

Installation and Operation
Instructions for

Keystone

Condensing Boiler

Model KS

Sizes 399–850 MBTU/h

Water Heater

Model KW

Sizes 199–850 MBTU/h

FOR YOUR SAFETY: This product must be installed and serviced by a professional service technician, qualified in hot water boiler and heater installation and maintenance. Improper installation and/or operation could create carbon monoxide gas in flue gases which could cause serious injury, property damage, or death. Improper installation and/or operation will void the warranty.

⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a nearby phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

Installation and service must be performed by a qualified installer, service agency, or gas supplier.

⚠ AVERTISSEMENT

Assurez-vous de bien suivre les instructions données dans cette notice pour réduire au minimum le risque d'incendie ou d'explosion ou pour éviter tout dommage matériel, toute blessure ou la mort.

Ne pas entreposer ni utiliser d'essence ni d'autres vapeurs ou liquides inflammables dans le voisinage de cet appareil ou de tout autre appareil.

QUE FAIRE SI VOUS SENTEZ UNE ODEUR DE GAZ:

- Ne pas tenter d'allumer d'appareils.
- Ne touchez à aucun interrupteur. Ne pas vous servir des téléphones dans le bâtiment où vous vous trouvez.
- Appelez immédiatement votre fournisseur de gaz depuis un voisin. Suivez les instructions du fournisseur.
- Si vous ne pouvez rejoindre le fournisseur de gaz, appelez le service des incendies.

L'installation et l'entretien doivent être assurés par un installateur ou un service d'entretien qualifié ou par le fournisseur de gaz.

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SECTION 1.

General Information

⚠ WARNING

Keystone units **must** be installed in accordance with the procedures detailed in this manual, or the Triangle Tube warranty will be voided. The installation must conform to the requirements of the local jurisdiction having authority, and, in the United States, to the latest edition of the National Fuel Gas Code, ANSI Z223.1/NFPA54. In Canada, the installation must conform to the latest edition of CSA B149.1 Natural Gas and Propane Gas Installation Code, and/or local codes. Where required by the authority having jurisdiction, the installation of Keystone boilers must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1. Any modifications to the boiler, its gas controls, or wiring may void the warranty. If field conditions require modifications, consult the factory representative before initiating such modifications.

1.1 Introduction

This manual provides information necessary for the installation, operation, and maintenance of Triangle Tube Keystone appliances. Read it carefully before installation.

All application and installation procedures should be reviewed completely before proceeding with the installation. Consult the Triangle Tube factory, or local factory representative, with any problems or questions regarding this equipment. Experience has shown that most operating problems are caused by improper installation.

Keystone is protected against over pressurization. A pressure relief valve is included with each Keystone. Some keystones may require that the PRV be installed prior to filling the system. Refer to Figures 1-6 for PRV locations.

IMPORTANT: The inlet gas pressure to the appliance must not exceed 13" W.C. (3.2kPa).

All installations must be made in accordance with 1) American National Standard Z223.1/NFPA54-Latest Edition "National Fuel Gas Code" or 2) CSA B149.1 "Natural Gas and Propane Installation Code" and with the requirement of the local utility or other authorities having jurisdiction. Such applicable requirements take precedence over the general instructions contained herein.

All electrical wiring is to be done in accordance with the local codes, or in the absence of local codes, with: 1) The National Electrical Code ANSI/NFPA No. 70-latest Edition, or 2) CSA STD. C22.1 "Canadian Electrical Code - Part 1". This appliance must be electrically grounded in accordance with these codes.

1.2 Model Identification

Consult the rating plate on the unit. The following information describes the model number structure.

(1) **Model Series Designation**

K = Keystone

(2) **Usage**

S = Hydronic

W = Volume Water

(3-5) **Size**

1 9 9 = 199,000 BTU/hr input

2 8 5 = 285,000 BTU/hr input

3 9 9 = 399,000 BTU/hr input

5 0 0 = 500,000 BTU/hr input

6 0 0 = 600,000 BTU/hr input

7 5 0 = 750,000 BTU/hr input

8 5 0 = 850,000 BTU/hr input

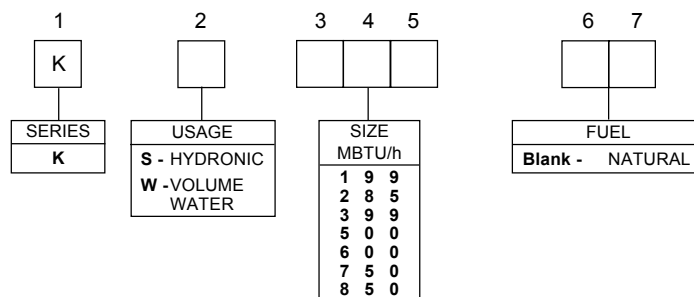
(6-7) **Fuel**

Blank = Natural Gas

1.3 Appliance Overview

See Figures 1 through 6.

Model Nomenclature



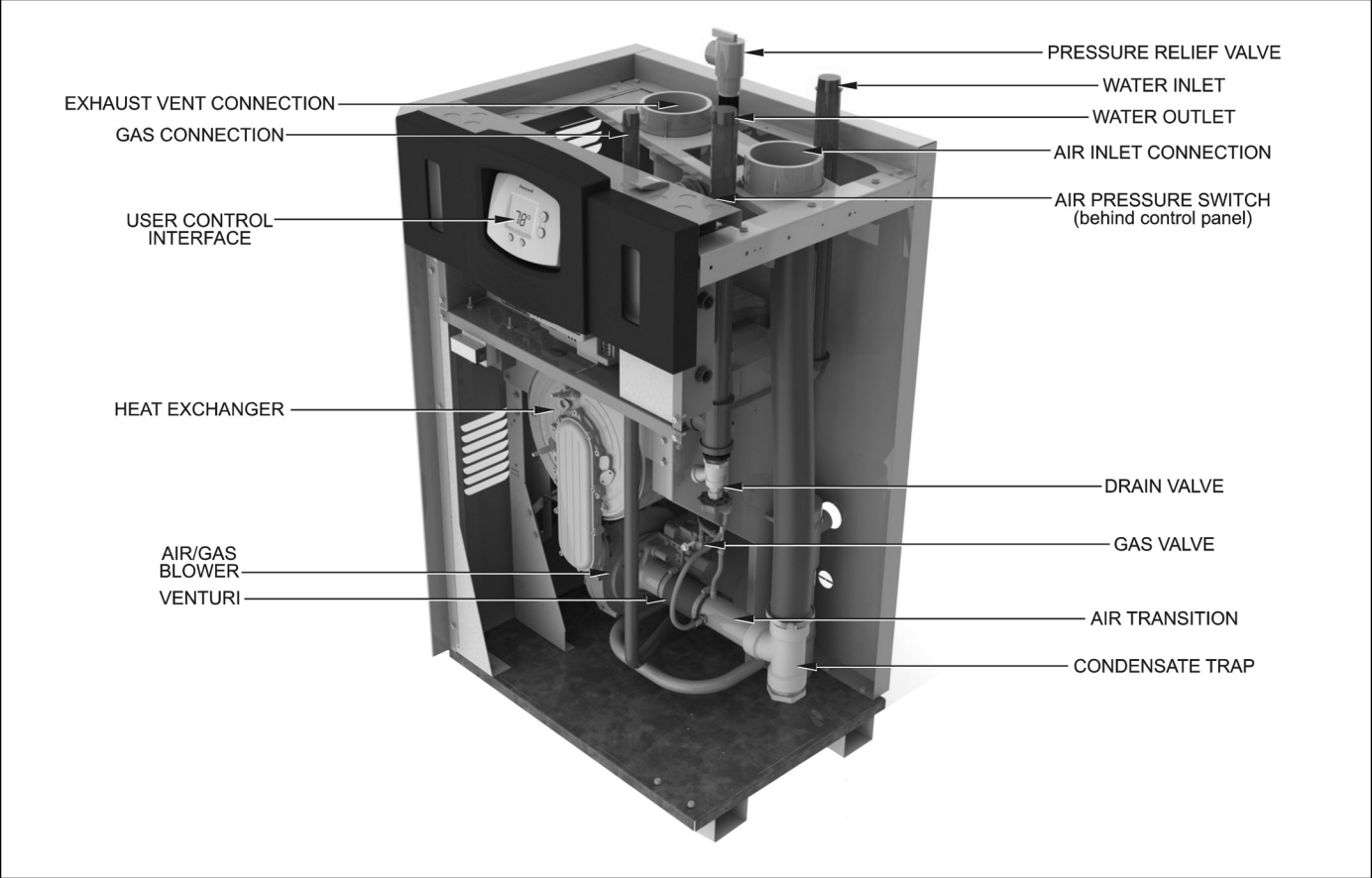


Figure 1. Location of Components, Size 199.

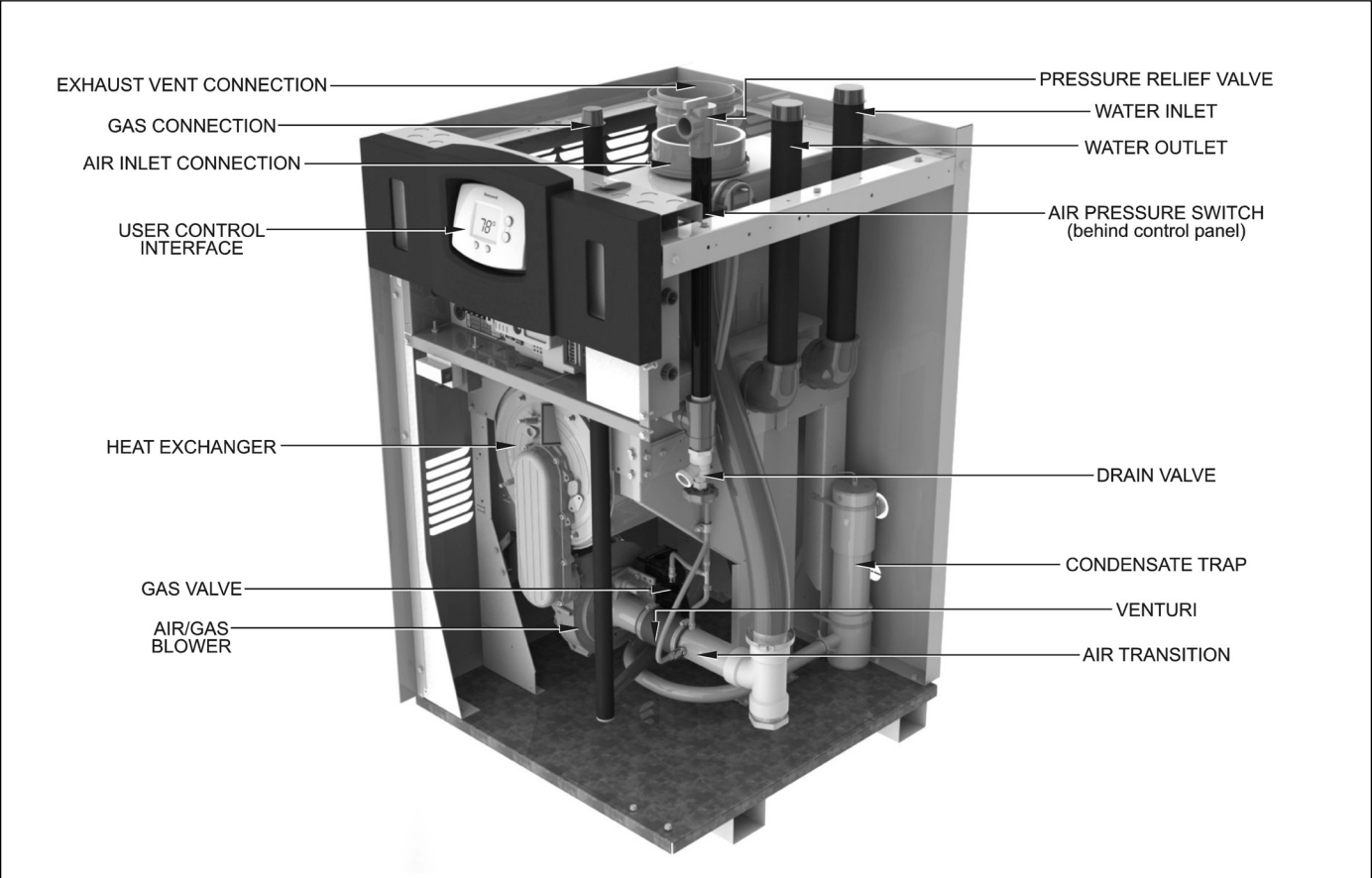


Figure 2. Location of Components, Size 285.

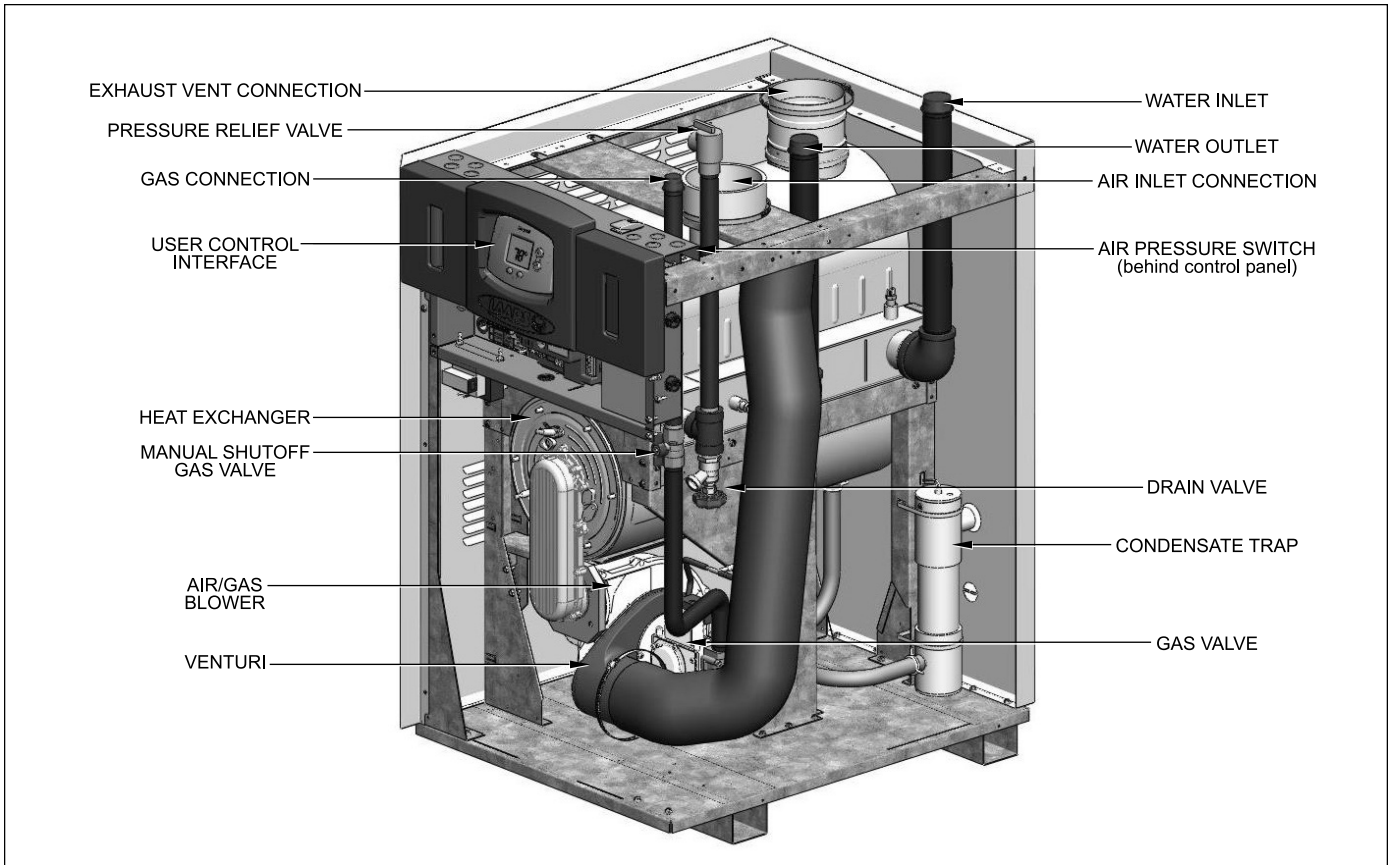


Figure 3. Location of Components, Size 399.

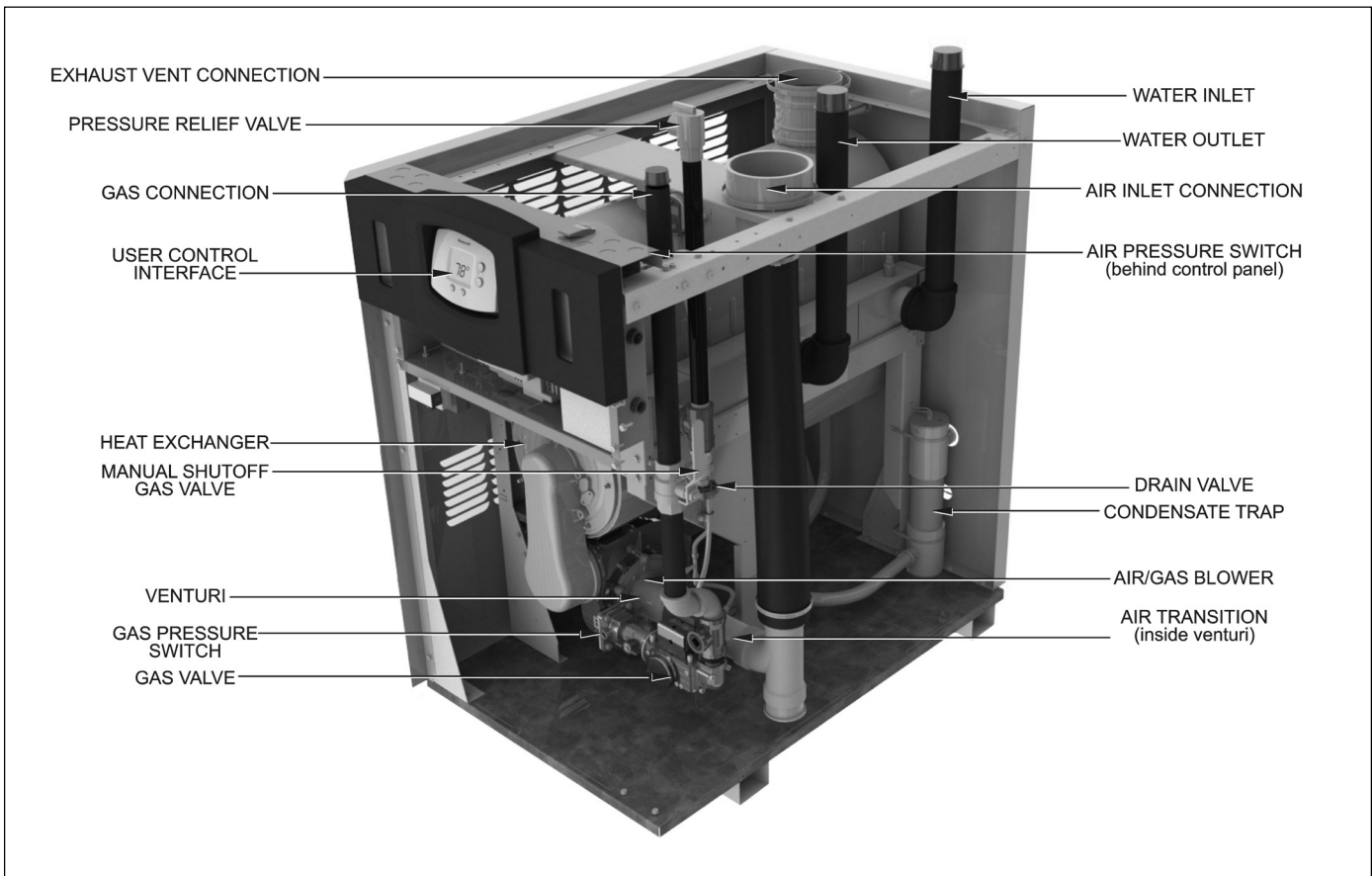


Figure 4. Location of Components, Size 500.

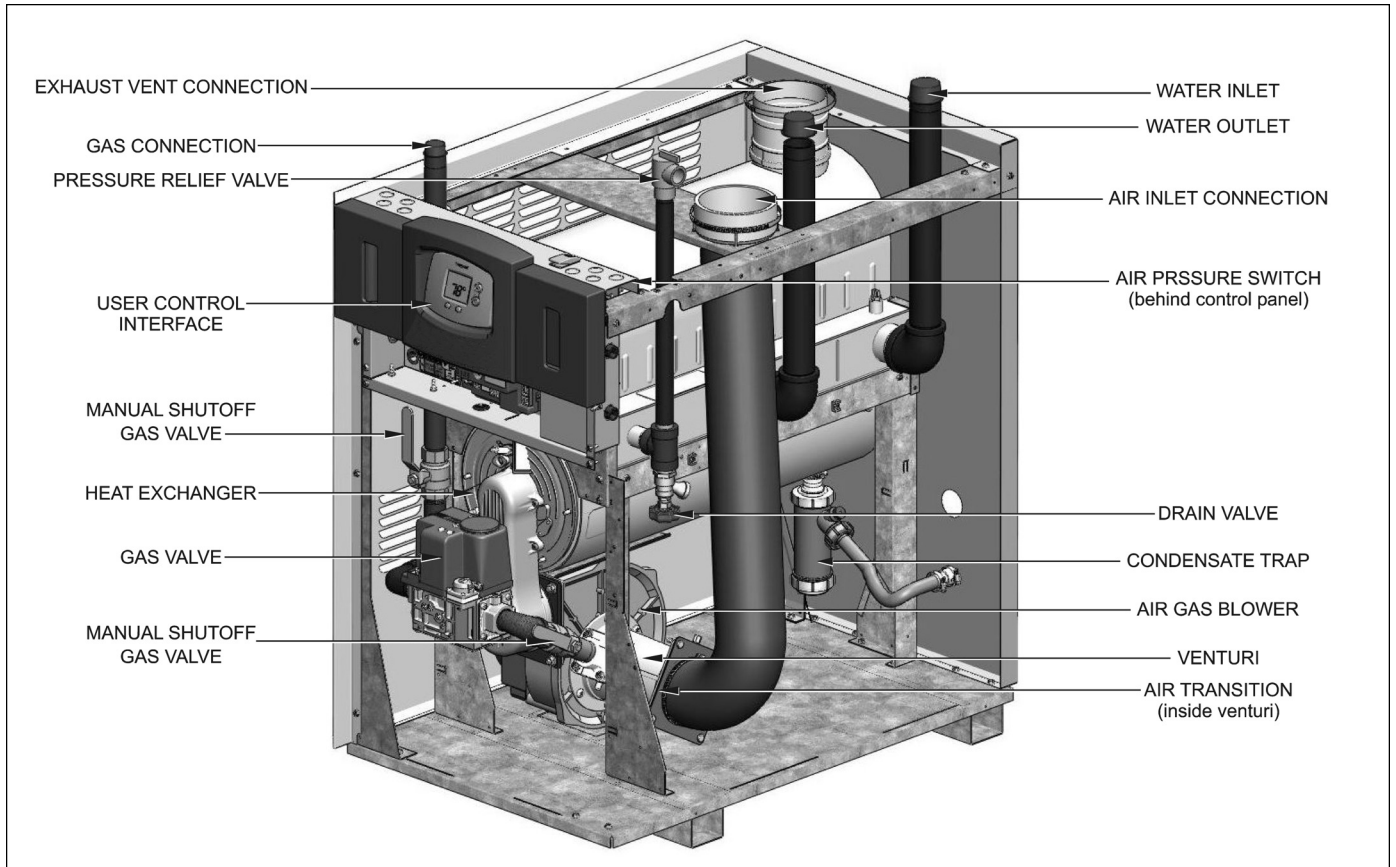


Figure 5. Location of Components, Size 600.

