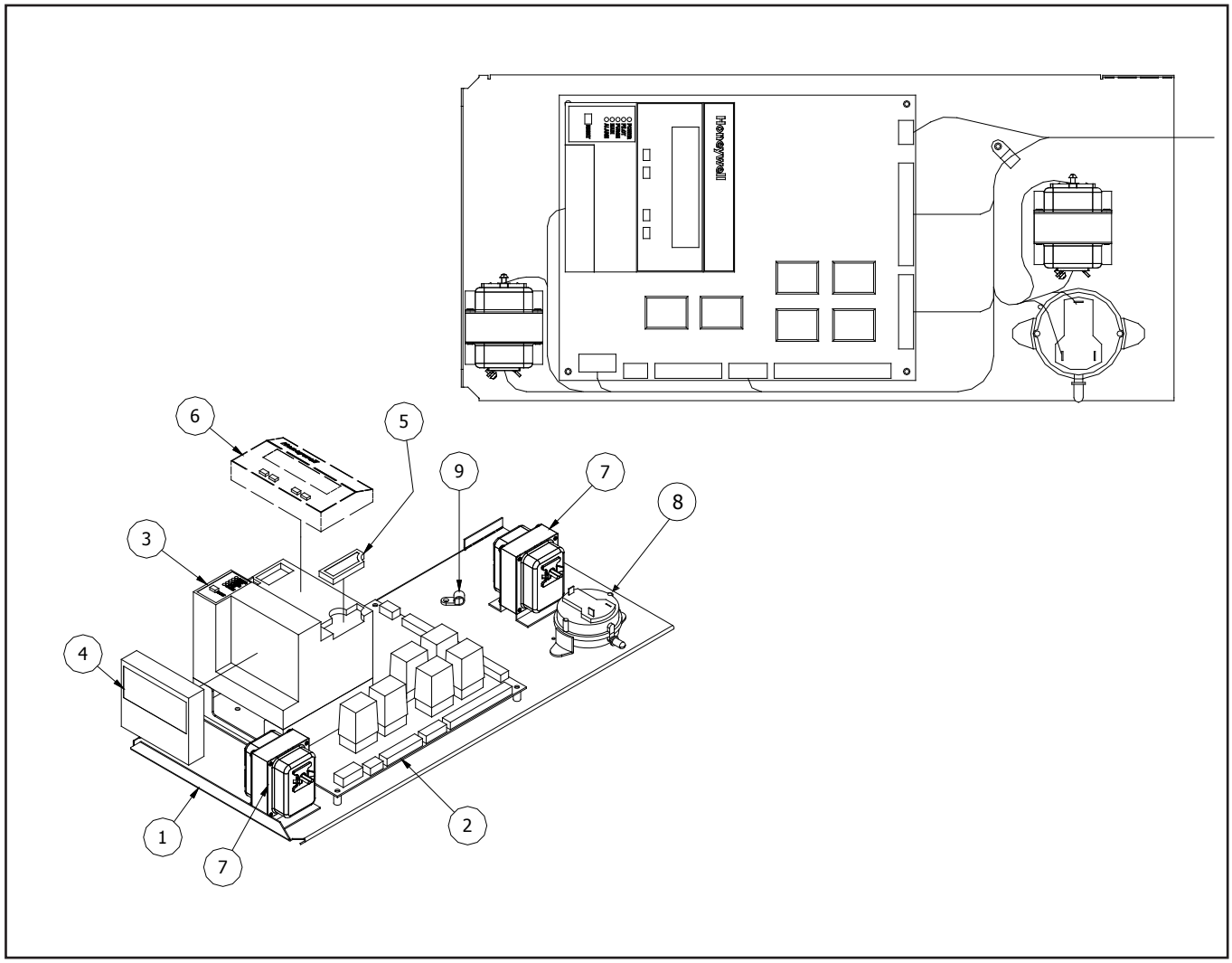
Heat Exchanger Assembly (SOL-500)			
			Part Number
Key No.	Description	Quantity	SOL-500
1	Heat Exchanger	1	603SOL0510
2	Immersion Well	2	80160456
3	Inlet/Outlet Temp. Sensor	2	801SOL0010
4A	Temp/Pressure Gauge 0-100PSI	1	103470-01
4B	Temp/Pressure Gauge 0-200PSI	1	103470-02
4C	Temp/Pressure Gauge 0-250PSI	1	103470-03
5	Water Flow Switch	1	80160175
6	Center Tube Baffles	8	718SOL0519
7	Front Tube Baffle	1	102269-02
8	Rear Tube Baffle	1	102270-02