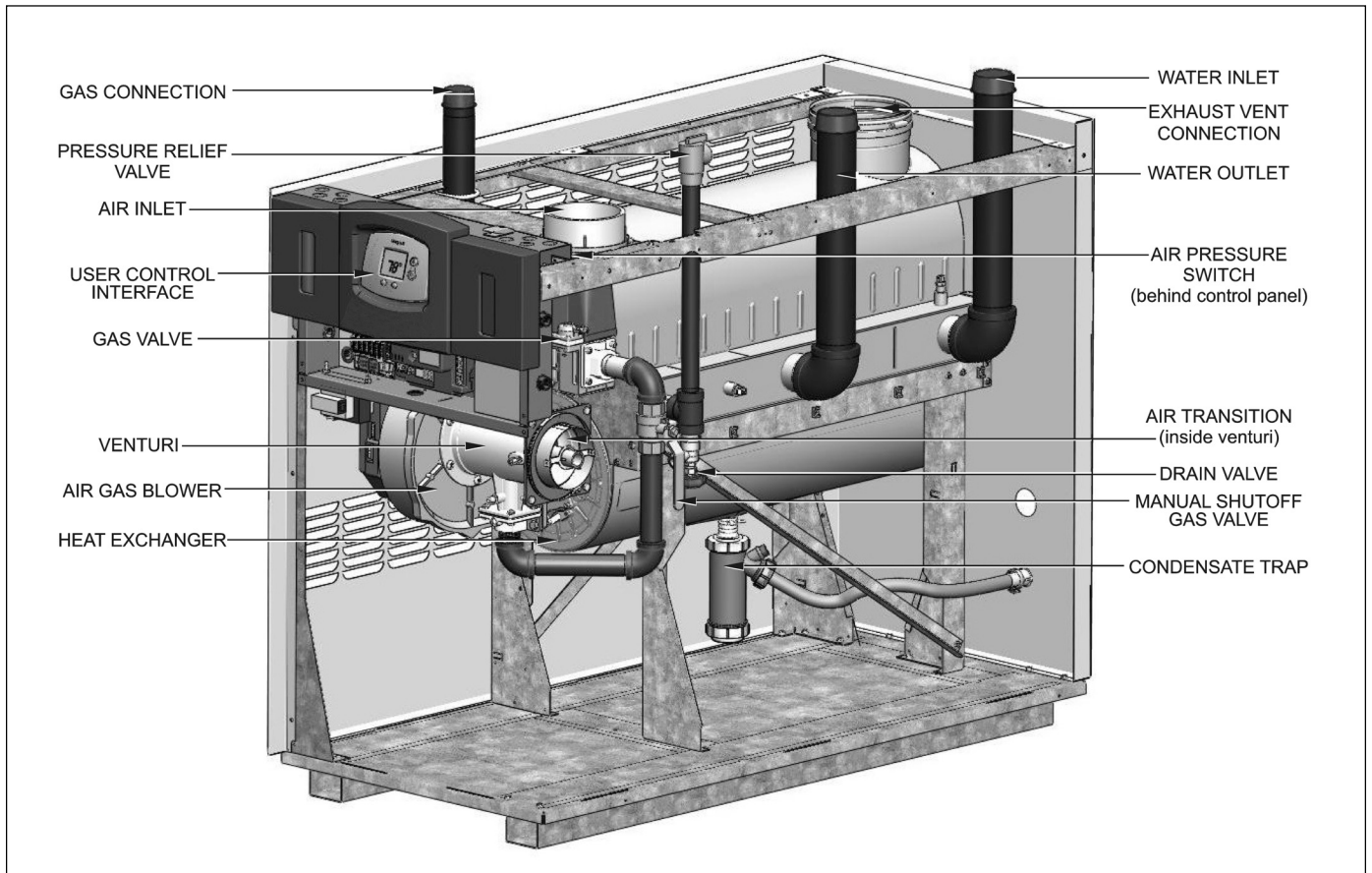


Figure 6. Location of Components, Sizes 750 and 850.

1.4 Warranty

Triangle Tube' Keystone appliances are covered by a limited warranty. The owner should complete the warranty registration at www.TriangleTube.com.

All warranty claims must be made to an authorized Triangle Tube representative. Claims must include the serial number and model (this information can be found on the rating plate), installation date, and name of the installer. Shipping costs are not included in the warranty coverage.

Some accessory items may be shipped in separate packages. Verify receipt of all packages listed on the packing slip. Inspect everything for damage immediately upon delivery, and advise the carrier of any shortages or damage. Any such claims should be filed with the carrier. **The carrier, not the shipper, is responsible for shortages and damage to the shipment whether visible or concealed.**

1.5 Unpacking

The Keystone is shipped in a single crate with the following standard components packed with the appliance (see Figure 7):

- A. exhaust vent terminal*
- B. air intake terminal
- C. temperature/pressure gauge kit
- E. CPVC exhaust pipe section* (199-500)
- F. outdoor/system sensor kit
- G. flow switch kit (500-850)
- H. alternate size vent/terminal screens
- J. exhaust vent adapter CPVC/ST ST (750-850)
- K. 4x6 PVC adapter with 4x7 PVC pipe section* (750-850) (not to be used on exhaust in Canada)

1. Remove all packing and tie-down materials.
2. Check contents of the carton against items shown.

* Components are not to be used in Canada as part of the venting system. Refer to Section 3.2.1.

1.6 Dimensions

Dimensions are shown in Figure 8.

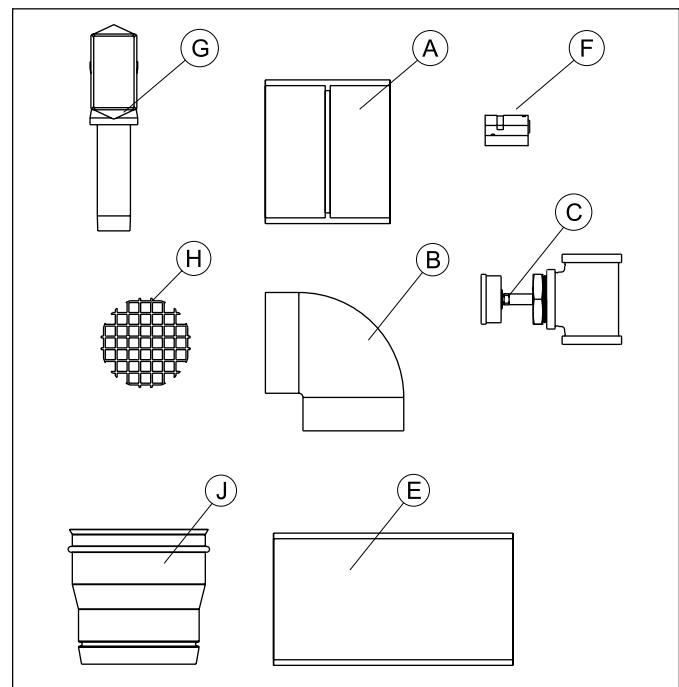
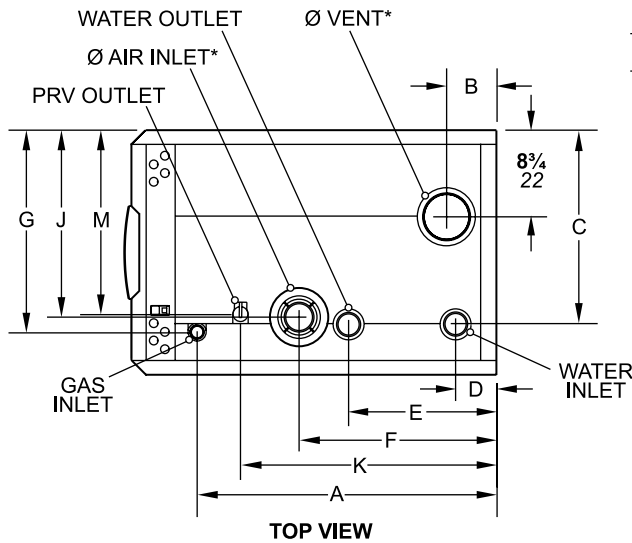


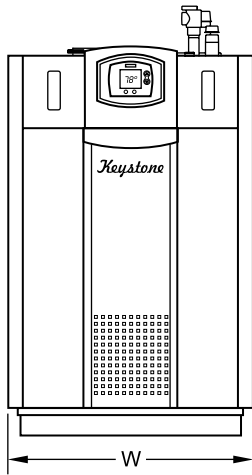
Figure 7. Contents of Shipping Package.



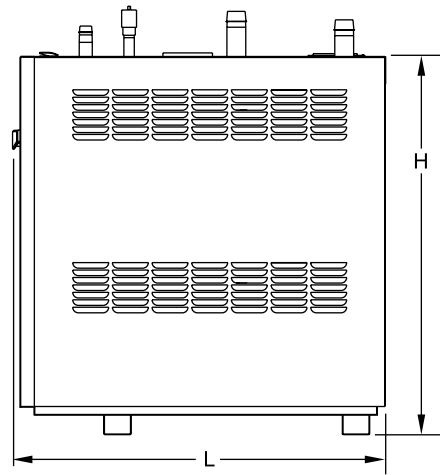
SIZE	W		L		H		AIR INLET		VENT	
	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM
199	25	64	26 ³ / ₄	68	38 ¹ / ₄	97	3	7.6	3	7.6
285	25	64	26 ³ / ₄	68	38 ¹ / ₄	97	4 ¹ / ₂	11	4 ¹ / ₂	11
399	25	64	31 ¹ / ₂	80	38 ¹ / ₄	97	4 ¹ / ₂	11	4 ¹ / ₂	11
500	25	64	37 ³ / ₄	96	38 ¹ / ₄	97	4 ¹ / ₂	11	4 ¹ / ₂	11
600	25	64	37 ³ / ₄	96	38 ¹ / ₄	97	4 ¹ / ₂	11	4 ¹ / ₂	11
750	25	64	51	130	38 ¹ / ₄	97	4 ¹ / ₂	11	6 ¹ / ₂	17
850	25	64	55 ¹ / ₄	130	38 ¹ / ₄	97	4 ¹ / ₂	11	6 ¹ / ₂	17

Dimensions are nominal and are shown in inches, cm.

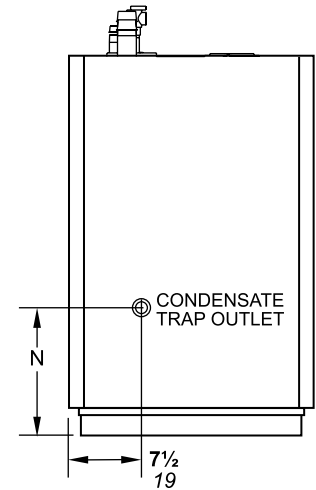
*Keystone is shipped with adapters for the air and vent that accept standard pipe of the proper size and type.



FRONT VIEW



RIGHT SIDE VIEW



BACK VIEW

SIZE	A		B		C		D		E		F		G		J		K		M		N	
	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM	IN	CM
199 KW	20 ¹ / ₂	52	5 ¹ / ₄	14	19	48	3 ¹ / ₄	8	17 ³ / ₄	45	7 ¹ / ₂	19	14 ¹ / ₄	36	19 ¹ / ₂	49	11 ³ / ₄	30	15 ¹ / ₄	39	13	33
285 KW	20 ¹ / ₄	52	7 ¹ / ₄	19	19 ³ / ₄	50	4 ¹ / ₄	16	11 ¹ / ₄	29	13 ¹ / ₂	34	14	36	15	38	17	43	18 ³ / ₄	48	13	33
399 KW	25	64	5 ¹ / ₄	13	19 ³ / ₄	50	4 ¹ / ₄	11	14 ³ / ₄	37	18 ¹ / ₂	47	19 ¹ / ₄	49	16 ¹ / ₂	42	21 ³ / ₄	55	18 ³ / ₄	48	13	33
500 KS	30 ¹ / ₄	77	5 ¹ / ₄	13	19 ¹ / ₂	50	4 ¹ / ₄	11	15 ¹ / ₄	38	20	51	20 ¹ / ₂	52	19	48	26	66	18 ³ / ₄	48	13	33
500 KW	30 ¹ / ₄	77	5 ¹ / ₄	13	19 ³ / ₄	50	4 ¹ / ₄	11	15 ¹ / ₄	38	20	51	20 ¹ / ₂	52	19	48	26	66	18 ³ / ₄	48	13	33
600 (both)	29 ³ / ₄	76	5	13	19 ¹ / ₂	50	4 ¹ / ₄	11	15	38	20	51	3	8	19	48	26	66	18 ³ / ₄	48	8 ¹ / ₄	21
750 (both)	35 ¹ / ₂	90	6	15	19 ¹ / ₂	50	5 ¹ / ₄	13	19	48	40 ¹ / ₂	103	3 ¹ / ₄	8	19	48	30 ³ / ₄	78	18 ³ / ₄	48	8 ¹ / ₄	21
850 (both)	39 ³ / ₄	101	6	15	19 ¹ / ₂	50	5 ¹ / ₄	13	19	48	44 ³ / ₄	114	3 ¹ / ₂	9	19	48	35	89	18 ³ / ₄	48	8 ¹ / ₄	21

Figure 8. Dimensional Drawing, Sizes 80-500.

SECTION 2. Locating the Appliance

2.1 Locating the Appliance

Keystone is for indoor installations only.

The appliance should be located to provide clearances on all sides for maintenance and inspection. It should not be located in an area where leakage of any connections will result in damage to the area adjacent to the appliance or to lower floors of the structure.

When such a location is not available, it is recommended that a suitable drain pan, adequately drained, be installed under the appliance.

The appliance is design certified by CSA-International for installation on combustible flooring; in basements; in closets, utility rooms or alcoves.

Keystone Boilers must never be installed on carpeting. The location for the appliance should be chosen with regard to the vent pipe lengths and external plumbing and on a level surface. The unit shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during operation and service (circulator replacement, control replacement, etc.). When vented vertically, the Keystone must be located as close as practical to the vertical section of the vent. If the vent terminal and/or combustion air terminal terminate through a wall, and there is potential for snow accumulation in the local area, both terminals should be installed at an appropriate level above grade or the maximum expected snow line.

The dimensions and requirements that are shown in Table 1 should be met when choosing the locations for the appliance.

2.2 Locating Appliance for Correct Vent Distance from Outside Wall or Roof Termination

The forced draft combustion air blower in the appliance has sufficient power to vent properly when the guidelines in Table 2 are followed.

NOTE: When located on the same wall, the Keystone combustion air intake terminal must be installed a minimum of 12" below the exhaust terminal. Sizes 500-850 also require a minimum horizontal distance from intake to exhaust terminal of 36".

For concentric vent terminal kit (optional), follow installation instructions included with the kit.

APPLIANCE SURFACE	SUGGESTED SERVICE ACCESS CLEARANCE	
	INCHES	CM
Left Side	1	2.5
Right Side	12	31
Top	24	61
Back	6	15
Closet, Front (285-500)	6	15
Alcove, Front (285-500)	24	61
Front (600-850)	24	61
Vent	—	—

Certified by CSA for zero clearance to combustible materials on all sides.

Table 1. Clearances.

SIZE	INTAKE / EXHAUST					
	STANDARD VENT	MAX EQUIV. FT.	MAX EQUIV. M	OPTIONAL VENT	MAX EQUIV. FT.	MAX EQUIV. M
199	3"	100	30.5	n/a	—	—
285	4"	100	30	n/a	—	—
399	4"	100	30	n/a	—	—
500	4"	100	30	n/a	—	—
600	4"	40	6.1	6"	100	30
750	4"	40	6.1	6"	100	30
850	4"	40	6.1	6"	100	30

Installations in the U.S. require exhaust vent pipe that is a combination of PVC & CPVC complying with ANSI/ASTM D1785 F441 or stainless steel complying with UL1738. Installations in Canada require exhaust vent pipe that is certified to ULC S636.

Intake (air) pipe must be PVC or CPVC that complies with ANSI/ASTM D1785 F441, ABS that complies with ANSI/ASTM D1527 or galvanized material.

Installer must comply fully with manufacturer's installation instructions, including use of minimum exhaust length CPVC, to maintain ANSI Z21.13 safety certification.

Closet and alcove installations do not allow the use of PVC under any circumstances

To calculate max equivalent length, measure the linear feet of the pipe, and add 5 feet (1.5m) for each elbow used.

Table 2. Vent / Air Pipe Sizes.

SECTION 3. Venting and Combustion Air

3.1 Combustion Air

Keystone boilers and water heaters must have provisions for combustion and ventilation air in accordance with the applicable requirements for Combustion Air Supply and Ventilation in the National Fuel Gas Code, ANSI Z223.1; or in Canada, the Natural Gas and Propane Installation Code, CSA B149.1. All applicable provisions of local building codes must also be adhered to.

A Keystone unit can take combustion air from the space in which it is installed, or the combustion air can be ducted directly to the unit. Ventilation air must be provided in either case.

3.1.1 Combustion Air From Room

In the United States, the most common requirements specify that the space shall communicate with the outdoors in accordance with method 1 or 2, which follow. Where ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect.

SIZE	HORIZONTAL INTAKE AND EXHAUST PVC VENT TERMINAL KITS					
	2" PVC		3" PVC		4" PVC	6" PVC
	Standard	Concentric CA006000	Standard CA005900	Concentric 239-44069-01	Standard	Standard
199	n/a	n/a	included	optional	n/a	n/a
285	n/a	n/a	optional	optional	included	n/a
399	n/a	n/a	n/a	n/a	included	n/a
500	n/a	n/a	n/a	n/a	included	n/a
600	n/a	n/a	n/a	n/a	included	optional
750	n/a	n/a	n/a	n/a	n/a	included
850	n/a	n/a	n/a	n/a	n/a	included

Concentric vent terminal = 10 ft. pipe length.

Table 3a. PVC Vent Terminal Kits.

Method 1: Two permanent openings, one commencing within 12" (300mm) of the top and one commencing within 12" (300mm) of the bottom, of the enclosure shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors. When directly communicating with the outdoors, or when communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4000 Btu/hr (550 square mm/kW) of total input rating of all equipment in the enclosure. When communicating to the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2000 Btu/hr (1100 square mm/kW) of total input rating of all equipment in the enclosure.

Method 2: One permanent opening, commencing within 12" (300mm) of the top of the enclosure, shall be permitted. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 Btu/hr (734 square mm/kW) of the total input rating of all equipment located in the enclosure. This opening must not be less than the sum of the areas of all vent connectors in the confined space.

Other methods of introducing combustion and ventilation air are acceptable, providing they conform to the requirements in the applicable codes listed above.

In Canada, consult local building and safety codes or, in absence of such requirements, follow CAN/CGA B149.

3.1.2 Ducted Combustion Air

The combustion air can be taken through the wall, or through the roof. When taken from the wall, it must be taken from out-of-doors by means of the TRIANGLETUBE horizontal wall terminal, shown in Table(s) 3. See Table 2 to select the appropriate diameter air pipe. When taken from the roof, a field-supplied rain cap or an elbow arrangement must be used to prevent entry of rain water (see Figure 9).

SIZE	PRO TECH (FasNSeal)			HEAT FAB (Saf-T-Vent)				Z FLEX (Z-Vent)		
	Boiler Adapter	Flue Termination	Intake Air Termination	Boiler Adapter	Intermediate Adapter	Flue Termination	Intake Air Termination	Boiler Adapter	Flue Termination	Intake Air Termination
500-600	F303759	FSBS4 FSRC4(R.C)	FSAIH04 303888	KB285600	9454BUREZ-1*	9492 5400CI	9414TERM	2SVSLA04	2SVSTP04 2SVSRCX04	2SVSTEX0490
750-850	F303759 (intake only)	FSBS6	FSAIH04 303888							

Table 3b. Approved Stainless Steel Terminations and Adapters.

MATERIAL	INSTALLATION STANDARDS	
	UNITED STATES	CANADA
ABS	ANSI/ASTM D1527	Air pipe material must be chosen based upon the intended application of the boiler.
PVC, sch 40	ANSI/ASTM D1785 or D2665	
CPVC, sch 40	ANSI/ASTM F441	
Single wall galv. steel	26 gauge	

Table 4. Required Combustion Air Pipe Material.

Use ABS, PVC, CPVC or galvanized pipe for the combustion air intake (see Table 4), sized per Table 2. Route the intake to the boiler as directly as possible. Seal all joints. Provide adequate hangers. The unit must not support the weight of the combustion air intake pipe. Maximum linear pipe length allowed is shown in Table 2. Subtract 5 allowable linear ft. (1.5m) for every elbow used.

The connection for the intake air pipe is at the top of the unit (see Figure 8).

In addition to air needed for combustion, air shall also be supplied for ventilation, including air required for comfort and proper working conditions for personnel.

3.2 Venting

⚠ WARNING

Failure to use CPVC or stainless steel venting for the first 20" (sizes 285-600) / 30" (size 199) of vent material or for any part of the venting that is installed inside a closet may lead to property damage, personal injury or death. The proper length of this material is supplied with boiler. Boilers in U.S. may use pipe included with boiler.

⚠ WARNING

Failure to use the appropriate vent material, installation techniques, glues/sealants could lead to vent failure causing property damage, personal injury or death.

⚠ WARNING

All venting must be installed according to this manual and any other applicable local codes, including but not limited to, ANSI Z223.1/NFPA 54, CSA B149.1, CSAB149.2 and ULC-S636. Failure to follow this manual and applicable codes may lead to property damage, severe injury, or death.

The flue temperature of the Keystone changes dramatically with changes in operating water temperature. Therefore, it is necessary to assess the application of the boiler to determine the required certified vent class. If the Keystone is installed in an application where the ambient temperature is elevated, and/or installed in a closet/alcove, CPVC or stainless steel material is required. If the system temperatures are unknown at the time of installation, class IIB or higher venting material is recommended.

The keystone is a Category IV appliance and may be installed with PVC and CPVC that complies with ANSI/ASTM D1785 F441, stainless steel vent

system that complies with UL1738 or Polypropylene that complies with ULC-S636 (see Table 5). When using polypropylene the vent system must use components from the same manufacturer. All of the components used must be listed to ULC-S636 by a recognized testing agency.

The unit's vent can terminate through the roof, or through an outside wall.

When using PVC/CPVC for vent material, venting must be connected to the CPVC section included with Keystone sizes 199-600. The CPVC vent section included with the Keystone may be broken by CPVC fittings if necessary, but never reduced in total length. See Table 2 to select the appropriate vent pipe diameter. Vent pipe must pitch upward, toward the vent terminal, not less than 1/4" per foot, so that condensate will run back to the Keystone to drain. Route vent pipe to the heater as directly as possible. Seal all joints and provide adequate hangers as required in the venting system manufacturer's Installation Instructions. Horizontal portions of the venting system must be supported to prevent sagging and may not have any low sections that could trap condensate. The unit must not support the weight of the vent pipe. Please see Table 2 for proper diameter vs. length allowed.

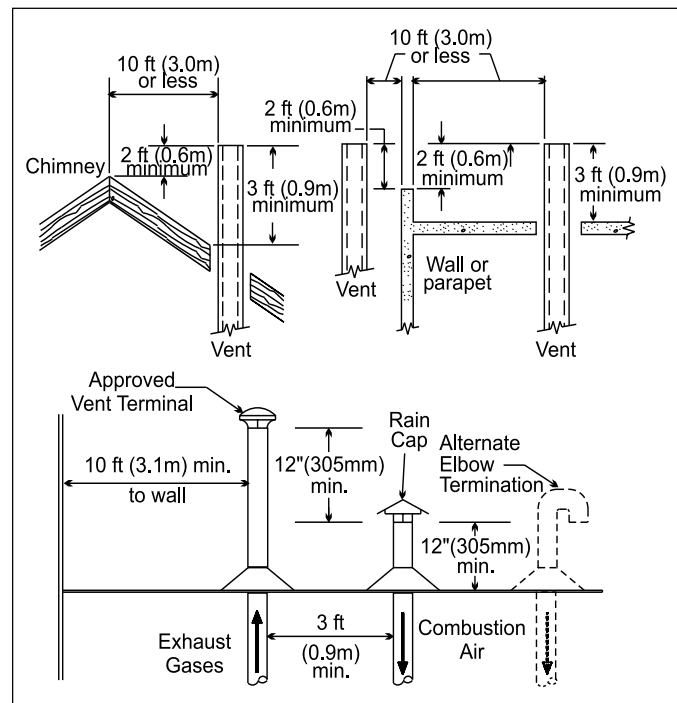


Figure 9. Combustion Air and Vent Through Roof.

MATERIAL	INSTALLATION STANDARDS	
	UNITED STATES	CANADA
Stainless Steel	UL 1738	Venting must be ULC-S636 certified for use as venting material. The venting material must be chosen based upon the intended application of the boiler.
PVC, sch 40	ANSI/ASTM D178	
CPVC, sch 40	ANSI/ASTM F441	
Polypropylene	ULC-S636	

Table 5. Required Exhaust Vent Material.

IMPORTANT NOTE ABOUT COMMON VENTING:

A single vent that is shared by multiple Keystone units **MUST** be engineered by a competent venting specialist, and involves the selection of draft inducing equipment, hardware and controls to properly balance flue gas pressures. **Do not common vent Keystone units unless the vent system meets this requirement. Keystone units are never permitted to share a vent with Category I appliances.**

A condensate drain trap is built into Keystone.

Connect a 3/4" PVC pipe between the drain connection and a floor drain (or condensate pump if a floor drain is not accessible).

The condensate drain must be installed so as to prevent accumulation of condensate. When a condensate pump is not used, the tubing must continuously slope downward toward the drain with no spiraling.

Consult local codes for disposal method.

⚠ Caution

Condensate is mildly acidic (pH≈5), and may harm some floor drains and/or pipes, particularly those that are metal. Ensure that the drain, drainpipe, and anything that will come in contact with the condensate can withstand the acidity, or neutralize the condensate before disposal. **Damage caused by failure to install a neutralizer kit or to adequately treat condensate will not be the manufacturer's responsibility.**

3.2.1 Venting Requirements Unique to Canada

Keystone boilers and water heaters are Vent Category IV appliances. Per the requirements of CAN/CSA-B149.1, only BH vent systems can be connected to these units and such vent systems, either ULC S636 certified stainless steel or other ULC S636 certified BH vent (eg. plastics) must be installed per the vent manufacturer's certified installation instructions.

As a result, two items listed in the Unpacking section (Figure 7) are **not to be used** with Keystone units for Canada (underlined):

- A. exhaust vent terminal** (*not to be used*)
- B. air intake terminal
- C. temperature/pressure gauge kit
- D. circulator pump/wire harness (units with pump)
- E. CPVC exhaust pipe section (199-500)** (*not to be used*)
- F. outdoor/system sensor kit
- G. flow switch kit (500-850)
- H. alternate size vent/terminal screens
- J. exhaust vent adapter CPVC/ST ST (750-850)

It is the responsibility of the appropriately licensed technician installing this Keystone unit to use ULC S636 certified vent material consistent with the requirements as described in the Venting and Combustion Air section.

IMPORTANT! It is also the responsibility of the installer to ensure that a flue gas sampling port is installed in the vent system. This flue gas sampling port must be installed near the flue connection of the Keystone unit: within 2 feet of the flue connection. There is no flue gas sampling port internal to the Keystone, so one must be installed in the vent system external to the Keystone unit. A flue gas sampling port available as a component of the ULC S636 certified vent system is preferred. However, if one is not available with the certified vent system, TriangleTube suggests using a tee with the branch connection sized to allow for insertion of a flue gas analyzer probe. The branch connection must be resealable with a cap or other by other means to ensure the vent system remains sealed (Figure 10).

Consideration must be given to the placement and orientation of the flue gas sampling port to ensure that condensate is free to flow back into the Keystone unit and not collect anywhere in the vent system - including in the flue gas sampling port.

An exhaust vent terminal must be installed. If an exhaust vent terminal is not available with the certified vent system, TriangleTube suggests the use of a coupler fitting from the certified vent system into which the vent terminal screen, included with the Keystone and shown in the Unpacking section of the Keystone Installation & Operating Instructions, be installed. Be sure to install and terminate both vent and combustion air pipes per the Venting and Combustion Air section of the Keystone instructions.

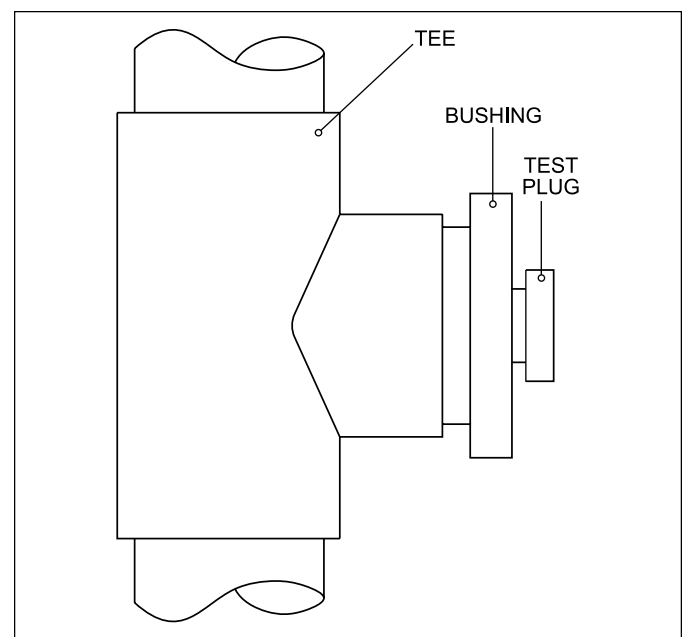


Figure 10. Test Port.

3.3 Locating Vent & Combustion Air Terminals

3.3.1 Side Wall Vent Terminal

The appropriate TriangleTube side wall vent terminal must be used. The terminal must be located in accordance with ANSI Z223.1/NFPA 54 and applicable local codes. In Canada, the installation must be in accordance with CSA B149.1 or .2 and local applicable codes. Consider the following when installing the terminal:

1. Figure 11 shows the requirements for mechanical vent terminal clearances for the U.S. and Canada.
2. Vent terminals for condensing appliances or appliances with condensing vents are **not** permitted to terminate above a public walkway, or over an area where condensate or vapor could create a nuisance or hazard.
3. Locate the vent terminal so that vent gases cannot be drawn into air conditioning system inlets.
4. Locate the vent terminal so that vent gases cannot enter the building through doors, windows, gravity inlets or other openings. Whenever possible, avoid locations under windows or near doors.
5. **Locate the vent terminal so that it cannot be blocked by snow. The installer may determine that a vent terminal must be higher than the minimum shown in codes, depending upon local conditions.**
6. Locate the terminal so the vent exhaust does not settle on building surfaces or other nearby objects. Vent products may damage surfaces or objects.
7. If the boiler or water heater uses ducted combustion air from an intake terminal located on the same wall, see Figures 11-13 for proper spacing and orientation.

If the vent termination is located in an area exposed to high winds, an optional PVC tee (the same diameter as the vent pipe) may be used. The tee'd vent termination offers greater protection from wind related operating issues.

3.3.2 Side Wall Combustion Air Terminal

The TRIANGLETUBE side wall combustion air terminal, or concentric terminal (see Table 3), must be used when the heater takes air from a side wall. Contact TriangleTube for AL29-4C termination fittings. Consider the following when installing the terminal (see Figures 11-13):

1. Do not locate the air inlet terminal near a source of corrosive chemical fumes (e.g., cleaning fluid, chlorine compounds, etc.)
2. Locate the terminal so that it will not be subject to damage by accident or vandalism. It must be at least 7 feet (2.1m) above a public walkway.
3. Locate the combustion air terminal so that it cannot be blocked by snow. The National Fuel Gas Code requires that it be at least 12 inches (30cm)

above grade, but the installer may determine it should be higher, depending upon local conditions.

4. If the Keystone is side-wall vented to the same wall, locate the vent terminal at least 1 foot (0.3m) above the combustion air terminal.
5. **For concentric vent, follow instructions included with vent kit.**
6. Multiple vent kits should be installed such that the horizontal distance between outlet group and inlet group is 36" (90cm) (see Figure 12).
7. Vent outlet for sizes 199-285 must be no lower than the center of the air inlet, and must be at least 12" (30cm) away from the air inlet. Vent outlets for models 500-850 must be at least 12" above the top of the air inlet, and must be at least 36" (90cm) horizontally from the air inlet (see Figure 13).

3.3.3 Vertical Vent Terminal

When the unit is vented through the roof, the vent must extend at least 3 feet (0.9m) above the point at which it penetrates the roof. It must extend at least 2 feet (0.6m) higher than any portion of a building within a horizontal distance of 10 feet (3.0m), and high enough above the roof line to prevent blockage from snow. The vent terminal included with the Keystone can be used in both vertical and horizontal applications. When the combustion air is taken from the roof, the combustion air must terminate at least 12" (30cm) below the vent terminal (see Figure 13).

3.3.4 Vertical Combustion Air Terminal

When combustion air is taken from the roof, a field-supplied rain cap or an elbow arrangement must be used to prevent entry of rain water (see Figure 13). The opening on the end of the terminal must be at least 12" (30cm) above the point at which it penetrates the roof, and high enough above the roof line to prevent blockage from snow. When the vent terminates on the roof, the combustion air must terminate at least 12" (30cm) below the vent terminal.

3.3.5 Installations in the Commonwealth of Massachusetts

In Massachusetts the following items are required if 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. From Massachusetts Rules and regulations 248 CMR 5.08

1. Installation of Carbon Monoxide Detectors

At the time of installation of the side wall vented gas fueled appliance, the installing plumber or gas-fitter shall observe that a hard-wired carbon monoxide detector with an alarm battery back-up is installed on the floor level where the gas appliance 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 hori-

	U.S. Installations (see note 1)	Canadian Installations (see note 2)
A = Clearance above grade, veranda, porch, deck, or balcony	12 inches (30 cm) See note 6	12 inches (30 cm) See note 6
B = Clearance to window or door that may be opened	Direct vent only: 12 inches (30cm); Other than Direct vent: 4 ft (1.2m) below or to side of opening; 1 ft (30cm) above opening	36 inches (91 cm)
C = Clearance to permanently closed window	See note 4	See note 5
D = Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet (61cm) from the center line of the terminal	See note 4	See note 5
E = Clearance to unventilated soffit	See note 4	See note 5
F = Clearance to outside corner	See note 4	See note 5
G = Clearance to inside corner	See note 4	See note 5
H = Clearance to each side of center line extended above meter/regulator assembly	See note 4	3 feet (91 cm) within a height 15 feet above the meter/regulator assembly
I = Clearance to service regulator vent outlet	See note 4	3 feet (91 cm)
J = Clearance to nonmechanical air supply inlet to building or the combustion air inlet to any other appliance	Direct vent only: 12" (30cm) 80-285; 36" (91cm) 399-850. Other than Direct vent: 4 ft (1.2m) below or to side of opening; 1 ft (30cm) above opening	36 inches (91 cm)
K = Clearance to a mechanical air supply inlet	3 feet (91 cm) above if within 10 feet (3 m) horizontally	6 feet (1.83 m)
L = Clearance above paved sidewalk or paved driveway located on public property	Vent termination not allowed in this location for category IV appliances.	Vent termination not allowed in this location for category IV appliances.
M = Clearance under veranda, porch, deck, or balcony	See note 4	12 inches (30 cm) (see note 3)

Notes:

1. In accordance with the current ANSI Z223.1 / NFPA 54 National Fuel Gas Code.
2. In accordance with the current CAN/CGA-B149 Installation Codes.
3. Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.
4. For clearances not specified in ANSI Z223.1 / NFPA 54, clearance is in accordance with local installation codes and the requirements of the gas supplier.
5. For clearances not specified in CAN/CGA-B149, clearance is in accordance with local installation codes and the requirements of the gas supplier.
6. IMPORTANT: terminal must be placed such that it remains a minimum 12" above expected snow line. Local codes may have more specific requirements, and must be consulted.

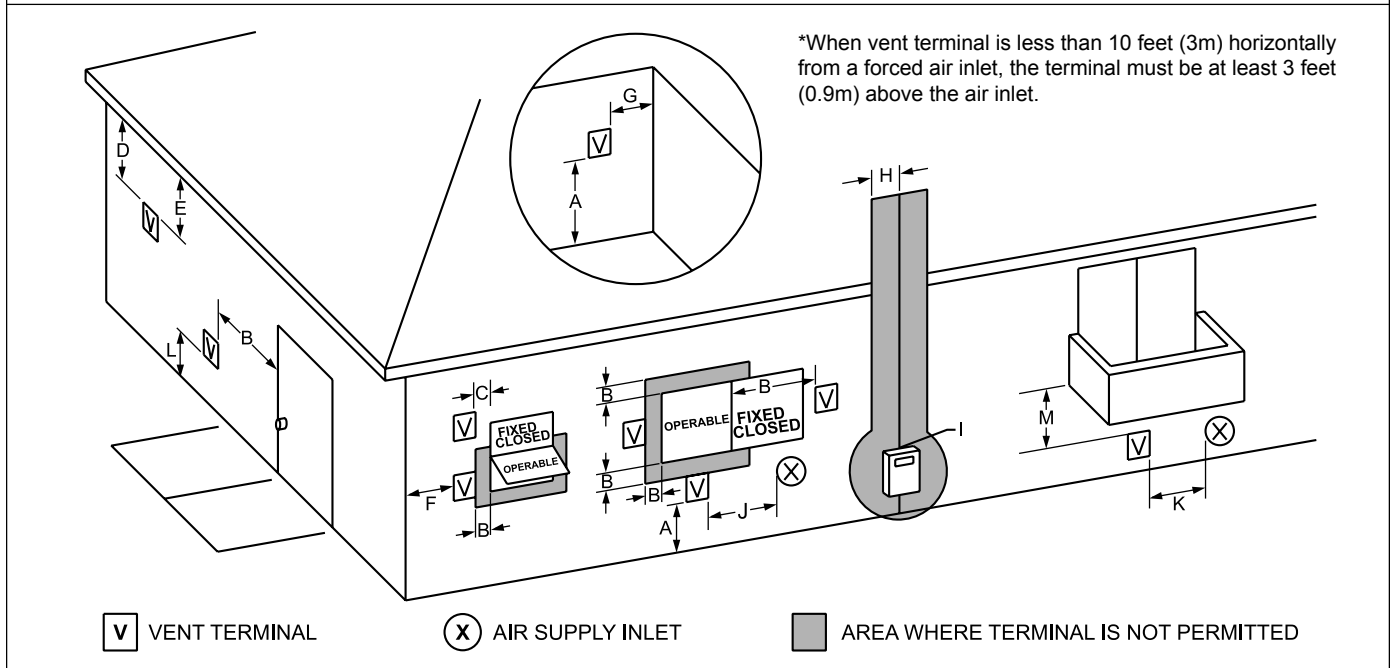


Figure 11. Combustion Air and Vent Through Side Wall.

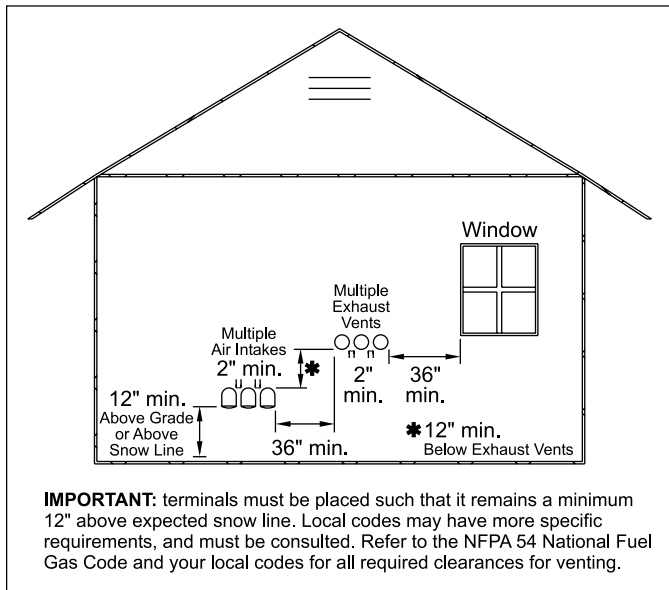


Figure 12. Multiple Side-Wall Terminals, Air and Vent.

zontally vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for installation of hard-wired carbon monoxide detectors.

a. In the event that the side-wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard-wired carbon monoxide with alarm and battery back-up may be installed on the next adjacent floor level.

b. In the event that the requirements of the subdivision cannot 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 be installed.

2. Approved Carbon Monoxide Detectors

Each carbon monoxide detector 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 horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print 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 appliance 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) 1-4.

3.4 Common Vent Test

NOTE: This section does not describe a method for common venting Keystone units. It describes what must be done when a unit is removed from a common vent system. Keystone units require special vent systems and fans for common vent. Contact the factory if you have questions about common venting Keystone units.

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 appliances remaining connected to it.

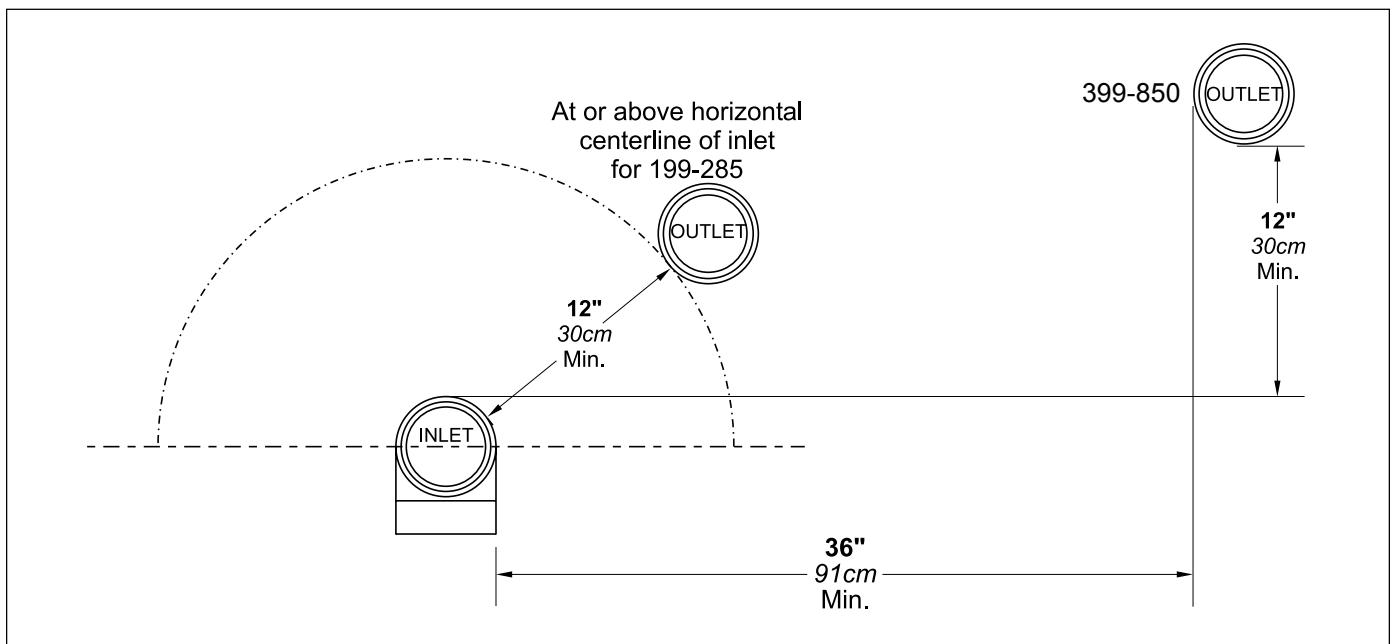


Figure 13. Minimum Venting Distance.

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 it 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 instructions. Adjust thermostat so the appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after 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, fireplace 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 that the installation conforms to the National Fuel Gas Code, ANSI Z223.1/NFPA 54 and/or CSA B149.1, Installation Codes. 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 and guidelines in the National Fuel Gas Code, ANSI Z223.1 NFPA 54 and/or CSA B149.1, Installation Codes.

SECTION 4. Gas Supply and Piping

4.1 Gas Supply and Piping

Gas piping should be supported by suitable hangers or floor stands, not the appliance.

Review the following instructions before proceeding with the installation.

1. Verify that the appliance is fitted for the proper type of gas by checking the rating plate. Keystone will function properly without the use of high altitude modification at elevations up to 10,000 feet (3050 m).
2. The maximum inlet gas pressure must not exceed 13" W.C. (3.2kPa). The minimum inlet gas pressure is 4" W.C. (1.0kPa).
3. Refer to Tables 6A, 6B, 6C and 6D to size piping.
4. Run gas supply line in accordance with all applicable codes.
5. Locate and install manual shutoff valves in accordance with state and local requirements.
6. A sediment trap must be provided upstream of the gas controls.
7. All threaded joints should be coated with piping compound resistant to action of liquefied petroleum gas.
8. The appliance and its individual shutoff valve must be disconnected from the gas supply piping during any pressure testing of that system at test pressures in excess of 1/2 PSIG (3.45kPa).
9. The unit must be isolated from the gas supply system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 PSIG (3.45kPa).
10. The appliance and its gas connection must be leak tested before placing it in operation.
11. Purge all air from gas lines.

WARNING:

Open flame can cause gas to ignite and result in property damage, severe injury, or loss of life.

NOTE: The Keystone appliance and all other gas appliances sharing the gas supply line must be firing at maximum capacity to properly measure the inlet supply pressure. The pressure can be measured at the supply pressure port on the gas valve. Low gas pressure could be an indication of an undersized gas meter, undersized gas supply lines and/or an obstructed gas supply line. Some Keystone units are equipped with low and high gas pressure switches that are integrally vent limited. These types of devices do not require venting to atmosphere.

KEYSTONE NATURAL GAS REQUIRED		TO SIZE PIPING: Measure linear distance from meter outlet to last boiler. Add total input of all boilers and divide by 1000 to obtain cu ft / hr required. Add total equivalent length of fittings used according to Table 6B. Align total length (pipe and fittings) on left side column of Table 6C with highest cubic feet of gas required.
SIZE	CU FT / HR.	
199	199	
285	285	
399	399	
500	500	
600	600	
750	750	
850	850	

Notes:
Consult and confirm with Applicable Fuel Gas Code before beginning work. Verify gas inlet pressure is between 4 and 13 in W.C. before starting boiler.

Table 6A.

FITTING	EQUIVALENT LENGTHS OF STRAIGHT PIPE FOR TYPICAL SCH 40 FITTINGS					
	NOMINAL PIPE SIZE					
	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	LINEAR FEET					
90° ELBOW	3.6	4.4	5.2	6.6	7.4	8.5
TEE	4.2	5.3	6.6	8.7	9.9	12

Table 6B.

SCH 40 METAL PIPE CAPACITY FOR 0.60 SPECIFIC GRAVITY NATURAL GAS						
NOMINAL PIPE SIZE @ 0.30" W.C. PRESSURE DROP						
LENGTH	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
FT	CUBIC FEET OF GAS PER HOUR					
20	92	190	350	730	1100	2100
40		130	245	500	760	1450
60		105	195	400	610	1150
80		90	170	350	530	990
100			150	305	460	870

Table 6C.

SCHED 40 METAL PIPE CAPACITY FOR 1.50 SPECIFIC GRAVITY UNDILUTED PROPANE						
NOMINAL PIPE SIZE @ 11" W.C. INLET AND 0.5" W.C. PRESSURE DROP						
SIZE	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
LENGTH	MAXIMUM CAPACITY IN THOUSANDS OF BTU PER HOUR					
20	200	418	787	1616	2422	4664
40	137	287	541	1111	1664	3205
60	110	231	434	892	1337	2574
80	94	197	372	763	1144	2203
100	84	175	330	677	1014	1952

NOTES: 1. Follow all local and national LP gas codes for line sizing and equipment requirements. 2. Verify that inlet gas pressure remains between 4 and 13 inches of water column before and during operation.
Source: ANSI Z223.1-80 National Fuel Gas Code.

Table 6D.

SECTION 5. Pump Requirements

5.1 Keystone Boiler Flow and Head Requirements (see Table 7)

SIZE	TEMPERATURE RISE IN °F									
	20°F		25°F		30°F		35°F		40°F	
	FLOW GPM	H/L FT	FLOW GPM	H/L FT	FLOW GPM	H/L FT	FLOW GPM	H/L FT	FLOW GPM	H/L FT
399	39	28	31	20	25	14.5	22	11	19	9
500	48	24	38	16	32	12	27	9	24	8
600	58	44	46	31	38	22	33	18	29	15
750	72	37	58	23	48	17	41	13	36	10
850	81	33	65	22	54	15	46	10	41	8

SIZE	TEMPERATURE RISE IN °C									
	11°C		14°C		17°C		19°C		22°C	
	FLOW lpm	H/L m	FLOW lpm	H/L m	FLOW lpm	H/L m	FLOW lpm	H/L m	FLOW lpm	H/L m
399	148	8.5	117	6.1	95	4.4	83	3.4	72	2.7
500	182	7.3	144	4.9	121	3.7	102	2.7	91	2.4
600	220	13.4	174	9.4	144	6.7	125	5.5	110	4.6
750	273	11.3	220	7.0	182	5.2	155	4.0	136	3.0
850	307	10.1	246	6.7	204	4.6	174	3.0	155	2.4

Table 7. Water Flow Requirements.