Figure 35: Heat Exchanger Assembly (SOL-500)



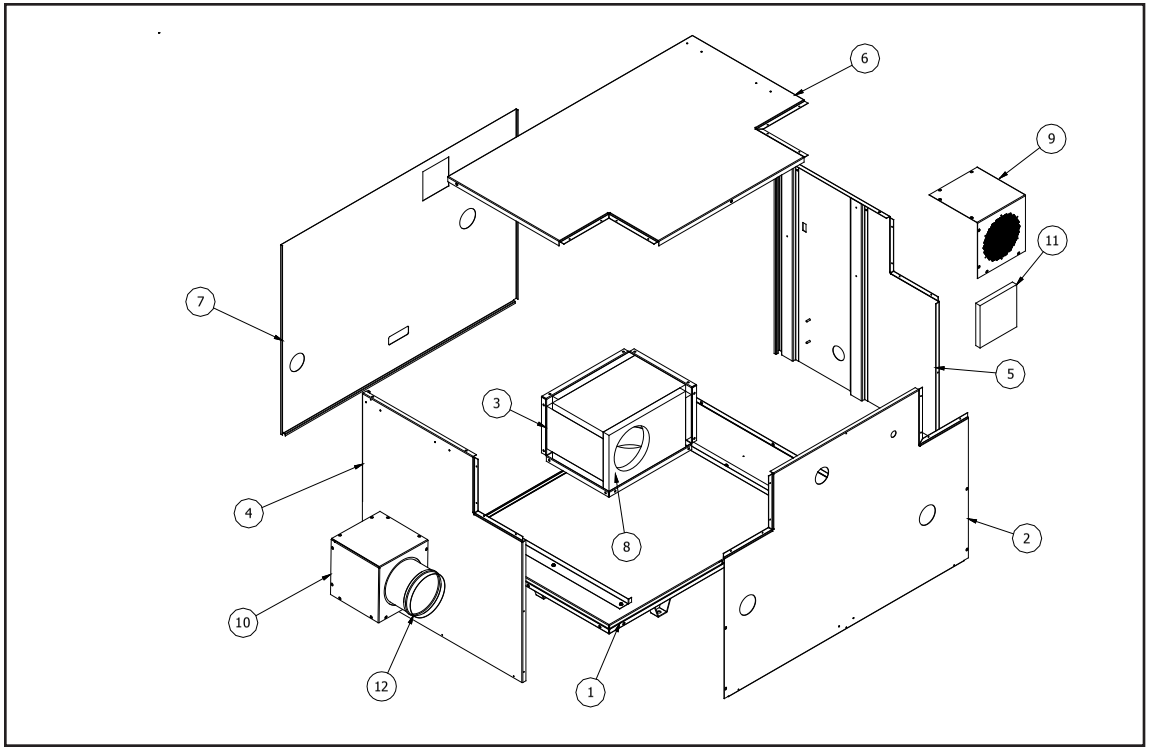
Key No.	Description	Part Number			
		SOL-750	SOL-1000	SOL-1250	SOL-1500
1	Heat Exchanger	102499-01	102499-02	102499-03	102499-04
2	Center Tube Baffles	718SOL0719	718SOL1019	718SOL1219	718SOL1519
3	Inlet/Outlet Temp Sensor	801SOL0010			
4	Hose Banding	924660281			
5	Hose Clamp	808609461			
6	Fiberglass Tape Gasket	9206032			
7	Front Tube Baffle (not shown)	102269-03	102269-04	102269-05	62269-06
8	Rear Tube Baffle (not shown)	102270-03	102270-04	102270-05	102270-06