5.2 Keystone Water Heater Flow and Head Requirements (see Table 8)

Size	NORMAL WATER*					
	Flow gpm	H/L feet	Temp Rise °F	Flow lpm	H/L m	Temp Rise °C
199	25	28	15	95	8.5	8
285	36	33	15	98	10.1	8
399	50	35	15	189	10.7	8
500	63	28	15	239	8.5	8
600**	60	24	19	227	7.3	11
750**	68	35	21	257	10.7	12
850**	68	26	24	257	7.9	13

*Maximum water hardness of 10 grains per gallon allowed.
**See section 6B.6 for pump information.

Table 8. Keystone Water Heater Flow Data.

SECTION 6A. Water Connections - KS Boiler

Section 6 is divided into two parts. The first is for KS models and is Section 6A. The second is for KW models and is Section 6B. Refer to the proper section for instructions in installing and piping your product. Refer to Table 9 for pipe sizes required.

6A.1 KS System Piping: Hot Supply Connections

NOTE: This appliance must be installed in a closed pressure system with a minimum of 12 psi (82.7kPa) static pressure at the boiler.

Hot water piping should be supported by suitable hangers or floor stands. Do not support piping with this appliance. Due to expansion and contraction of copper pipe, consideration should be given to the type of hangers used. Rigid hangers may transmit noise through the system resulting from the piping sliding in the hangers. It is recommended that padding be used when rigid hangers are installed. Maintain 1" (2.5cm) clearance to combustibles for hot water pipes.

Pipe the discharge of the relief valve (full size) to a drain or in a manner to prevent injury in the event of pressure relief. Install an air purger, an air vent, a diaphragm-type expansion tank, and a hydronic flow check in the system supply loop. Minimum fill pressure must be 12psig (82.7kPa). Install shutoff valves where required by code.

Suggested piping diagrams are shown in Figures 14 through 20. These diagrams are meant only as a guide. Components required by local codes must be properly installed.

Keystone's efficiency is higher with lower return water temperatures. Therefore, to get the most of low return temperature with multiple boilers, pipe as shown in Figures 16-18.

Keystone with a pump **MUST** be piped in a primary-secondary fashion (using either piping or a hydraulic separator) such that the pump that is mounted on the boiler **ONLY** serves the boiler.

The pump should be sized for the boiler per Table

SIZE	PIPE SIZE, INCHES
399	1¼
500	1½
600	1½
750	2
850	2

Table 9. Water Connection Pipe Sizes.

7 and for the piping it will serve, and should be supplied to job separately. Triangle Tube strongly recommends primary-secondary piping.

6A.2 KS Cold Water Make-Up

1. Connect the cold water supply to the inlet connection of an automatic fill valve.
2. Install a suitable back flow preventer between the automatic fill valve and the cold water supply.
3. Install shut off valves where required.

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

A boiler installed above radiation level, or as required by the authority having jurisdiction, must be provided with a low water cutoff device either as a part of the boiler or at the time of boiler installation.

6A.3 Freeze Protection

WARNING

Glycol must not be used in domestic hot water applications. Refer to Section 6B.4 for instructions on KW, domestic hot water freeze protection.

Keystone units are certified for indoor use only, and are not design-certified for placement outdoors.

Proper precautions for freeze protection are recommended for boiler installations in areas where the danger of freezing exists.

Power outage, interruption of gas supply, failure of system components, activation of safety devices, etc., may prevent a boiler from firing. **Any time a boiler is subjected to freezing conditions, and the boiler is not able to fire, and/or the water is not able to circulate, there is a risk of freezing in the boiler or in the pipes in the system.** When water freezes, it expands which may result in bursting of pipes, or damage to the boiler, which could result in leaking or flooding conditions.

Do not use automotive antifreeze. To help prevent freezing, TriangleTube recommends the use of inhibited glycol concentrations between 20% and 35% glycol. Typically, this concentration will serve as burst protection for temperatures down to approximately -5°F (-20°C). If temperatures are expected to be lower than -5°F (-20°C), glycol concentrations up to 50% can be used. *When concentrations greater than 35% are used, water flow rates must be increased to maintain a 20°F to 25°F temperature rise through the boiler.*

NOTE: TriangleTube supplied pumps are not all capable of maintaining the reduced temperature rise required with glycol concentrations greater than 35%. If glycol concentrations required are greater than 35% a field supplied pump should be used.

IMPORTANT NOTES: Different glycol products may provide varying degrees of protection. Glycol products must be maintained properly in a heating system, or they may become ineffective. Consult the glycol specifications, or the glycol manufacturer, for information about specific products, maintenance of solutions, and set up according to your particular conditions.

6A.4 KS Suggested Piping Schematics

Figures 14 through 20 show suggested piping configurations for KS boilers. These diagrams are only meant as a guide. All components or piping required by local code must be installed.

6A.5 Recognized Chemicals

The following manufacturers offer glycols, inhibitors, and anti foamants that are suitable for use in the Keystone. Please refer to the manufacturers instructions for proper selection and application.

1. Sentinel Performance Solutions Group
2. Hercules Chemical Company
3. Dow Chemical Company

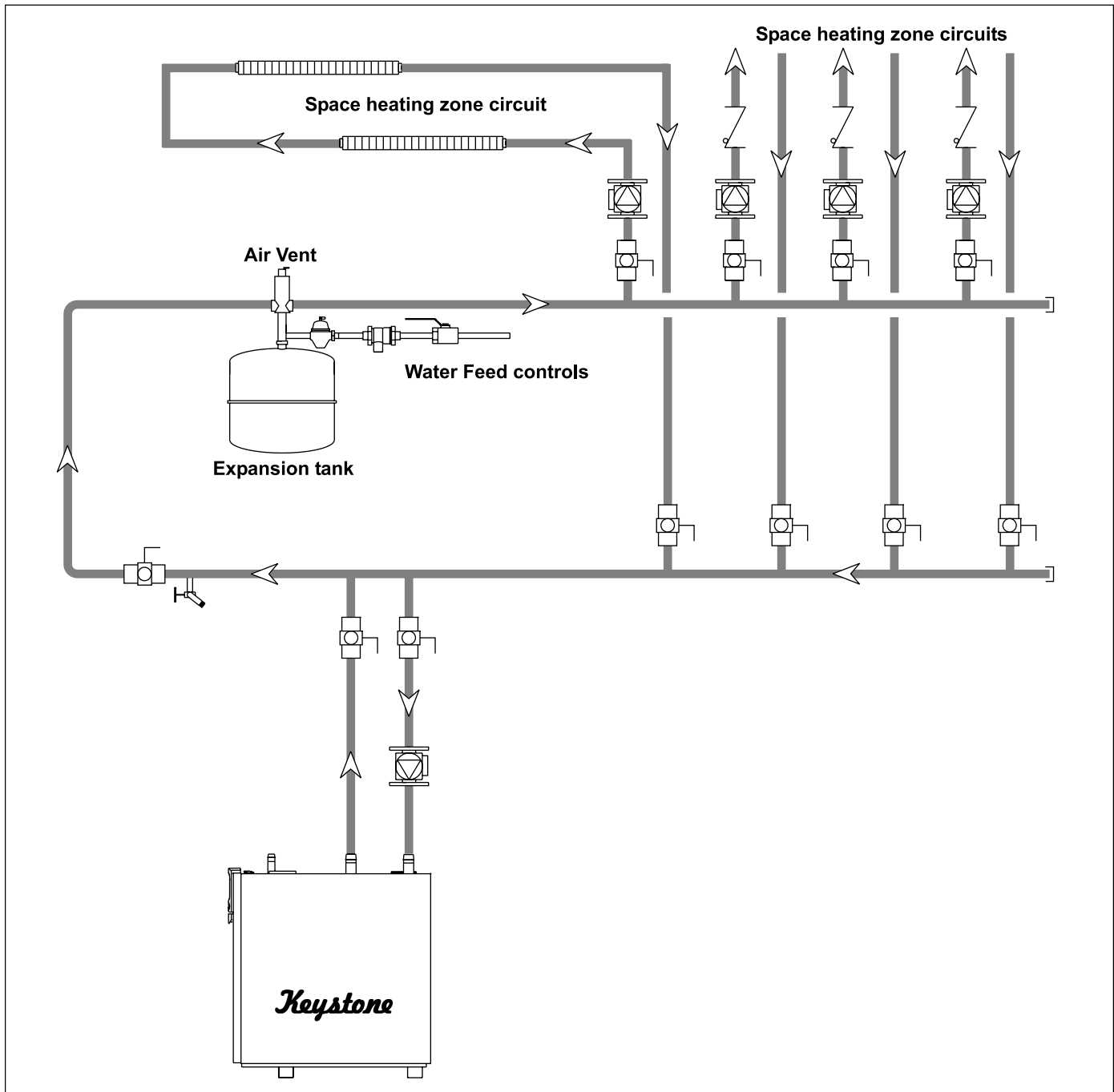


Figure 14. Hydronic Piping — Single Boiler (zoning with circulators).

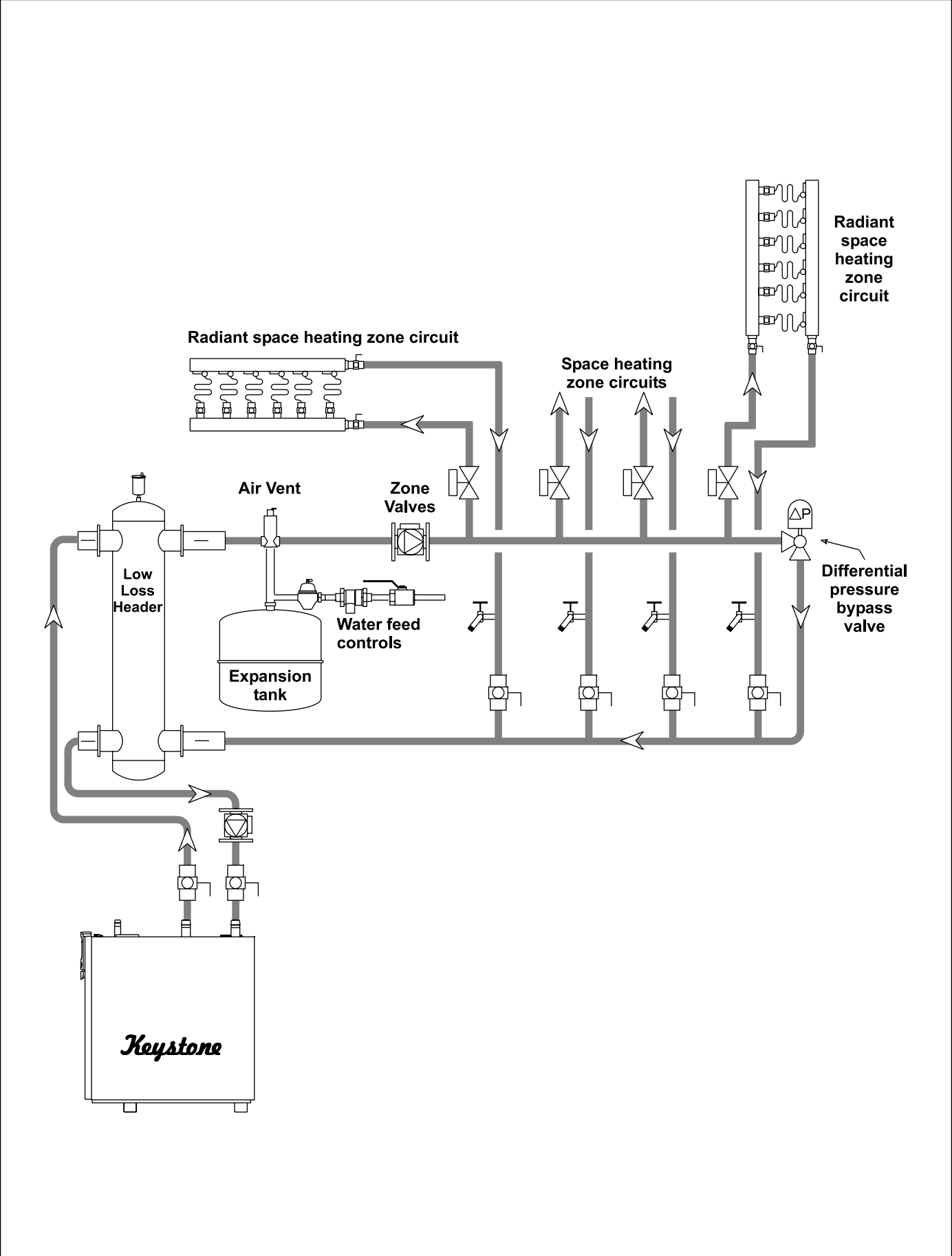


Figure 15. Hydronic Piping — Single Boiler, Low Temp Radiant Space Heating using Low Loss Header and Zone Valves.

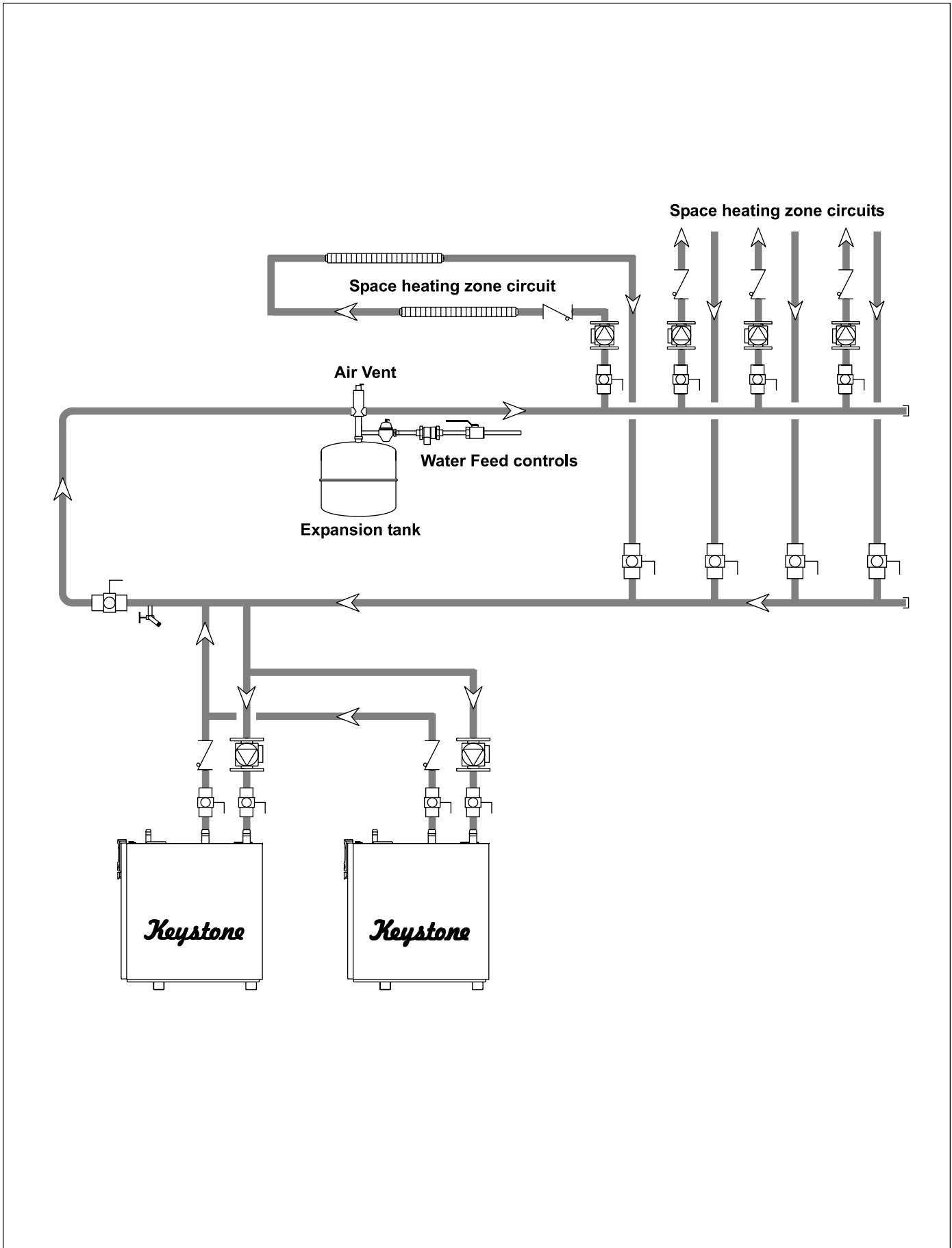


Figure 16. Hydronic Piping — Multiple Boilers (zoning with circulators).

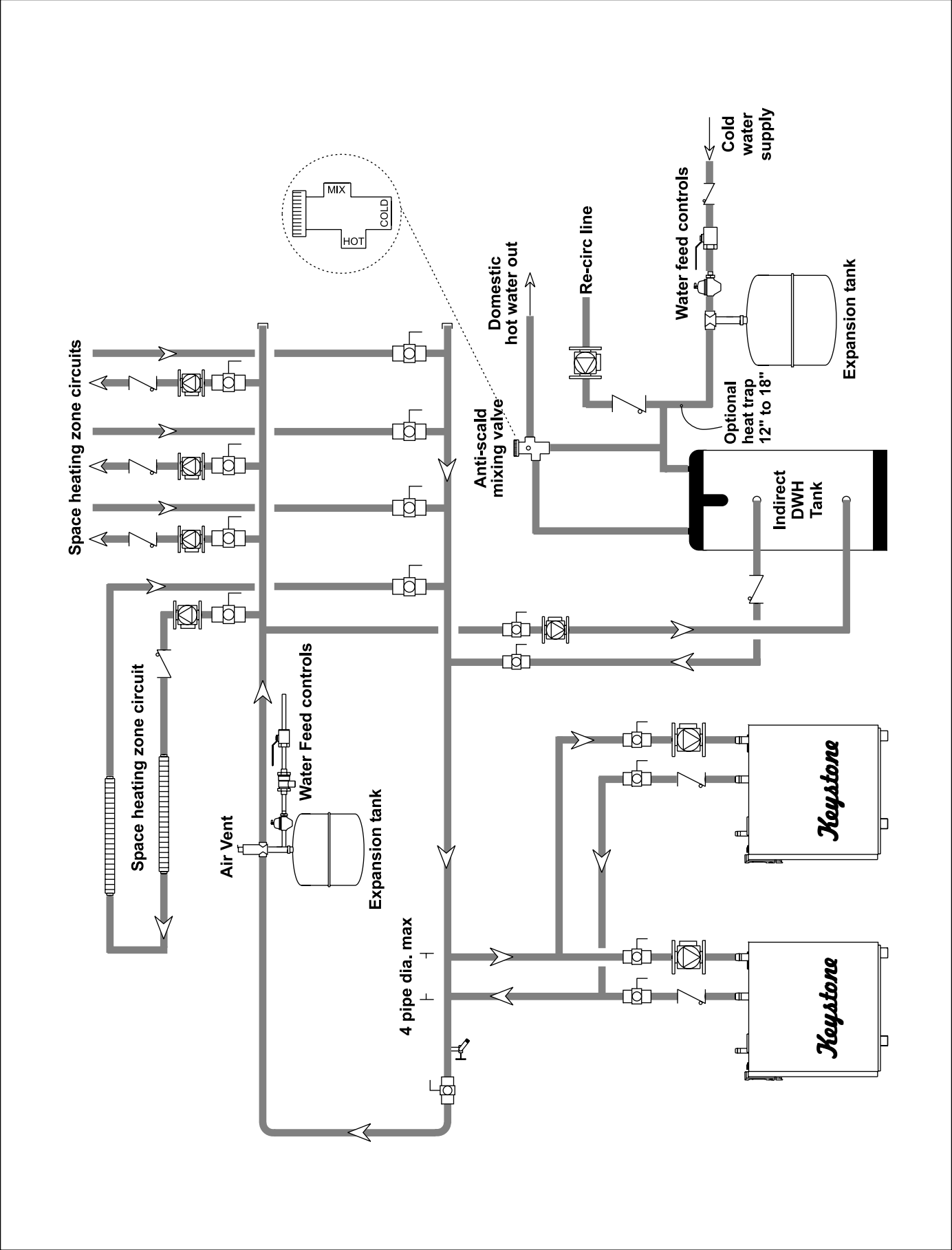


Figure 17. Hydronic Piping — Multiple Boilers with Indirect DWH Tank Piped from System Loop.

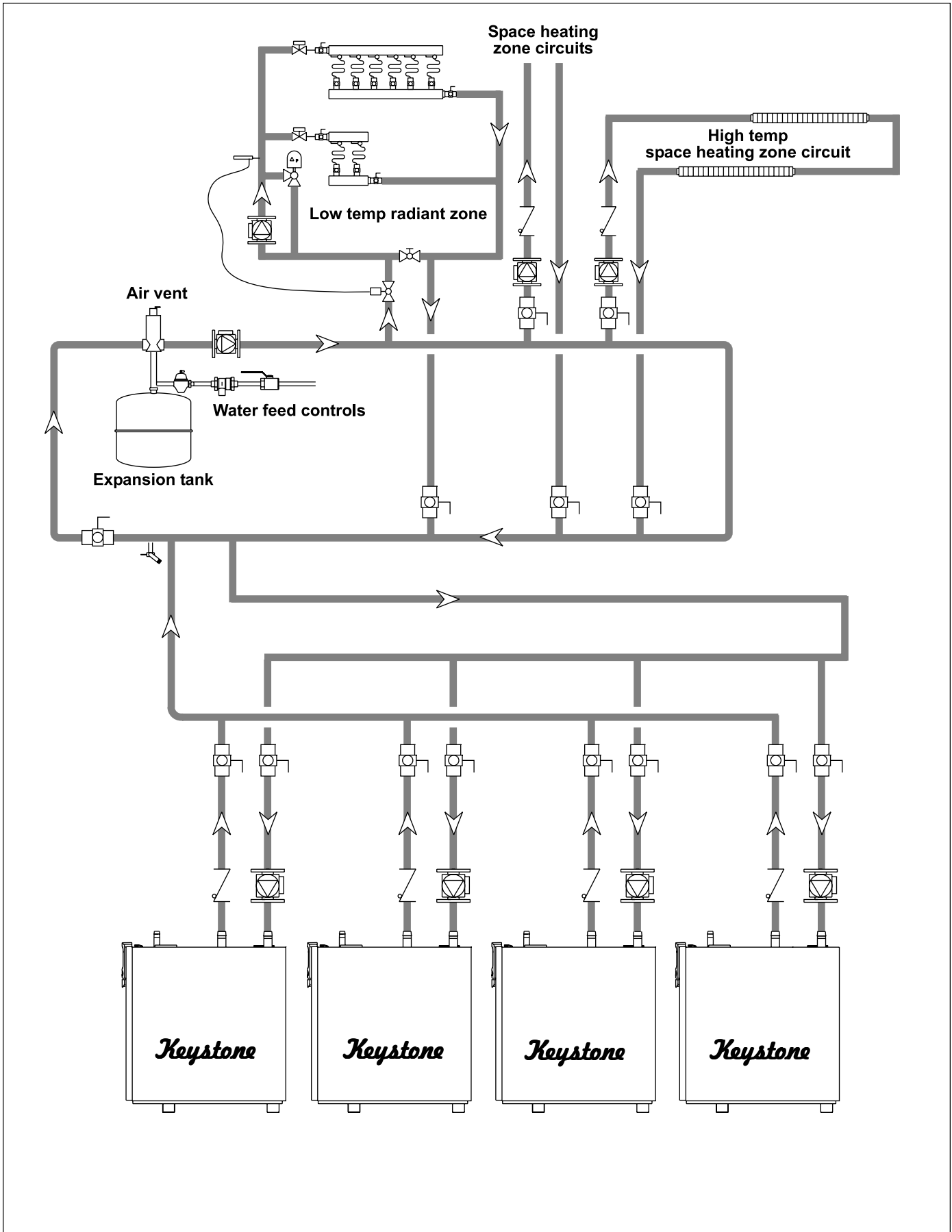


Figure 18. Hydronic Piping — Multiple Boilers, Reverse Return, Multi-Temp Zones (zoning with circulators).

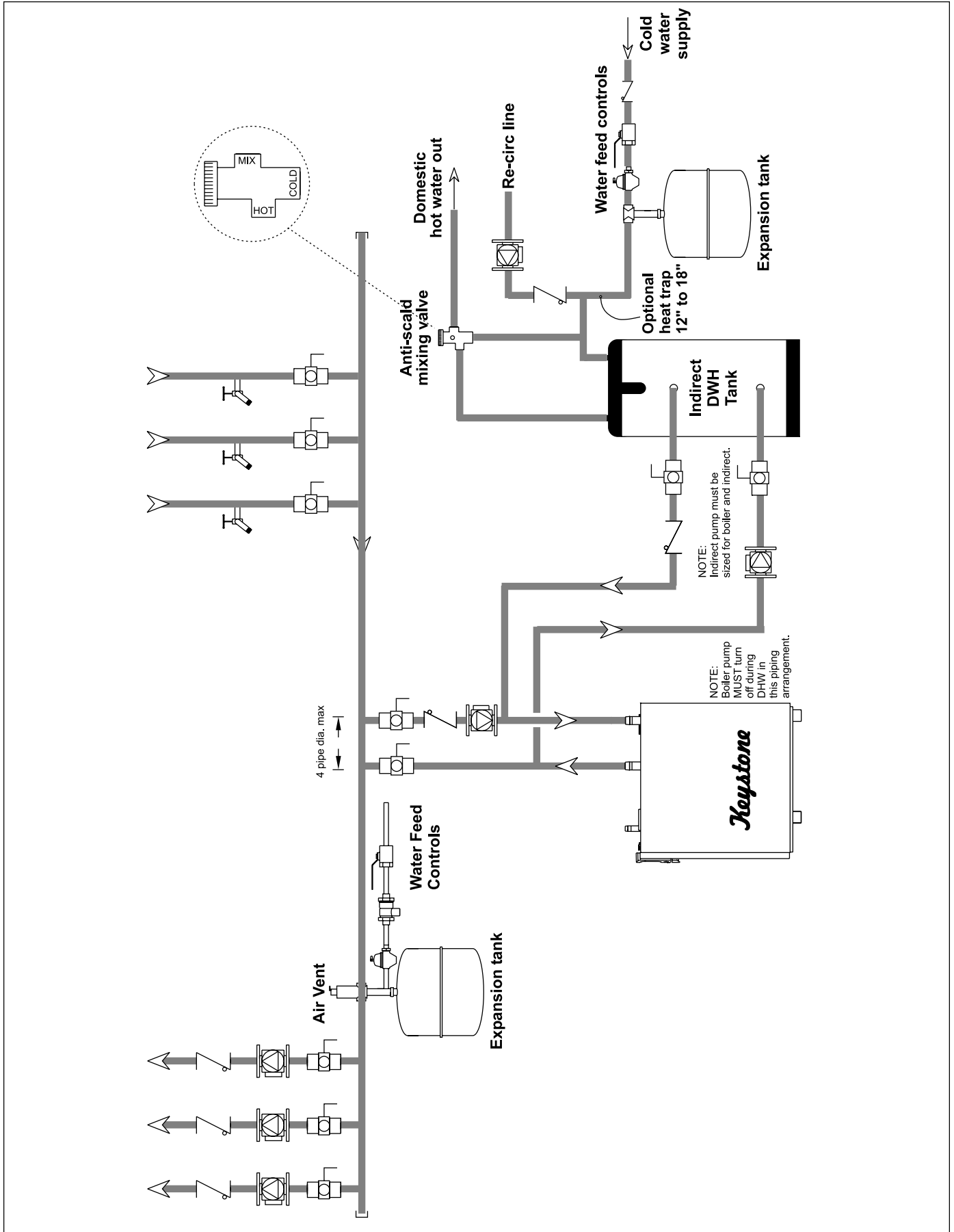


Figure 19. Hydronic Piping — Heating zones with indirect DWH tank piped with zone pumps (indirect directly off boiler). Boiler pump must shut down during DHW.

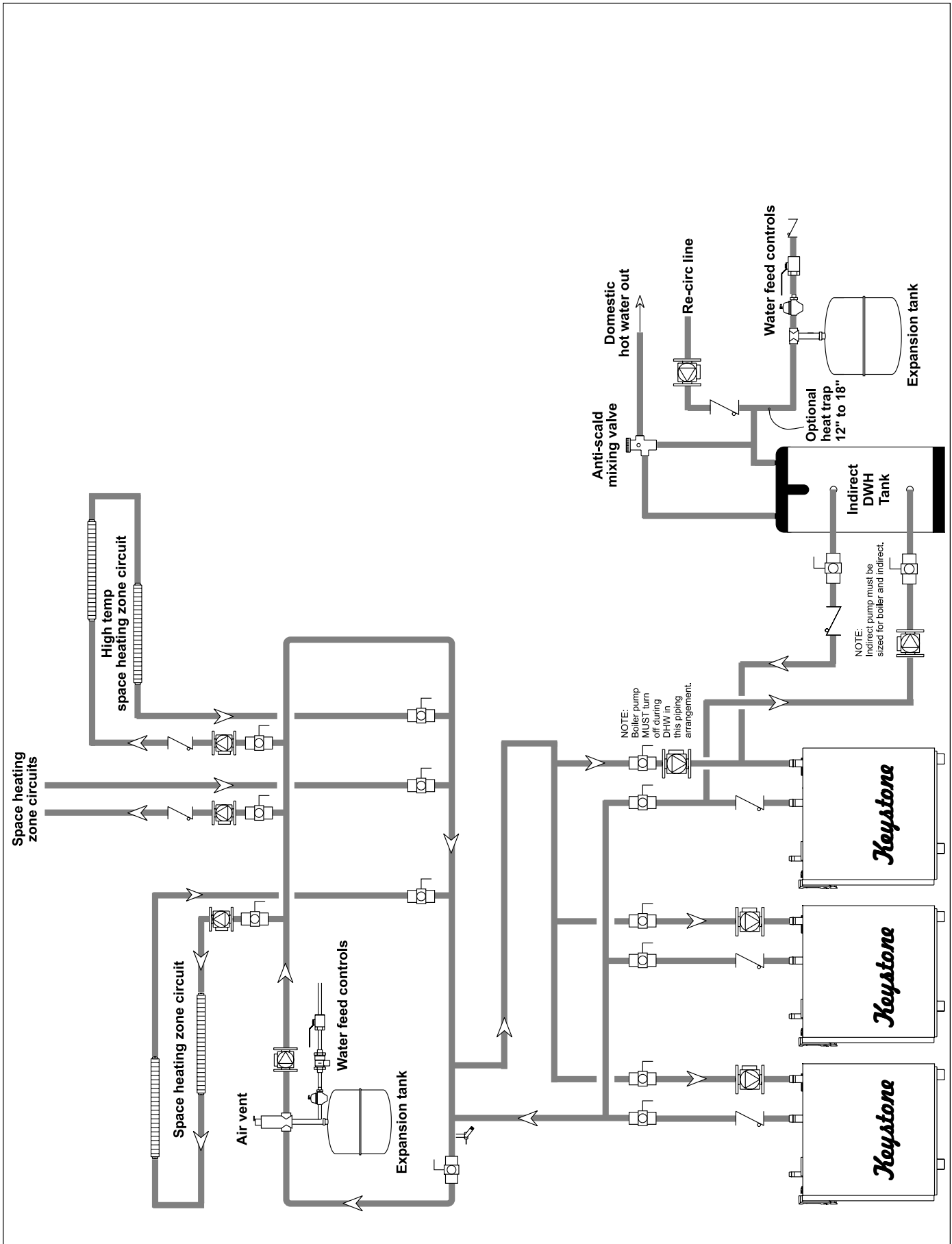


Figure 20. Hydronic Piping, multiple boilers with indirect DWH off one boiler. Boiler pump must shut-down during DHW.

SECTION 6B. Water Connections - KW Water Heater

Section 6 is divided into two parts. The first is for KS models and is Section 6A. The second is for KW models and is Section 6B. Refer to the proper section for instructions in installing and piping your product. Refer to Table 9 for pipe sizes required.

6B.1 KW Water Quality

KW water heaters must be installed in water conditions of 10gpg hardness or less with a pH range of 6.5 to 8.5. Operating the KW in water with higher hardness levels will cause heat exchanger fouling, erosion, or corrosion leading to premature component failure, reduced efficiency, heat exchanger failure or system failure. Failure of this type will not be warranted. If the water in use exceeds the conditions recommended water softeners or other devices should be installed to improve water quality.

6B.2 Piping Requirements

Water piping should be supported by suitable hangers and floor stands. Do not support piping with the appliance. Due to expansion and contraction of copper pipe, consideration should be given to the type of hangers and supports used. Rigid hangers may transmit noise through the system resulting from piping sliding in the hangers. It is recommended that padding be used when rigid hangers are installed. Maintain 1" (2.5cm) clearance to combustibles for hot water pipes.

Pipe the discharge of the relief valve (full size) to the drain or in a manner to prevent injury in the event of pressure relief. Install a diaphragm-type expansion tank, flow check, and shutoff valves where needed or as required by code.

The piping should be installed such that the pump supplies flow to the heater it is attached to only. Properly-sized field-supplied pumps should be used.

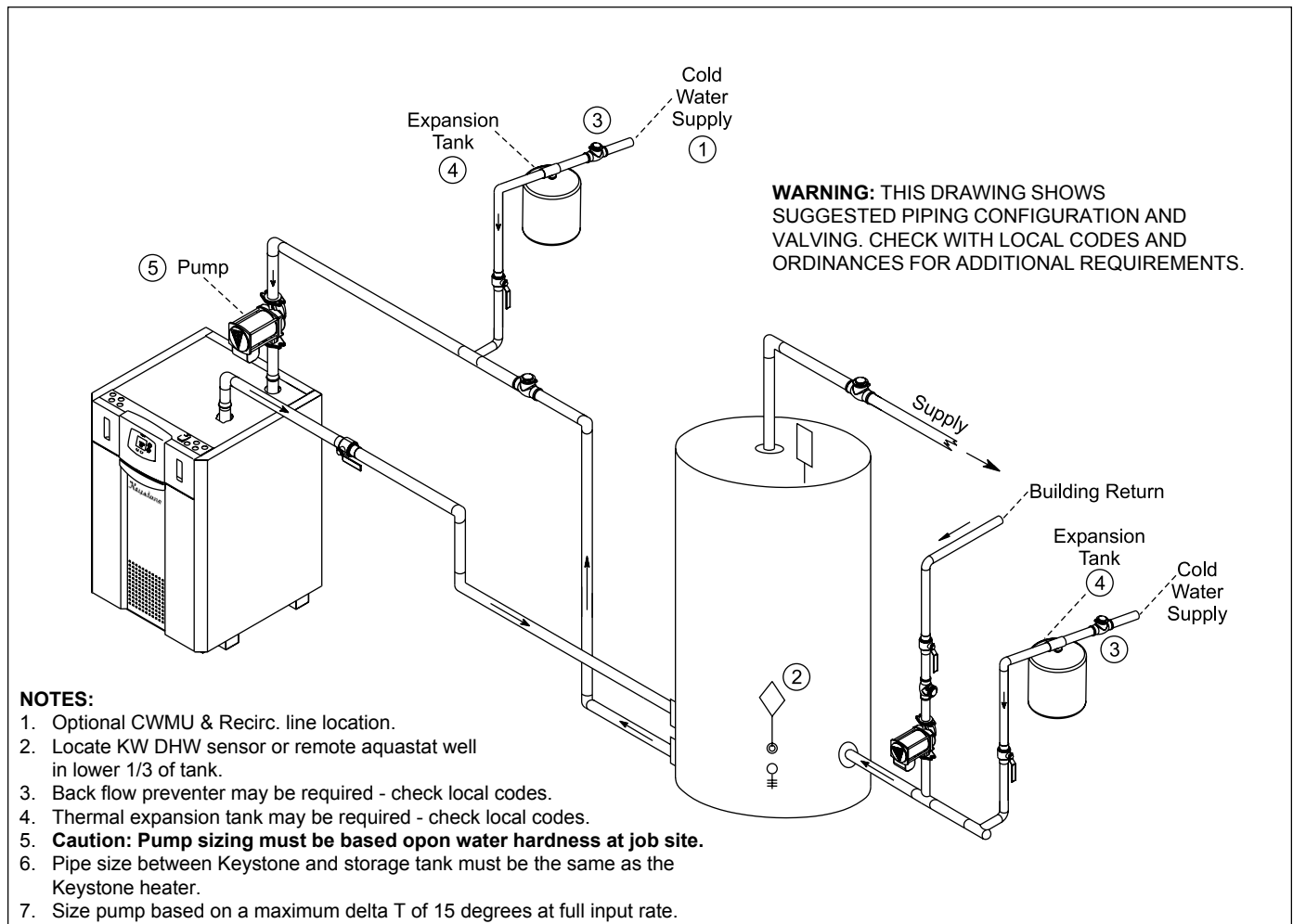


Figure 21. DHW Piping, One Heater, One Vertical Tank.

6B.3 Cold Water Make-Up

The cold water make-up may be connected to the tank or to the inlet of the boiler as shown in Figures 21-24. Install back flow preventers and shut offs where needed or required by code.

6B.4 Freeze Protection

Keystone heaters are not certified for outdoor installation, so the chance of freezing is minimized. In an event such as power outage, component failure or other issue when freezing is likely, the heater and system must be drained to avoid the risk of damage due to freezing. Glycol must **NOT** be used in volume water heating applications.

6B.5 KW Suggested Piping Schematics

Figures 21-24 show suggested piping configurations for KW boilers. These diagrams are only meant as a guide. All components or piping required by local code must be installed.

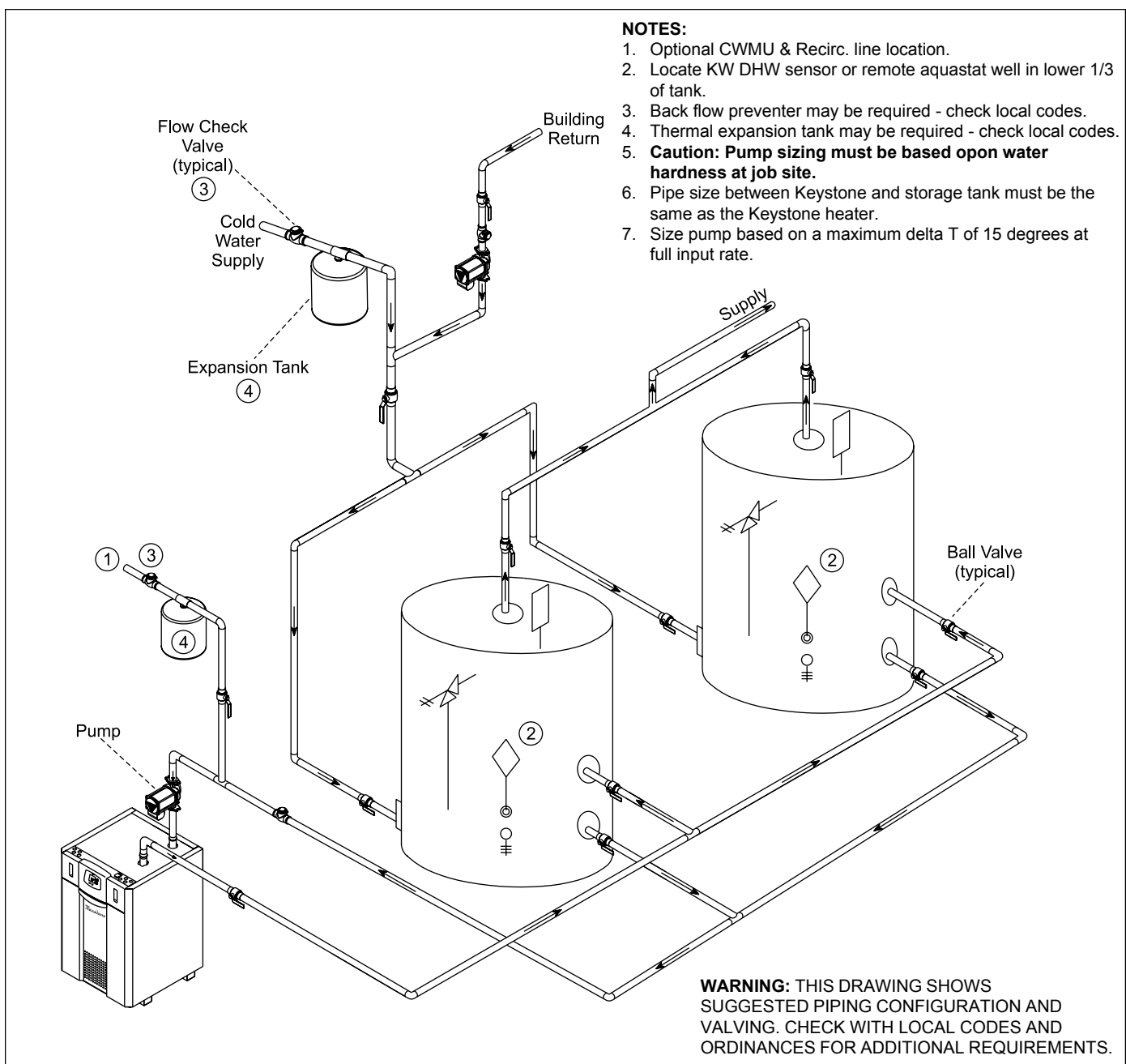


Figure 22. DHW Piping, One Heater, Two Vertical Tanks.

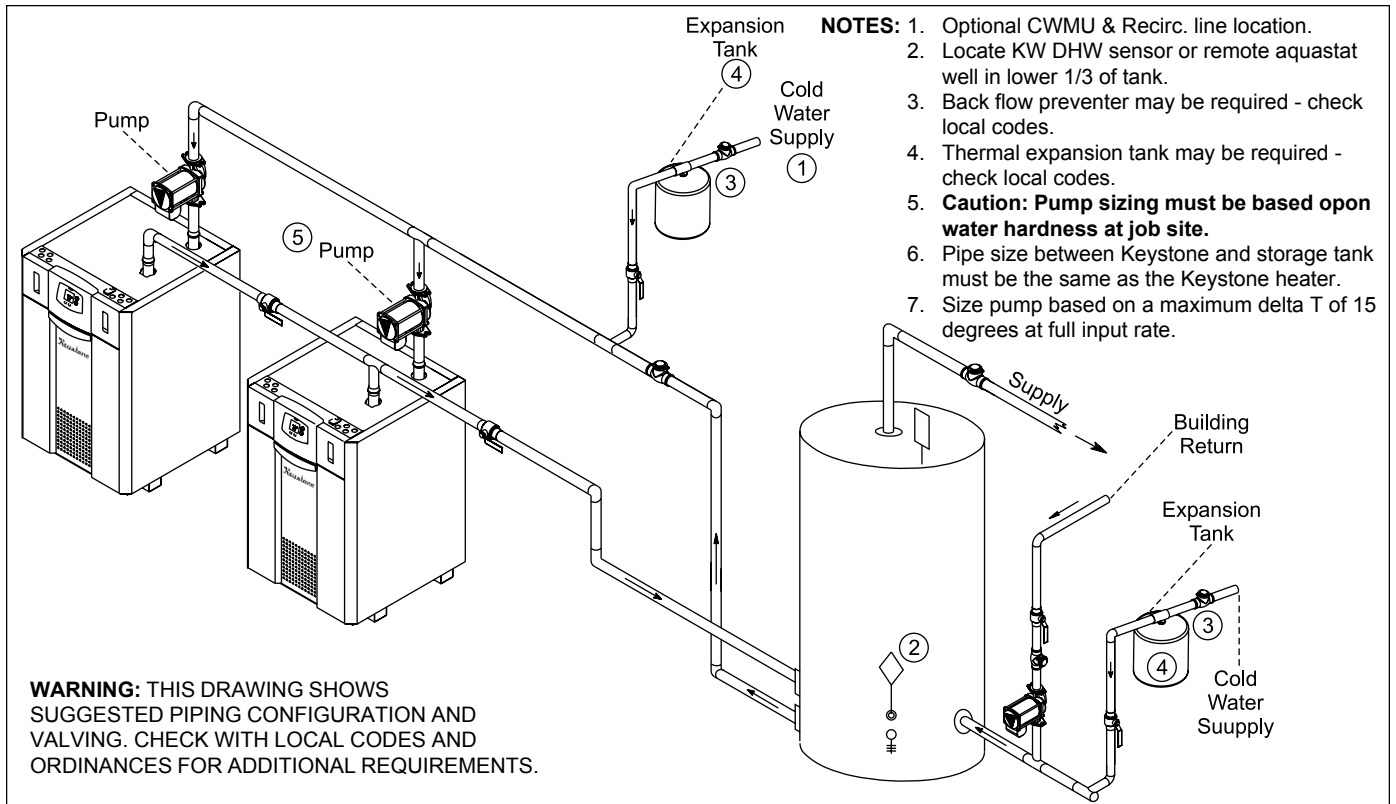


Figure 23. DHW Piping, Two Heaters, One Vertical Tank.

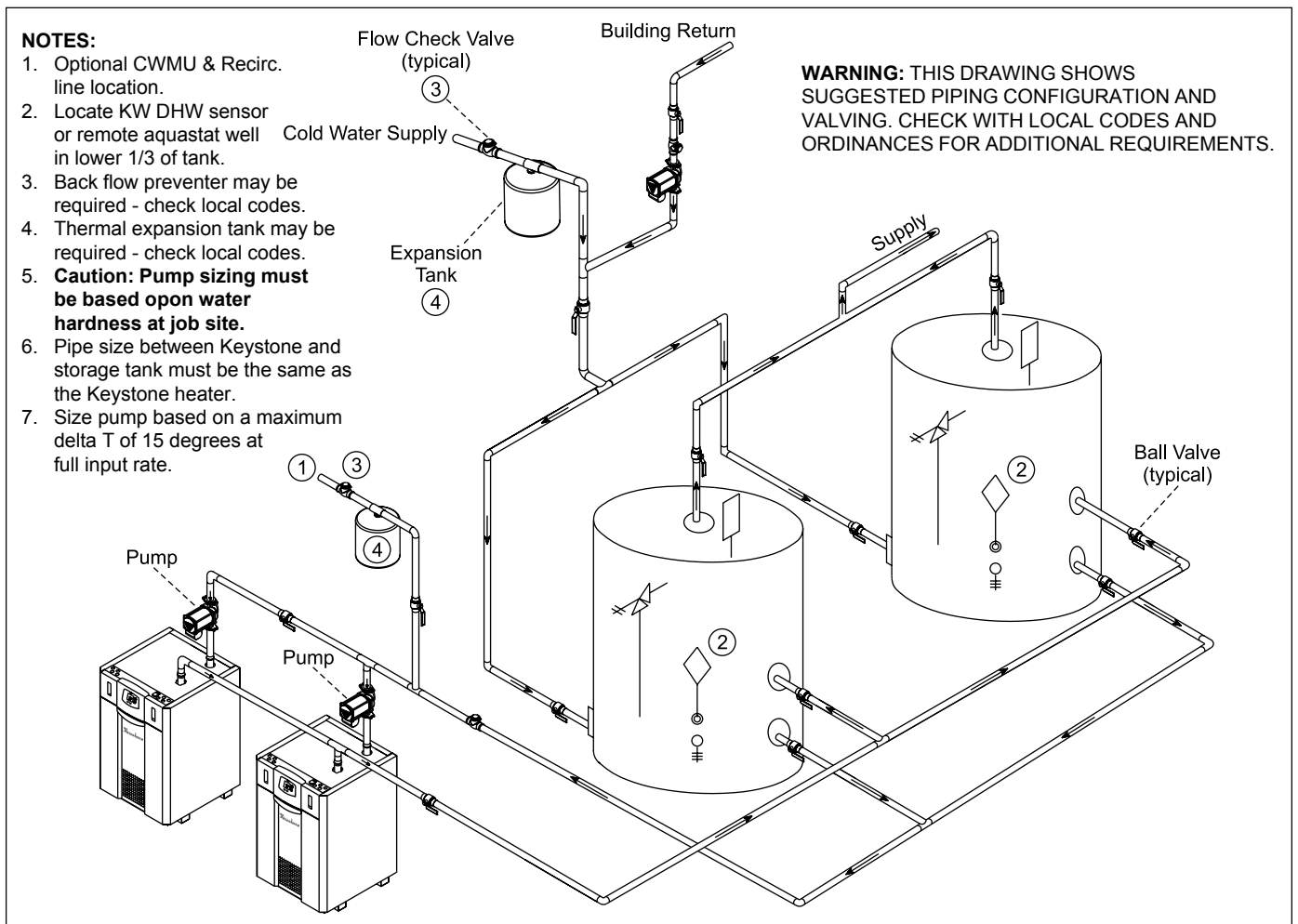


Figure 24. DHW Piping, Two Heaters, Two Vertical Tanks.