Figure 36: Heat Exchanger Assembly (SOL-750 through 1500)



Key No.	Description	Quantity	Part Number
1. Electrical Panel			SOL-500/1500
1	Q7800H1009 Electrical Side Panel	1	704SOL0006
2	Q7800H1009 Honeywell Relay Module Circuit Board	1	101182-01
3	Relay Module Honeywell RM7897A1002	1	801602121
4	Flame Rectification Amplifier	1	80160207
5	Purge Card	1	8136362
6	Keyboard Display Module	1	80160640
7	Transformer, 120V Primary, 24V Secondary	2	801600502
8	Combustion Airflow Switch	1	102382-03
9	Wire Harness	1	813SOL0011

Figure 37: Electrical Panel



Key No.	Description	Part Number				
		SOL-500	SOL-750	SOL-1000	SOL-1250	SOL-1500
1	Base Panel Assembly	604SOL0511	604SOL0711	604SOL1011	604SOL1211	604SOL1511
2	Jacket, Rear Panel Assembly	604SOL0503	604SOL0703	604SOL1003	604SOL1203	604SOL1503
3	Exhaust CV Assembly	618SOL0001	618SOL0701	618SOL0701	618SOL1201	618SOL1501
4	Jacket, Right Side Panel Assembly	604SOL0504	604SOL0704	604SOL1004	604SOL1204	604SOL1504
5	Jacket, Left Side Panel Assembly	604SOL0505	604SOL0705	604SOL1005	608SOL1205	604SOL1505
6	Jacket, Top Panel Assembly	604SOL0506	604SOL0706	604SOL1006	604SOL1206	604SOL1506
7A	Jacket, Front Panel (Left Side SOL-1250 & 1500)	704SOL0502	604SOL0702	604SOL1002	704SOL0090	704SOL0091
7B	Jacket, Front Panel (Right Side SOL-1250 & 1500)	—	—	—	704SOL0092	704SOL0093
8	Insulation Box	820SOL0032	820SOL0033	820SOL0033	820SOL0033	820SOL0033
9	Intake Corner Vent Assembly	604SOL0508	604SOL0708	604SOL0708	604SOL1208	604SOL1208
10	Exhaust Corner Vent	704SOL0507	704SOL0707	704SOL0707	704SOL1207	704SOL1207
11	Air Inlet Filter	811SOL0020	811SOL0022	811SOL0022	811SOL0022	811SOL0022
12	Stack Adapter	811EVC006	811EVC008	811EVC008	811EVC010	811EVC010

Figure 38: Boiler Jacket Assembly

SERVICE RECORD

Date | Service Performed

SERVICE RECORD

Date | Service Performed

Important Product Safety Information
Refractory Ceramic Fiber Product

Warning:

This product contains refractory ceramic fibers (RCF). RCF has been classified as a possible human carcinogen. After this product is fired, RCF may, when exposed to extremely high temperature (>1800F), change into a known human carcinogen. When disturbed as a result of servicing or repair, RCF becomes airborne and, if inhaled, may be hazardous to your health.

AVOID Breathing Fiber Particulates and Dust

Precautionary Measures:

Do not remove or replace previously fired RCF (combustion chamber insulation, target walls, canopy gasket, flue cover gasket, etc.) or attempt any service or repair work involving RCF without wearing the following protective gear:

1. A National Institute for Occupational Safety and Health (NIOSH) approved respirator
2. Long sleeved, loose fitting clothing
3. Gloves
4. Eye Protection

- Take steps to assure adequate ventilation.
- Wash all exposed body areas gently with soap and water after contact.
- Wash work clothes separately from other laundry and rinse washing machine after use to avoid contaminating other clothes.
- Discard used RCF components by sealing in an air tight plastic bag.