SECTION 7. Electrical Connections

⚠ WARNING

The appliance must be electrically grounded in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the latest edition of the National Electrical Code, ANSI/NFPA 70, in the U.S. and with latest edition of CSA C22.1 Canadian Electrical Code, Part 1, in Canada. Do not rely on the gas or water piping to ground the metal parts of the boiler. Plastic pipe or dielectric unions may isolate the boiler electrically. Service and maintenance personnel, who work on or around the boiler, may be standing on wet floors and could be electrocuted by an ungrounded boiler. Electrocutation can result in severe injury or death.

Single pole switches, including those of safety controls and protective devices must not be wired in a grounded line.

All electrical connections are made on the terminal blocks that are located inside the control panel.

NOTE: All internal electrical components have been prewired. No attempt should be made to connect electrical wires to any other location except the terminal blocks.

Wiring connections are shown in Figures 27 and 28.

Important Note: DO NOT MAKE/BREAK KEYSTONE LINE VOLTAGE TO SIGNAL CALL FOR HEAT. A “call for heat / end call for heat” MUST be connected to the field interlock terminals. Some Keystone components are designed to have constant voltage during normal operation. If the Keystone’s supply voltage is toggled as a call for heat signal, premature failure of these components may result.

Keystone does not recognize 4mA as a signal to shut off. If the call for heat is not connected between the field interlock terminals, Keystone will remain in low fire when it sees 4mA as a modulating signal.

⚠ Caution

Keystone supply voltage must not be disengaged, except for service or isolation, or unless otherwise instructed by procedures outlined in this manual. To signal a call for heat, use the 24V field-interlock, as shown in the wiring diagram(s).

7.1 Main Power

Connect a 15A fused, 120-volt supply to the main power switch (hot leg is connected directly to switch). Neutral leg is connected directly to the white wire. Ground wire can be connected to the grounding lug in the control panel (see Figure 25).

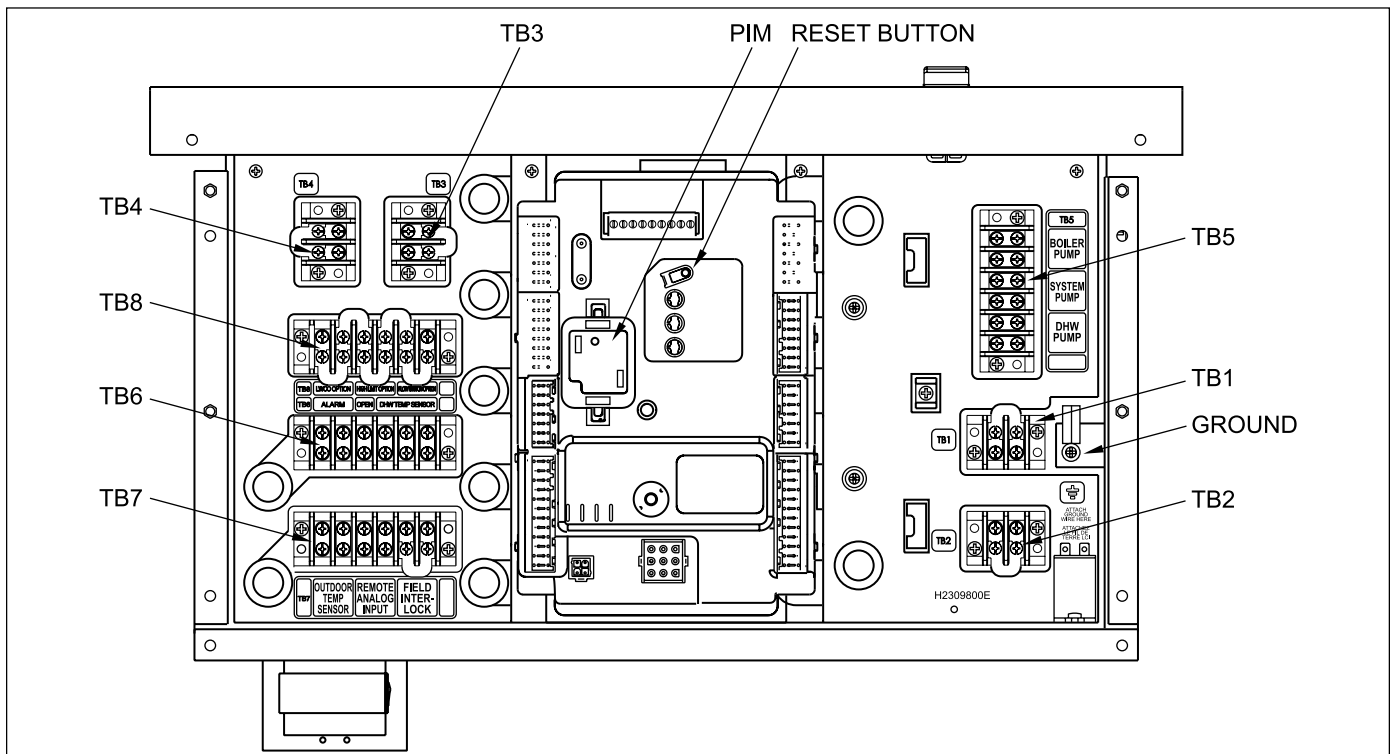


Figure 25. Control Panel Layout.

PUMP SELECTION	BOILER			PUMP CONNECTIONS RATINGS (Boiler, System Pump and DHW Pump Connections)
	VOLTS	PHASE	AMPS	
199–850 No Pump	120	Single	2*	115V – Maximum 1HP or 7.4A max

*Minimum 15A circuit required

Table 10. Electrical Data.

7.2 Pump Connections

Keystone energizes the pump contacts upon a call for heat. Once the call for heat is satisfied the pump will remain on for the defined pump overrun time.

NOTE: System and DHW contacts are dry contacts. Appropriate voltage must be supplied to the System and DHW pumps for proper operation. Boiler pump contact (max 7.4 FLA) is fed by 120V (violet wire) internally from main power feed.

System pump connections are located on terminal block 5 (TB5) in the control panel (see Figure 25). The system pump contacts are rated for 120Vac, 7.4 amps. To use the contacts, power must be supplied on one terminal with the other terminal wired to the pump or a relay controlling the pump.

DHW pump connections are located on terminal block 5 (TB5) in the control panel and are rated for 120Vac, 7.4 amps. To use the contacts, power must be supplied on one terminal, and the other terminal wired to the pump or a relay controlling the pump.

7.3 24Vac Transformer with Integral Circuit Breaker

24Vac is supplied by a transformer mounted underneath the control panel. All 24Vac power is supplied through a circuit breaker that is part of the transformer. The transformer is then connected to terminal blocks 3 and 4 (TB3 and TB4).

7.4 Hydronic Call for Heat

Connect the call for heat to terminal block 7 (TB7), connections labeled "T-T or interlock" in the control panel.

7.5 Outdoor Air Temperature Sensor

Connect the outdoor air temperature sensor to terminal block 7 (TB7), connections labeled Outdoor temp sensor. The outdoor air temperature sensor is used for warm weather shutdown and outdoor reset.

NOTE: Setpoint defaults to 120°F without the outdoor sensor connected.

7.6 Domestic Hot Water Connection

Connect a DHW sensor or aquastat to terminal block 6 (TB6), connections labeled DHW stat. The aquastat or sensor will be automatically detected and initiate the DHW call as needed.

7.7 System Sensor (lead lag/cascading operation only)

Connect the system sensor to terminal block 6 (TB6), connections labeled system sensor. Can be used in a well for DHW tank applications with lead/lag.

7.8 External Control Connections

Connect 4-20mA signals from external controls or building automation systems to terminal block 7 (TB7) in the control panel. The connections are labeled "Remote Analog Input". When making the connections follow the polarity designations shown on the label.

7.9 Optional Field Connections

Terminal block 8 (TB8) in the control panel can be used for connecting optional components, such as, low water cutoffs, flow switches, additional high limits and other field supplied devices that must be interlocked with the boiler. All safeties or end switches must be wired in series by removing the supplied jumpers.

7.10 Lead lag/ Cascading Wiring Connections

Connect each boiler in the cascade system together by daisy chaining each control from Modbus port 1 (MB1) of the first boiler to the second and so on. This can be done using 22awg or thicker shielded twisted pair wire with drain. Two twisted pairs or three conductors are needed.

- To daisy-chain the boilers connect a wire from Modbus port 1 (MB1) terminal A of the first boiler to Modbus port 1 (MB1) terminal A of the second boiler.
- If there are more boilers in the system connect a wire from Modbus port 1 terminal A of boiler 2 to Modbus port 1 terminal A of boiler 3.
- Repeat these steps until all Modbus port 1 terminal A connections are wired.
- Repeat the above steps for Modbus port 1 terminal B and C connections to complete the wiring.
- Connect the drain wire from the twisted pair wire to ground on one end of the wire only.

7.11 Wiring Diagrams (see Figures 27 and 28)

Caution

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

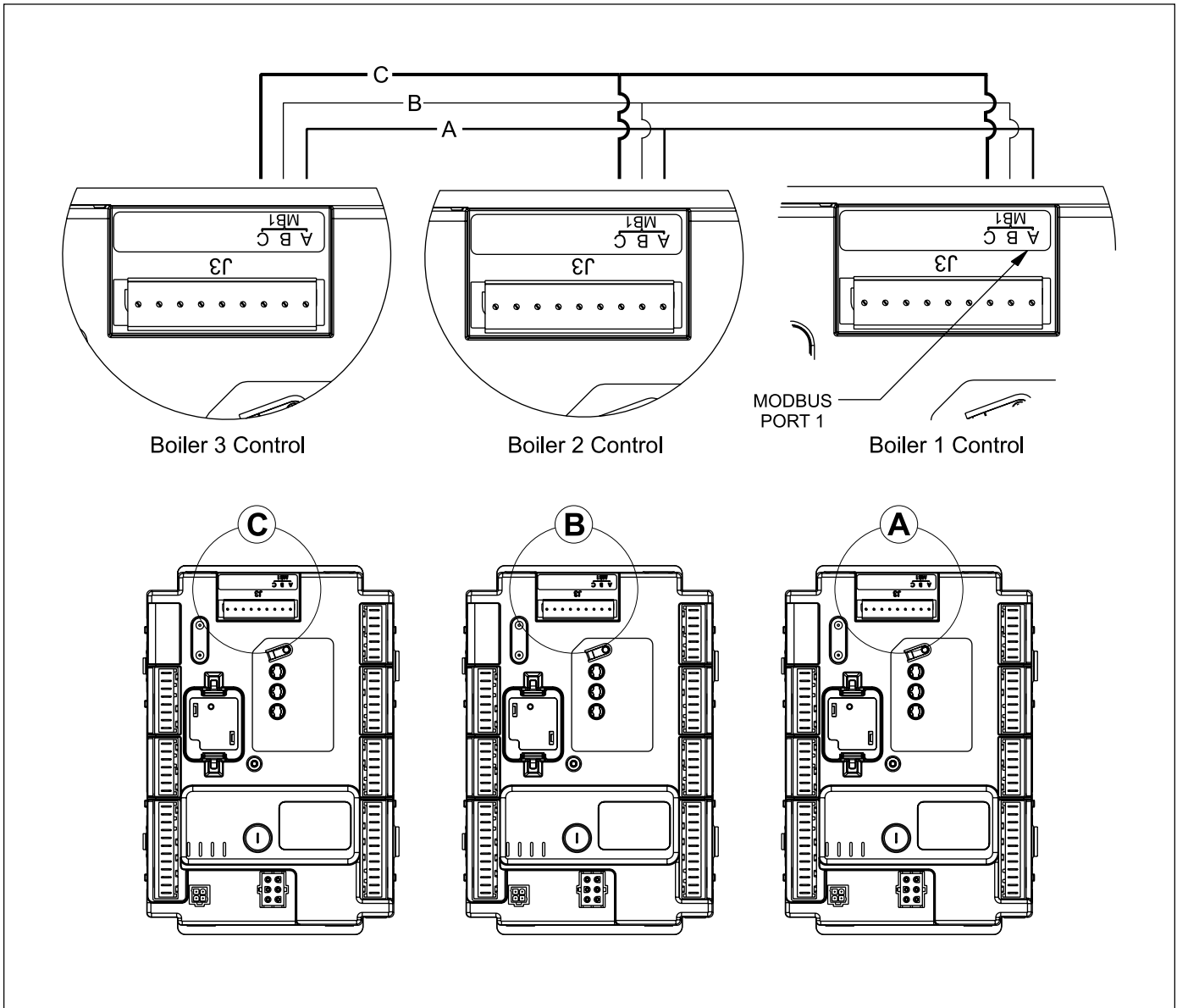


Figure 26. Lead-Lag / Cascading Wiring Connections.

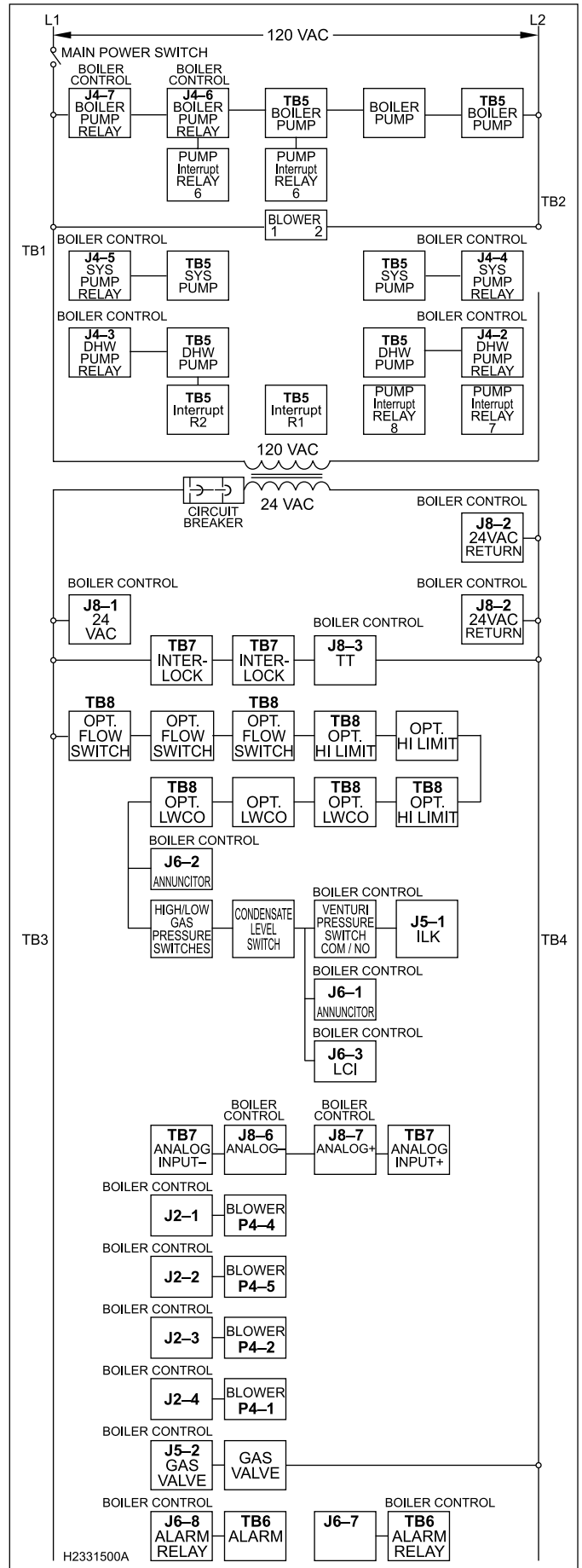
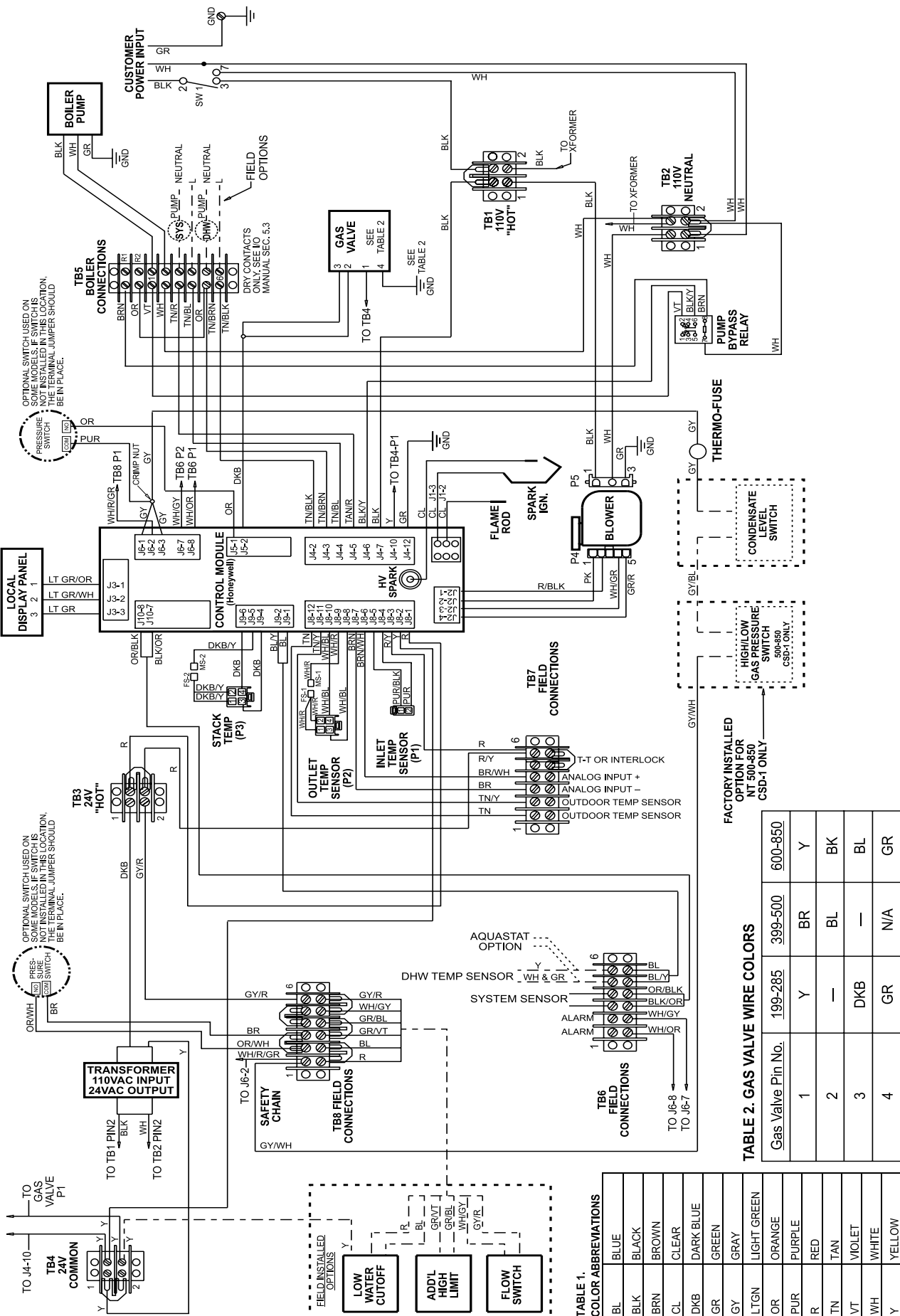


Figure 27. Ladder Diagram.



H2337300C

Figure 28. Wiring Diagram (all sizes).

TABLE 1. COLOR ABBREVIATIONS

BL	BLUE
BLK	BLACK
BRN	BROWN
CL	CLEAR
DKB	DARK BLUE
GR	GREEN
GY	GRAY
LTGN	LIGHT GREEN
OR	ORANGE
PUR	PURPLE
R	RED
TN	TAN
VT	VIOLET
WH	WHITE
Y	YELLOW

TABLE 2. GAS VALVE WIRE COLORS

Gas Valve Pin No.	199-285	399-500	600-850
1	Y	BR	Y
2	—	BL	BK
3	DKB	—	BL
4	GR	N/A	GR

SECTION 8. Keystone Control Setup and Operation

The Keystone control is an integrated electronic control that replaces many of the individual components found on older appliances. The control acts as the ignition control, pump control, high limit and cascading/lead lag control and is setup using the display on the appliance.

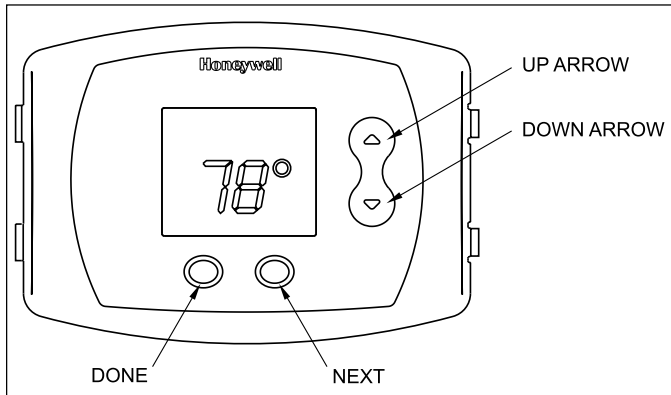


Figure 29. Control Buttons on User Interface.

8.1 Display Navigation

The display is divided into three menu structures, USER, SETUP and DIAGNOSTIC. The menu structure and variables in each are shown in Tables 12-14. Once in a particular menu structure navigation consists of pressing the next button to scroll from item to item and then pressing the up and down arrows to change values.

MENU ITEM	FUNCTION	RANGE	DEFAULT
Outlet water temperature	Displays the current outlet water temperature & allows the setpoint to be adjusted	55-190°F	120°F
Inlet water temperature	Displays the current inlet water temperature	—	—
Delta T	Displays the current temperature rise across the heat exchanger	—	—
DHW water temperature	Displays the current DHW temperature & allows the setpoint to be adjusted	60-182°F	120°F
Stack temperature	Displays the current stack temperature	—	—
Outdoor temperature	Displays the current outdoor air temperature	—	—
LL	Displays the current system temperature and allows the setpoint to be adjusted	60-190°F	120°F
Firing Rate	Displays an indicator of the current firing rate based upon fan RPM. The actual firing rate may vary.	—	—

Table 12. User Mode Menu Structure.

Once the value is adjusted the NEXT or DONE button can be pressed. The DONE button returns you to the Home screen. The NEXT button increments the display to the next item in the menu structure.

USER mode is the home screen shown on the control. If the display is not in USER mode wait for the display timeout period to be reached or press the Done button to return to the USER menu.

SETUP mode is accessed by holding the up and down arrow keys simultaneously for 3 seconds.

DIAGNOSTIC mode is accessed by holding the NEXT button for 3 seconds.

8.2 Ignition Control- Sequence of Events

1. Call for heat
2. Safety chain check
3. Fan starts and waits to achieve prepurge RPM
4. Prepurge timer is started once the prepurge RPM is achieved.

MENU ITEM	DEFINITION
F or C	Selects temperature units
LBTHODLOD	Outdoor reset enable/disable - enables menu items
LBT	Low boiler setpoint during outdoor reset
HOD	High outdoor temperature setpoint
LOD	Low outdoor temperature setpoint
RMT Add	Used for Lead/Lag (follow menus)
LL	Lead/Lag enable/disable - enables menu items
HS	Hysteresis - temp range between on/off cycles
bL	Base Load % - input rate before next boiler fires
Sd	Warm weather shut-down temperature
ASC	Anti short cycle - minutes of delay between startup
bAC	Future use - Press DONE to exit menu.
PAS	Future use - Press DONE to exit menu.

NOTE: When enabling/disabling functions, select "Done" and wait 30 seconds before scrolling.

Table 13. Setup Mode Parameters.

MENU ITEM	DESCRIPTION
mA	Display the flame sense signal
Alert codes	Displays the current alert code
Lockout code	Displays the current lockout code
Outlet Limit	Displays outlet temperature limit
DHW limit	Displays Domestic Hot Water limit setting
Stack Limit	Displays Stack limit setting
Min. firing rate	Displays the minimum firing rate allowed
Min. forced firing rate	Allows the user to force the boiler to fire at the minimum firing rate
Max forced firing rate	Allows the user to force the boiler to fire at the maximum firing rate
Rate indicator	Displays a indicator of the firing rate based off of the fan RPM. Actual firing rate may vary depending upon setup.

Table 14. Diagnostic Mode Menu Structure.

5. Pre ignition time of 2 seconds to check the flame sensor operation and status. During this period an intermittent spark can be seen.
6. Trial for ignition period, 4 seconds. The direct spark ignition switches to constant spark for three seconds, during which time the gas valve is open. For the last second of the ignition period direct spark is de-energized and the flame sensor checks for established flame. If flame is sensed the control enters "Run" to satisfy the demand. If flame is not established the control enters a retrystarting from step 2. If flame has not been established in the appropriate number of retries the control will lockout with a 109 error code.
7. Call for heat complete
8. Gas valve off
9. Fan and pump over run times active to purge the system

This sequence is the basic operating sequence of the appliance whether there is a DHW, or hydronic call for heat.

8.3 Modulation Control

The control uses a PID algorithm to adjust the firing rate of the boiler as the control point is approached. The goal of the control is to operate at a minimum firing rate to match the load on the appliance. This is done by using a setpoint, and on / off differentials. The control modulates to achieve the setpoint temperature, which could be several degrees away from the actual off point. The off point is calculated by adding the setpoint + off differential. The setpoint and differentials used in operation is dependent upon the call for heat being applied. If there is a DHW call the DHW setpoint and off differentials are used. If there is a hydronic call the CH setpoint and off differential is used. When the setpoint + off differential is achieved the control interrupts appliance firing until the water temperatures reaches the setpoint - on differential. Both the hydronic and DHW setpoints are adjustable through the USER mode menu structure.

8.4 Pump Control

The control can operate three pumps. The boiler pump is active anytime there is a call for heat applied to the control. The DHW and system pumps are active based upon the call and priority of the heat demand being supplied. When there is a hydronic call supplied the system pump is active. If there is a DHW call supplied while the hydronic call is active the system pump turns off and the DHW turns on. This happens because of domestic hot water priority, which forces the control to attempt to satisfy the domestic water demand prior to the hydronic demand. When the last heat demand is satisfied the boiler pump enters an overrun time.

8.5 Anti-Short Cycle (ASC)

The anti short cycle period is started whenever the gas valve turns off. This period is to help prevent short cycling. Depending upon the time selected the control will wait up to 10 minutes before attempting to start the trial for ignition sequence. The ASC time can be adjusted by entering setup mode.

8.5 High Limit

The control uses a dual thermistor sensor to monitor the Keystone's maximum temperature. The high limit sensor is installed in the outlet water. A dual thermistor sensor is used, so that the two temperatures can be monitored and compared to confirm accuracy. The control will automatically reduce the firing of the Keystone to prevent the high limit from tripping. The high limit setpoint is not adjustable.

8.7 Outlet Water Temperature

The outlet water temperature is a dual thermistor sensor and is limit rated. The control compares each of the temperature readings to determine accuracy. The outlet sensor is used as the primary control point for high limit, temperature operation, and modulation. The operating setpoint can be adjusted through the USER menu structure.

8.8 Inlet Water Temperature

The inlet water temperature uses a single thermistor sensor and is used to calculate the delta T of the system.

8.9 Heat Exchanger Temperature Rise

The heat exchanger temperature rise is calculated from the outlet and inlet sensor temperatures. The result is displayed in the USER menu structure.

8.10 Stack Temperature

The stack temperature is a dual thermistor sensor and is limit rated. The control compares each of the temperature readings to determine accuracy. The stack sensor is used as a limiting feature to avoid excessive temperatures in the venting.

8.11 Domestic Hot Water Temperature

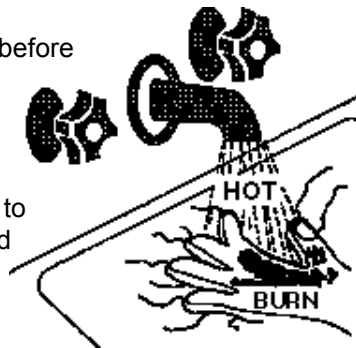
The domestic hot water temperature sensor is used to monitor the DHW demand. The control uses the DHW sensor to control the operation and modulation rate of the appliance when there is a DHW demand. The DHW setpoint can be adjusted through the USER menu structure.

8.12 Lead Lag / Cascading

Lead Lag/Cascading allows multiple boilers to be connected together and controlled from one common sensor input. Up to 8 boilers can be connected together in a single system. To setup Lead/Lag or cascading

⚠ DANGER

- Water temperature over 125°F (52°C) can cause severe burns instantly or death from scalds.
- Children, disabled and elderly are at highest risk of being scalded.
- See instruction manual before setting temperature at heating appliance.
- Feel water before bathing or showering.
- If this appliance is used to produce water that could scald if too hot, such as domestic hot water use, adjust the outlet control (limit) or use temperature limiting valves to obtain a maximum water temperature of 125°F (52°C).



operation there are several settings in the "setup" menu structure that must be adjusted for the specific installation, each is covered in the following sections.

8.12.1 Lead Lag Setpoint

The lead lag setpoint is set from the "user" menu using the "LL" variable. This is the temperature the boiler is attempting to maintain at the system sensor. This setting doesn't control the boiler outlet temperature, so the water temperature at the boiler outlet may be much hotter than the system temperature setpoint. Adjust the LL setpoint to the desired operating temperature of the system.

8.12.2 Lead Lag Master/Slave Selection

In the SETUP menu structure, the "LL" menu allows the lead lag system to be turned on and the boiler to be configured as a master or slave control. In each lead lag system there can only be one master control, so proper selection is important to avoid operating issues. To set the boiler to lead lag "master" operation the LL menu should be set to "LDR". To set the boiler to slave, "SLA" should be selected.

8.12.3 Lead Lag Address

The Lead Lag address must be set for each boiler connected to the lead lag system. Each boiler must have a unique address selected for the system to work properly. Typically, the lead or master boiler should be set to address one and the remaining boilers should be set to values 2–8 depending upon how many boilers are installed in the system.

8.12.4 Lead Lag Hysteresis

The lead lag system uses a hysteresis value set in the setup menu, called, "HS". The hysteresis and setpoint values control the on and off points of the boiler. If the lead lag setpoint is adjusted to 120°F with a hysteresis value of 5°F the boiler will turn off when the water temperature reaches 125°F and will turn back on when the water temperature reaches 115°F. Set the hysteresis values to match the boiler to the system operating characteristics. Setting this value correctly

will help reduce the chance of short cycling.

8.12.5 Lead Lag Base Load Setting

The lead lag system uses a base load setting that is set through the "setup" menu called "bL". The base load setting identifies the firing rate that the operating boiler must achieve before the next boiler in the system is allowed to operate. The default setting is 50% to avoid short cycling and operating the boilers at higher, less efficient, firing rates.

8.13 Boiler Pump Interrupt

⚠ WARNING

Failure to plumb, pump and install the appliance correctly when using this feature may lead to reduced or no water flow through the heat exchanger, causing premature failure of the heat exchanger, personal injury or death. Please consult the factory with any questions regarding the use of this feature.

The boiler pump interrupt feature is used in some applications when the boiler is being used for both hydronic and domestic hot water heating. The interrupt jumper is used to turn off the boiler pump during a domestic hot water demand. For this to work properly the system must be plumbed and pumped to allow the domestic hot water pump to supply the flow and head requirements for the boiler and indirect water heater together. It is not necessary to use the interrupt jumper in all applications. Specific modes of operation that may require the use of this feature are shown in Section 6.

NAME	FUNCTION	VALUE
CH on differential	Burner demand begins when the outlet water temperature reaches "Outlet water temperature setpoint" minus "CH on differential"	5°F
CH off differential	Burner demand ends when the outlet water temperature reaches "Outlet water temperature setpoint" plus "CH off differential"	5°F
DHW on differential	Burner demand begins when the outlet water temperature reaches "Outlet water temperature setpoint" minus "DHW on differential"	2°F (80-285) 5°F (399-850)
DHW off differential	Burner demand ends when the outlet water temperature reaches "Outlet water temperature setpoint" plus "DHW off differential"	10°F (80-285) 5°F (399-850)
Pump overrun	Operates the pump for the overrun time after the burner demand has ended	1 or 5 minutes
High limit	Locks the boiler out when the high limit temperature is reached (requires manual reset)	200°F
Flame threshold	Flame signals lower than the flame threshold interrupt burner operation	0.8Vdc
DHW priority time	Time for domestic hot water priority	60 min.

Table 15. Default Control Settings.

SECTION 9.

Modes of Operation

The Keystone control allows the boiler to operate in many different modes of operation. The mode must be selected based upon the requirements of the installation. The following sections describe the basic operation of the Keystone in each of the different modes. Familiarize yourself with each mode and how the operation of the boiler varies, depending upon the installation and inputs the control is monitoring.

9.1 Hydronic Heating Demand

When using the Keystone for hydronic heating a call for heat must be supplied to the "T-T or Interlock" terminal. Once the call is supplied the control starts the boiler and system pumps and begins the ignition process. The ignition process consists of a prepurge, trial for ignition, and run period. The prepurge period starts on a call for heat once the fan RPM reaches a preset level. The trial for ignition period follows once the start-up RPM of the fan is reached. The trial for ignition period lasts 4 seconds during which the direct spark ignition system and gas valve are energized. At the end of the trial for ignition period the flame signal is compared with the preset flame threshold value. If the flame signal is higher than the flame threshold the Keystone enters "run". If the flame signal is below the threshold the Keystone returns to prepurge and starts the ignition process over. In "run" the Keystone monitors the flame signal, call for heat, safeties, and water temperatures and modulates as needed between 100% and 20% of rate to satisfy the call for heat.

9.2 Hydronic Heating with Outdoor Reset

Outdoor reset varies the control point setpoint based on the actual outdoor temperature. The reset function works as shown in Figure 30. When the outdoor air temperature reaches the "high outdoor temperature setpoint (HOD)", the control point setting is adjusted to the low boiler temperature setpoint (LBT). When the outdoor air temperature reaches the low outdoor temperature setpoint (LOD), the control setpoint is adjusted to the CH/Outlet water setpoint temperature. HOD, LOD and LBT can be adjusted by accessing SETUP mode. CH setpoint is adjustable from the USER menu structure.

9.3 Hydronic Heating with Domestic Hot Water (DHW) Priority

When using the Keystone for hydronic heating with domestic hot water priority a call for heat must be supplied to the "T-T or Interlock" terminal. Once the call is supplied the control starts the boiler and system pumps and begins the ignition process. The ignition process consists of a prepurge, trial for ignition, and run period. The pre-purge period starts on a call for heat

once the fan RPM reaches a preset level. The trial for ignition period follows once the start-up RPM of the fan is reached. The trial for ignition period lasts 4 seconds during which, the direct spark ignition system and gas valve are energized. At the end of the trial for ignition period the flame signal is compared with the preset flame threshold value. If the flame signal is higher than the flame threshold the Keystone enters "run". If the flame signal is below the threshold the Keystone returns to pre-purge and starts the ignition process over. In "run" the Keystone monitors the flame signal, call for heat, safeties, and water temperatures modulating as needed between 100% and 20% of rate to satisfy the call for heat. When a DHW demand is applied during a hydronic call for heat the priority feature forces the boiler to switch to the DHW demand for the priority time. The DHW priority demand forces the control to operate to the DHW setpoint, de-energizes the system pump and energizes the DHW pump.

9.4 Hydronic Heating Using External Modulation Control

When using the Keystone for hydronic heating with external modulation control a call for heat must be supplied to the "T-T or Interlock" terminal. Once the call is supplied the control starts the boiler and system pumps and begins the ignition process. The ignition process consists of a prepurge, trial for ignition, and run period. The prepurge period starts on a call for heat once the fan RPM reaches a preset level. The trial for ignition period follows once the start-up RPM of the fan is reached. The trial for ignition period lasts 4 seconds during which the direct spark ignition system and gas valve are energized. At the end of the trial for ignition period the flame signal is compared with the preset flame threshold value. If the flame signal is higher than the flame threshold the Keystone enters "run". If the flame signal is below the threshold the Keystone returns to prepurge and starts the ignition process over. In "run" the Keystone monitors the flame signal, call for heat, safeties, and water temperatures. The boiler setpoint is

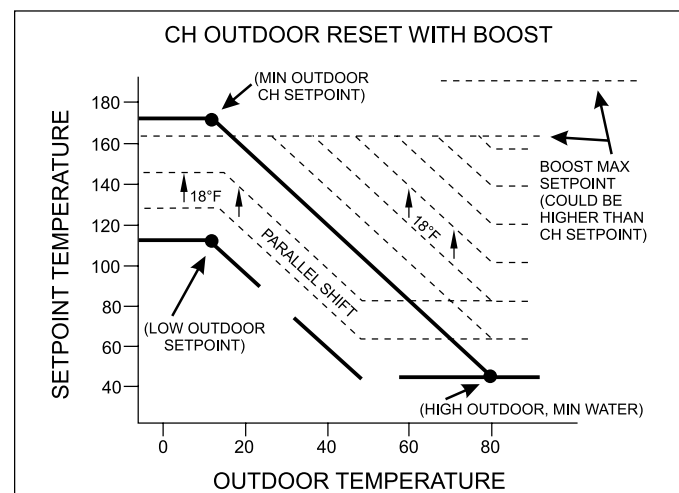


Figure 30. Outdoor Reset Setpoint Temperatures.

used to limit the maximum water temperature leaving the boiler only. The modulation rate is controlled by a 4-20mA (0-10Vdc using converter) signal supplied by an external control. When setting up a system using an external control care must be taken to set the external control algorithms to prevent the boiler from short cycling or "hunting" to prevent premature component failure.

9.5 Hydronic Heating Using Local Lead-Lag/Cascading Feature

When using single or multiple Keystones in lead lag configuration, the system sensor and TT terminals of the Master boiler create heat demand. The TT terminals on the slave boilers are ignored as the demand for those heaters is given from the master control. The system sensor is also used to control the modulation rate of the lead lag system. (see Section 7 for wiring instructions).

Let's consider the following example:

Three Keystone boilers (let's call them "Lead", "Slave1" and "Slave2") tied together via Modbus 1 connection, with appropriate RMT Address (1, 2, 3). System sensor input is used to indicate common secondary loop temperature.

System setpoint = 150°F
 HS (hysteresis) = 10°F (default)
 BL (base load) = 50% (default)
 Anti-short-cycle = 5 minutes

Run sequence is initiated when system temperature falls to 140°F (setpoint less hysteresis value). Lead boiler will start. All firing rates will depend on several application characteristics, including flow rate, system load, water volume, etc. Boilers will start at a rate of 35%. If the load is such that Lead's rate increases to 50%, "Slave1" will go through its startup sequence and begin firing at 35%. At this point, both boilers (Lead and Slave1) will continue to respond simultaneously to the load/system characteristics, by modulating up or down together, in relation to the relative system setpoint and load characteristics.

Scenario 1: If the system loop temperature rises quickly, and moves above setpoint, then the boilers will simultaneously drop their firing rate. If when reaching the point where both boilers drop toward their minimum firing rate (20%), then the first slave will drop out. Slave1 will remain unavailable until its ASC timer has expired (5 minutes). If the load were to increase such to drive all active boilers to 50% firing rate or more, during the ASC time, Slave2 will begin its startup sequence and begin to fire at 35%, etc.

Scenario 2: If the system loop temperature continues to drop (load increases), then the two boilers will increase firing rate together. At 50%, Slave2 will begin its firing sequence and be added to the group.

All three boilers will continue to fire simultaneously at equal input rates or...

1. Modulation rate approaches minimum firing rate (20%), in which case Slave2 will first drop out, and then Slave1, accordingly.
2. System temperature reaches 10°F (HS- hysteresis value) above setpoint (e.g. 160°F), in which case remaining boiler will shut off
3. Any of the boilers approach its high limit temperature the individual boiler will modulate back.

9.6 Hydronic Heating Using Local Lead-Lag/Cascading Feature with Indirect Hot Water

When using the lead lag boiler system to provide indirect domestic hot water heating, the DHW demand should be supplied to the master boiler through the existing DHW terminals. The lead lag system will change the operating mode of the Master boiler only to supply water at the DHW setpoint. The remaining boilers on the system will continue to supply hydronic heating.

When the system is supplying both hydronic heat and domestic hot water at the same time both the system pump and DHW pump contacts are closed, so special attention must be paid to allow for proper operation. During a DHW call, the master boiler pump may need to be turned off in applications serving both hydronic and domestic heating. This will cause the DHW pump to provide flow through the boiler and indirect tank (pump must be sized properly) when there is a DHW call. To turn off the boiler pump in this application the "boiler pump interrupt" jumper should be installed. The terminal block location is terminal block 5 (TB5) contacts labeled "boiler pump interrupt" in the control panel.

9.7 Warm Weather Shutdown

Warm weather shutdown overrides a hydronic call for heat when the outdoor air temperature is greater than the warm weather shutdown setpoint. Warm weather shutdown is always active whenever there is an outdoor sensor attached to the control. To avoid warm weather shutdown the warm weather shutdown temperature should be increased as necessary. The warm weather shutdown setpoint can be adjusted in SETUP mode, using the SD menu.

9.8 Domestic Hot Water Demand (KW only)

When using the Keystone for DHW heating a call for heat must be supplied to the "DHW stat" terminal located on terminal block 6 (TB6). The DHW heating call can be from the supplied DHW sensor or from an aquastat. If the DHW sensor is used the heater operates to maintain the temperature at the DHW sensor. This may allow the actual heater outlet water temperature to exceed the DHW sensor setpoint. If an aquastat is used to supply the DHW demand the heaters firing rate is controlled by the DHW setpoint temperature and the

water temperature at the heat exchanger outlet. Once the DHW call is supplied the control starts the boiler and DHW pumps and begins the ignition process. The ignition process consists of a prepurge, trial for ignition, and run period. The prepurge period starts on a call for heat once the fan RPM reaches a preset level. The trial for ignition period follows once the start-up RPM of the fan is reached. The trial for ignition period lasts 4 seconds during which the direct spark ignition system and gas valve are energized. At the end of the trial for ignition period the flame signal is compared with the preset flame threshold value. If the flame signal is higher than the flame threshold the Keystone enters "run". If the flame signal is below the threshold the Keystone returns to prepurge and starts the ignition process over. In "run" the Keystone monitors the flame signal, call for heat, safeties, and water temperatures modulating as needed between 100% and 20% of rate to satisfy the call for heat.

9.9 Domestic Hot Water Heating Using External Modulation Control

When using the Keystone for DHW heating with external modulation control a call for heat must be supplied to the "T-T or Interlock" terminal. By supplying a call to the "T-T or interlock" terminal the operating temperature setpoint defaults to the hydronic heating setpoint, so all of the temperature adjustments must be made to the hydronic setpoint. Once the call is supplied, the control starts the boiler and system pumps and begins the ignition process.

The ignition process consists of a prepurge, trial for ignition, and run period. The prepurge period starts on a call for heat once the fan RPM reaches a preset level. The trial for ignition period follows once the start-up RPM of the fan is reached. The trial for ignition period lasts 4 seconds during which the direct spark ignition system and gas valve are energized. At the end of the trial for ignition period the flame signal is compared with the preset flame threshold value. If the flame signal is higher than the flame threshold the Keystone enters "run". If the flame signal is below the threshold the Keystone returns to prepurge and starts the ignition process over. In "run" the Keystone monitors the flame signal, call for heat, safeties, and water temperatures. The heater setpoint is used to limit the maximum water temperature leaving the boiler only. The modulation rate is controlled by a 4-20mA (0-10Vdc using converter) signal supplied by an external control. When setting up a system using an external control care must be taken to set the external control algorithms to prevent the boiler from short cycling or "hunting" to prevent premature component failure.

9.10 Domestic Hot Water Heating Using Local Lead-Lag/Cascading Feature

When using multiple Keystones to supply Domestic hot water only the heaters should be setup as stated in Section 8.12 "Lead/Lag Cascading," and Section 9.5 "Hydronic Heating Using Local Lead/Lag Cascading Feature." When the heaters are installed in this fashion, all of the setpoints and adjustments are done through the Lead Lag menus.

SECTION 10. Operating Instructions

10.1 Filling the Boiler System

1. Ensure the system is fully connected. Close all bleeding devices and open make-up water valve. Allow system to fill slowly.
2. If make-up water pump is employed, adjust pressure switch on pumping system to provide a minimum of 12 psi (81.8 kPa) at the highest point in the heating loop.
3. If a water pressure regulator is provided on the make-up water line, adjust the pressure regulator to provide at least 12 psi (81.8 kPa) at the highest point in the heating loop.
4. Open bleeding devices on all radiation units at the high points in the piping throughout the system, unless automatic air bleeders are provided at such points.
Note that there is an air bleed located on the left side of Keystone, on top of the water manifold.
5. Cycle the boiler pump on and off 10 times, 10 seconds on and 10 seconds off to remove all air from the heat exchanger. Then run system and appliance pump for a minimum of 30 minutes with the gas shut off.

WARNING

Failure to remove all air from the heat exchanger could lead to property damage, severe injury or death.

6. Open all strainers in the circulating system, check flow switch operation (if equipped), and check for debris. If debris is present, clean out to ensure proper circulation.
7. Recheck all air bleeders as described in Step 4.
8. Check liquid level in expansion tank. With the system full of water and under normal operating pressure, the level of water in the expansion tank should not exceed $\frac{1}{4}$ of the total, with the balance filled with air.
9. Start up boiler according to the procedure in this manual. Operate the entire system, including the pump, boiler, and radiation units for one (1) hour.
10. Recheck the water level in the expansion tank. If the water level exceeds $\frac{1}{4}$ of the volume of the expansion tank, open the tank drain, and drain to that level.
11. Shut down the entire system and vent all radiation units and high points in the system piping, as described in Step 4.
12. Close make-up water valve and check strainer in pressure reducing valve for sediment or debris from the make-up water line. Reopen make-up water valve.

13. Check gauge for correct water pressure and also check water level in the system. If the height indicated above the boiler insures that water is at the highest point in the circulating loop, then the system is ready for operation.
14. Prime condensate trap with water (not required for KS 600, 750, 850).
15. Refer to local codes and the make-up water valve manufacturer's instructions as to whether the make-up water valve should be left open or closed.
16. After placing the unit in operation, the ignition system safety shutoff device must be tested.
First, shut off the manual gas valve, and call the unit for heat. Main gas terminals will be energized, attempting to light, for four (4) seconds, and then will de-energize. The unit will go into lockout after the required number of trial for ignition periods.
Second, turn the power off, press the manual reset button on the boiler control, or the user display, open the manual gas valve and allow the unit to light. While the unit is operating, close the manual gas valve and ensure that power to the main gas valve has been cut.
17. Within three (3) days of start-up, recheck all air bleeders and the expansion tank as described in Steps 4 and 8 above.

Important Note: The installer is responsible for identifying to the owner/operator the location of all emergency shutoff devices.

WARNING

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 that may have been under water.

10.2 Operating the Burner and Set Up

Initial setup must be checked before the unit is put in operation. Problems such as failure to start, rough ignition, strong exhaust odors, etc. can be due to improper setup. Damage to the boiler resulting from improper setup is not covered by the limited warranty.

10.2.1 Burner Operation

REQUIRED TOOLS: differential pressure gauge capable of reading negative 0.01 inches W.C. (0.002kPa), screw drivers, torx bits, combustion analyzer.

1. Using this manual, make sure the installation is complete and in full compliance with the instructions and all local codes.
2. Determine that the appliance and system are filled with water and all air has been bled from both. Open all valves.
3. Observe all warnings on the Operating Instructions

- label and turn on gas and electrical power to appliance.
4. Keystone will enter the start sequence. Blower and pump will energize for pre-purge, then the ignition sequence starts. After all safety devices are verified, the gas valve opens. If ignition doesn't occur, turn off the Keystone, check that there is proper gas supply. Wait 5 minutes and start the unit again.
 5. Turn Keystone on.
 6. **After placing the appliance in operation, the Burner Safety Shutoff Device must be tested:**
 - (a) Close gas shutoff valve with burner operating.
 - (b) Flame will go out and blower will continue to run for the post purge cycle. One or three additional attempts to light will follow including pre-purge, ignitor on, valve/flame on and post purge. Ignition will not occur as the gas is off. The ignition control will lockout.
 - (c) Open gas shutoff valve. Reset the boiler control by pressing the **RESET** button on the control or on the display. Restart the appliance. The ignition sequence will start again and the burner will start. The appliance will return to its previous mode of operation.

Caution

Should any odor of gas be detected, or if the gas burner does not appear to be functioning in a normal manner, CLOSE MAIN SHUTOFF VALVE. Do not shut off switch. Contact your heating contractor, gas company, or factory representative.