First Aid Procedures:

- If contact with eyes: Flush with water for at least 15 minutes. Seek immediate medical attention if irritation persists.
- If contact with skin: Wash affected area gently with soap and water. Seek immediate medical attention if irritation persists.
- If breathing difficulty develops: Leave the area and move to a location with clean fresh air. Seek immediate medical attention if breathing difficulties persist.
- Ingestion: Do not induce vomiting. Drink plenty of water. Seek immediate medical attention.

Thermal Solutions

(seller)

LIMITED WARRANTY

LIMITED WARRANTY

Subject to the terms and conditions herein and except as provided below with respect to products or parts not manufactured by Thermal Solutions, Seller warrants to the original owner at the original installation site that products manufactured by Seller ("Products") comply, at the time of manufacture, the heat exchanger with recognized hydronics industry regulatory agency standards and requirements then in effect and will be free from defects in materials and workmanship for a period of 3 years from date of shipment (the "Warranty Period"). The burner is also covered under the limited warranty for 1 year from date of shipment (the "Warranty" Period).

For products or parts not manufactured by Thermal Solutions, the warranty obligations of Thermal Solutions shall, in all respects, be limited to one year.

REMEDY

A. The sole remedy for breach of this warranty is expressly limited to the repair or replacement of any part found to be defective under conditions of normal use within the Warranty Period. Labor for removal and/or installation is not included.

B. Warranty - The owner must notify the original installer of the Product and Seller (Attention: Thermal Solutions, P.O. Box 3244, Lancaster, PA 17604-3244), in writing, within the Warranty Period, providing a detailed description of all claimed defects. Transportation to a factory or other designated facility for repairs of any products or items alleged defective shall, in all events, be the responsibility and at the cost of the owner.

EXCLUSIONS

Seller shall have no liability for and this warranty does not cover:

A. Incidental, special or consequential damages, such as loss of the use of products, facilities or production, inconvenience, loss of time or labor expense involved in repairing or replacing the alleged defective Product.

B. The performance of any Product under conditions varying materially from those under which such Product is usually tested under industry standards as of the time of shipment.

C. Any damage to the Product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy.

D. The design or operation of owner's plant or equipment or of any facility or system of which any Product may be made a part.

E. The suitability of any Product for any particular application.

F. Any failure resulting from misuse, modification not authorized by Seller in writing, improper installation or lack of or improper maintenance.

G. Equipment furnished by the owner, either mounted or unmounted, or when contracted for by the owner to be installed or handled.

H. Leakage or other malfunction caused by:

   1. Defective installations in general and specifically, any installation which is made:

      a. in violation of applicable state or local plumbing housing or building codes,

      b. without a certified ASME, pressure relief valve, or

      c. contrary to the written instructions furnished with the unit

   2. Adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes and/or headers or corrosive elements in the atmosphere.

   3. Misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by seller, operation with fuels or settings other than those set forth on the rating plate or accidental or exterior damage.

I. Production of noise, odors, discoloration or rusty water.

J. Damage to surrounding area or property caused by leakage or malfunction.

K. Costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation reinstallation or repair, charges to return the boiler and or components.

Seller's liability under this warranty shall not in any case exceed the amount paid for the Product found to be defective.

THIRD-PARTY WARRANTIES

For goods or components not manufactured by Seller, the warranty obligations of Seller shall, in all respects, conform and be limited to one year from the date of shipment

SEVERABILITY

To the extent that any provision of this warranty would be void or prohibited under applicable law, such provisions shall be limited in effect to the minimum extent necessary to render the remaining provisions hereof enforceable.

THERMAL® SOLUTIONS

Innovative Equipment for Hot Water Systems