10.2.2 Boiler Setup and Adjustment

1. Connect a manometer capable of reading 0.01"wc to the gas valve locations shown in Figure 31. The positive side of the manometer should be connected to the location labeled "air pressure tap." The negative side of the manometer should be connected to the location labeled "gas pressure tap." This differential pressure should be slightly negative (see Table 16).
2. Measure the CO₂/O₂ in the flue products at high fire. The Keystone can be forced to high fire to allow for easier setup. Refer to Section 8.1, Table 14 for instructions on how to access the forced rate menu. The CO₂ readings should be between the values shown in Table 16. If the CO₂ is not within the range shown, adjustments may be made. To adjust the high fire CO₂, locate the high fire adjuster screw according to the appropriate figure. Slowly make adjustments in 1/16 of a revolution increments until the CO₂ is within the range identified.
3. Measure the CO₂/O₂ in the flue products at low fire. Keystone can be forced to low fire to allow for easier setup. Refer to Section 8.1, Table 14 for instructions on how to access the forced rate menu. CO₂ readings should be between the values shown

in Table 16. If the CO₂ is not within the range shown, adjustments may be made. To adjust the low fire CO₂, locate the low fire adjuster screw according to the appropriate figure. Slowly make adjustments in 1/16 of a revolution increments until the CO₂ is within the range identified.

4. Repeat steps 2 and 3 to confirm that the CO₂ ranges are within the required ranges. Adjust if necessary.
5. Confirm that the differential pressure is still within the appropriate range.
6. **If any of the measurements cannot be adjusted to the specified ranges or the CO levels are above 150ppm when adjusted please consult the factory for further information.**
7. Remove the differential pressure gauge from the air and gas pressure taps making sure to close all ports after the gauge has been removed.

WARNING

Improper adjustment may lead to poor combustion quality, increasing the amount of carbon monoxide produced. Excessive carbon monoxide levels may lead to personal injury or death.

GAS TYPE	HIGH FIRE, CO ₂	LOW FIRE, CO ₂	DIFFERENTIAL PRESSURE
Natural	9.0 to 8.8%	0.5% lower than high fire setting	-.005 to -.015" wc
Propane	10.0 to 9.8%		

Table 16. CO₂ Range and Pressure Differential.

10.3 Shutting Down Keystone

1. Turn off the main electrical disconnect switch.
2. Close all manual gas valves.
3. If freezing is anticipated, drain Keystone and be sure to also protect building piping from freezing. All water must be removed from heat exchanger or damage from freezing may occur.

This step to be performed by a qualified service person.

10.4 To Restart Keystone

If drained, follow Section 10.1 in this manual for proper filling and purging.

1. Turn off the main electrical disconnect switch.
2. Close all manual gas valves.
3. **WAIT FIVE (5) MINUTES.**
4. Set the aquastat or thermostat to its lowest setting.
5. Open all manual gas valves.
6. Reset all safety switches (pressure switch, manual reset high limit, etc.).
7. Set the temperature controller to the desired temperature setting and switch on electrical power.
8. Burner will go through a prepurge period and ignitor warm-up period, followed by ignition.

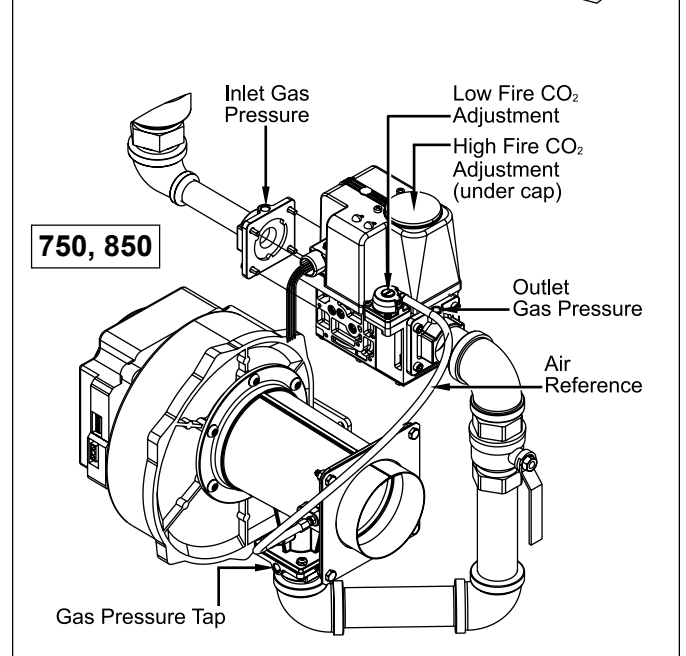
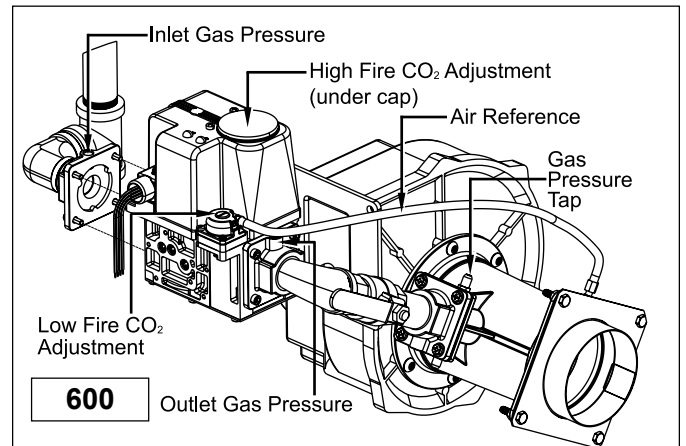
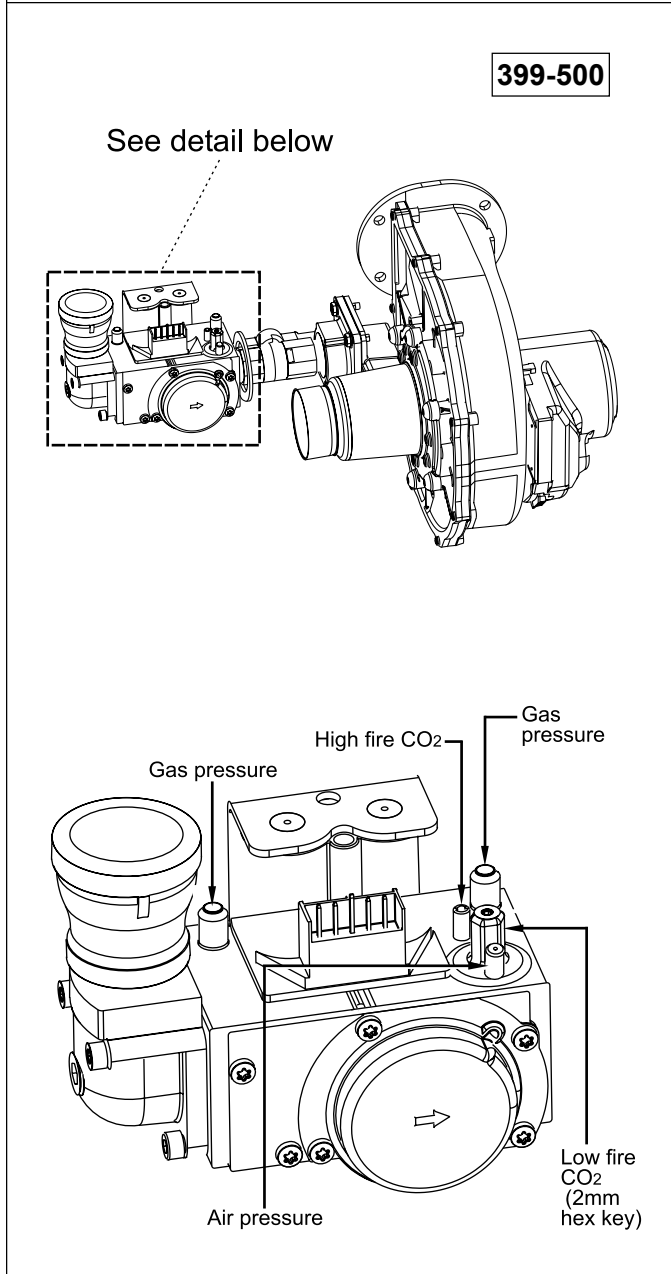
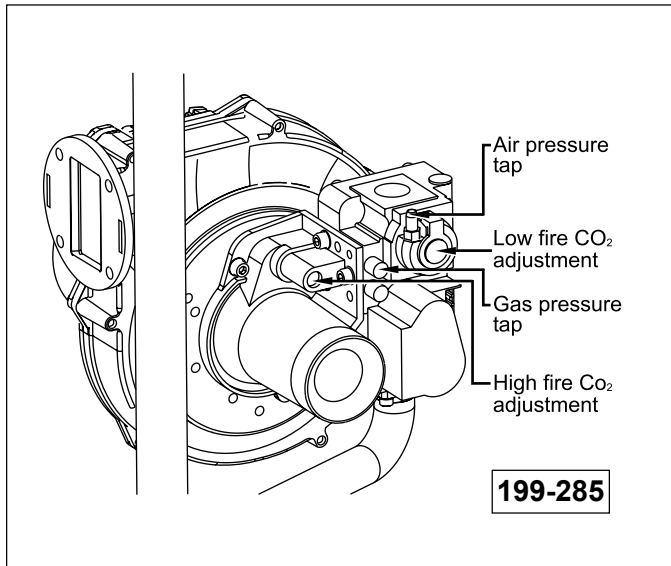


Figure 31A. Keystone Gas Valves (199, 285, 399 and 500).

Figure 31B. Keystone Gas Valves (600, 750 and 850).

SECTION 11. Maintenance

WARNING

Disconnect all power to the appliance before attempting any service to the appliance. Contact with electricity can result in severe injury or death.

11.1 System Maintenance

(yearly, unless otherwise noted)

1. Lubricate the system water-circulating pump, if required, per the instructions on the pump.
2. If a strainer is employed in a pressure reducing valve or the piping, clean it every six months.
3. Inspect the venting system for obstruction or leakage at least once a year. Periodically clean the screens in the vent terminal and combustion air terminal (when used).
4. Keep the appliance area clear and free from combustible materials, gasoline, and other flammable vapors and liquids.
5. If the appliance is not going to be used for extended periods in locations where freezing normally occurs, it should be isolated from the system and completely drained of all water.
6. Low water cutoffs, if installed, should be checked every year. Float type low water cutoffs should be flushed periodically.
7. Inspect and clean the condensate collection, float switch and disposal system yearly.
8. When a means is provided to neutralize condensate, ensure that the condensate is being neutralized properly.
9. Inspect flue passages, and clean with brushes/vacuums, if necessary. Sooting in flue passages indicates improper combustion. Determine the cause and correct.
10. Inspect the vent system and air intake system, and ensure that all joints are sealed properly. If joints need to be resealed, completely remove existing sealing material, and clean with alcohol. Apply new sealing material, and reassemble.

11.2 Appliance Maintenance and Component Description

Use only genuine Triangle Tube replacement parts.

Caution

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

Keystone gas and electric controls are engineered for long life and dependable operation, but the safety of equipment depends on their proper functioning. Only a qualified service technician should inspect the basic

items listed below every year:

- | | |
|------------------------|---------------------|
| a. Appliance control | f. Flow switch |
| b. Automatic gas valve | g. Low water cutoff |
| c. Pressure switches | h. Burner |
| d. Blower | i. Heat exchanger |
| e. Pump | |

11.2.1 Burner

Check the burner for debris. Remove the blower arm assembly to access the burner. Remove the 4 bolts connecting the blower to the arm (see Figure 32). Remove the 5 bolts, which hold the burner arm in place. Pull burner up and out. Clean burner, if necessary, by blowing compressed air from the outside of the burner into the center of the burner, and wipe the inside of the burner clean with glass cleaner. A dirty burner may be an indication of improper combustion or dirty combustion air. Determine the cause, and correct. If damaged, replace the burner gasket when replacing the burner.

NOTE: When installing the burner, make sure the flange is aligned with the mating surface, as each is keyed to control fit.

11.2.2 Modulating Gas Valve / Venturi

The modulating gas valve consists of a valve body that incorporates the ON/OFF gas flow control and a negative pressure regulator. It provides the air/gas ratio control in combination with the venturi to the unit. It is designed to operate with gas supply pressure between 4 and 13 inches w.c.. To remove the gas valve and or venturi, shut off the 120 Volt power supply to the boiler. Turn off all manual gas valves connecting the boiler to the main gas supply line. Remove the front door of the boiler to gain access to the gas valve and venturi. Disconnect the four (4) flange bolts connecting the gas manifold pipe to the gas valve. Remove the electrical connections to the gas valve. Remove the bolts connecting the venturi flange to the blower. This allows the entire gas valve/venturi assembly to be removed as an assembly to facilitate inspection and cleaning.

After the valve has been removed, reassemble in reverse order making sure to include all gaskets and O-rings. Turn on the manual gas valves and check for gas leaks. Turn on the 120 Volt power. Place the unit in operation following the instructions in Section 10. Once the boiler is operating check for leaks again and confirm all fasteners are tight.

Check appliance setup according to Section 10.

11.2.3 Appliance Control

Keystone has an integrated control that incorporates manual reset high limit control, operating temperature control, modulating control, ignition control, outdoor reset control, pump control and many other features. If any of these features are thought to be defective, please consult the factory for proper troubleshooting practices prior to replacing the control. If control replacement is required, turn off all power to the appliance and shut off all manual gas valves to the

appliance. Remove the front door to the appliance and the control panel plastic bezel. Remove all wire connections from the control board. The control board connections are keyed to only allow connection in the proper location, but proper handling techniques should be used to avoid damage to the wiring or connectors. To remove the control push in on the two tabs on the left side of the board to unlatch the clips from the control panel. Rotate the control around the fastening points on the right side of the control to remove the hooks from the control panel. To replace the control repeat the steps above in the reverse order making sure to connect all wires in the proper location. Place the appliance in operation following the steps outlined in Section 10.

11.2.4 Ignitor Assembly

The ignitor assembly is a two rod system that consists of a ground rod and a sense rod. To remove the ignitor assembly, shut off the 120 Volt power supply to the appliance. Turn off all manual gas valves connecting the appliance to the main gas supply line. Remove the front door of the boiler to gain access to the ignitor assembly. Remove the two wires connected to the assembly. Then remove the two bolts connecting the ignitor assembly to the burner door. Remove and

replace the old ignitor assembly gasket. Reinstall a new ignitor assembly in the reverse order if the old assembly is determined defective. Replace gasket if necessary.

11.2.5 Flame Sensor

The flame sensor is a single rod system. To replace the flame sensor electrode, shut off the 120 Volt power supply to the boiler. Turn off all manual gas valves connecting the boiler to the main gas supply line. Remove the front door of the boiler to gain access to the flame sensor electrode. Remove the flame sensor wire from the electrode. Remove the two bolts fastening the electrode to the burner doors. Remove and replace the old flame sensor gasket. Reinstall a new flame sensor electrode in the reverse order if the old electrode is determined defective.



Caution
Igniters and sensors get hot and can cause burns or injury.

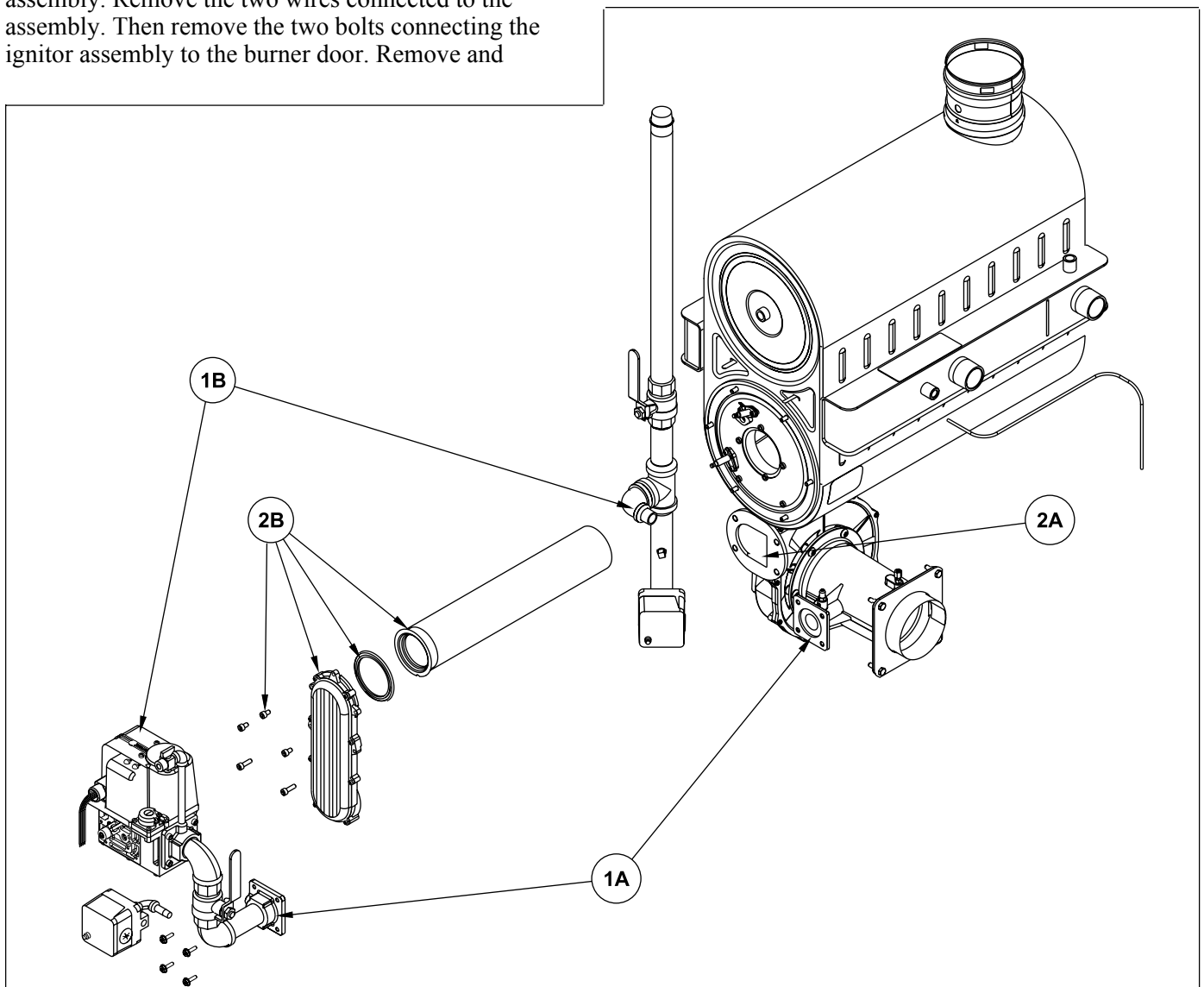


Figure 32. Burner Service.

11.2.6 Transformer with Integral Circuit Breaker

The appliance has a 24Vac transformer with integral 4 amp circuit breaker installed for supplying the control voltage required for the appliance only. The transformer is sized for the appliance load only and should not be used to supply power to additional field devices. If additional loads are added or a short occurs during installation the integral circuit breaker may trip. If this happens make sure to reset the circuit breaker prior to replacing the transformer.

Depending upon the revision of the appliance the transformer may be mounted to the back or underneath the control panel. In either case, if the transformer must be replaced turn off the 120Vac power to the appliance. Remove the transformer wires from terminal blocks. Remove the fasteners holding the transformer and remove the transformer. Replace with a new transformer in reverse order.

If the transformer is replaced with parts other than the OEM transformer, be sure to add circuit protection if it is not integral to the new transformer.

WARNING

Failure to include proper circuit protection may lead to premature component failure, fire, injury or death.

11.2.7 Blower

The combustion air blower is a high-pressure centrifugal blower with a variable speed motor. Speed of the motor is determined by the control logic. 120 Volts remain on to the blower at all times. If a blower change is required, turn off the 120 Volt power and gas supply to the unit. Take the front panel off. Disconnect the 120 Volt and control signal connections from the blower. Disconnect the bolts connecting the venturi to the blower housing. Disconnect the fan outlet bolts from the burner door blower arm. If the fan is determined to be defective replace the existing fan with a new one reversing the steps above. Make sure to install all of the required O-rings and gaskets between the blower arm and the blower and blower face and venturi flange.

11.2.8 Heat Exchanger Coils

Black carbon soot buildup on the external surfaces of the heat exchanger is caused by one or more of the following; incomplete combustion, combustion air problems, venting problems and heater short cycling. Soot buildup or other debris on the heat exchanger may restrict the flue passages.

If black carbon soot buildup on the heat exchanger is suspected, disconnect electrical supply to the unit, and turn off the gas supply by closing the manual gas valve on the unit. Access the heat exchanger through the burner door at the front of the boiler, and inspect the tubing using a flashlight. If there is a buildup of black carbon soot or other debris on the heat exchanger, clean per the following:

Caution

Black carbon soot buildup on a dirty heat exchanger can be ignited by a random spark or flame. To prevent this from happening, dampen the soot deposits with a wet brush or fine water spray before servicing the heat exchanger.

1. Shut off the 120 Volt power supply to the boiler
2. Turn off all manual gas valves connecting the boiler to the main gas supply line.
3. For size 600 only (*all other sizes please skip to step four*). Size 600 will require the gas valve to be removed in order to remove the burner door. To do this, remove the wire connections from the gas valve. Remove the flange bolts from the gas supply pipe connected to the gas valve (1B). Remove the flange bolts connecting the gas train to the venturi (1A). Remove the gas train assembly keeping gaskets and o-rings.
4. Remove the four bolts connecting the blower flange to the burner door arm.
5. Remove the nuts located on the outside diameter of the burner door to the heat exchanger.
6. Remove the burner door/burner assembly from the heat exchanger.
7. Disconnect the condensate drain line.
8. Attach a longer hose to drain and run to a bucket.
9. Clean the heat exchanger by brushing light accumulations of soot and debris. Use a brush with soft bristle (non metal) to avoid damaging the surface of the heat exchanger tubes.
10. Once the tubes have been brushed clean rinse the tubes and combustion chamber with a small amount of water to rinse all of the debris out of the bottom of the flue collector and into the longer condensate trap line, which is being diverted into a separate container.

NOTE: The Warranty does not cover damage caused by lack of required maintenance, lack of water flow, or improper operating practices.

WARNING

Failure to rinse the debris from the heat exchanger and temporary drain line may lead to clogged condensate lines, traps and neutralizers. Condensate pumps (if used) may also be damaged from the debris left behind, possibly causing property damage.

11. Install all components removed in the reverse order to place the appliance back in operation. Make sure all gaskets are in place as components are installed. Replace any damaged gaskets. Do NOT reuse damaged gaskets.
12. Place the appliance in operation according to Section 10 checking all gas connections for leaks. Confirm all fasteners are tight.

11.2.9 Gas Pressure Switches (optional)

The high and low gas pressure switches are 24V manual reset switches that act to cut power to the gas valves if the gas pressure is too low or too high for proper operation. The gas pressure switches used are integrally vent limited, and do not require venting to atmosphere. To remove a switch, remove the screw on the plastic housing and pull the clear cover off. Disconnect the two wires from the screw terminals. Twist the switch off the pipe nipple. Reassemble in reverse order. For natural gas, set the low gas pressure switch to 3" w.c. For propane, set the low gas pressure switch to 5" w.c. For natural and propane, set the high gas pressure switch to 14".

11.2.10 Gas Conversion

Keystone units can be converted from natural to propane gas or from propane to natural gas easily in the field. Some units require the addition of a gas orifice along with proper gas valve adjustment. Other units require no additional parts, only proper gas valve adjustment. Please contact the TriangleTube factory for specific information regarding the gas conversion of an appliance. If a gas conversion is performed, the unit must be identified with the appropriate gas labels and a conversion sticker to allow technicians performing maintenance in the future to properly identify the gas type of the appliance.

SIZE (MBTU)	KIT NUMBER
199	CA006204
285	CA006205
399	CA006207
500	CA006207
600	CA006207
750	CA006207
850	CA006207

Table 17. Propane Gas Conversion Kits.**SECTION 12.
Trouble Shooting****12.1 Sequence of Operation**

Keystone is a cold start appliance that should start only on a call for heat from a tank aquastat, room thermostat, zone valve end switch or other space temperature control device.

1. Upon a call for heat: (a) the internal pump and system pump will start; (b) the blower will begin a 30 second pre-purge.
2. Following the prepurge cycle the direct spark ignition will spark and will begin a 4 second trial for ignition. The unit is allowed one or three ignition retries.
3. The gas valve will then be energized and a reduced rate ignition will occur. The unit will remain in a reduced rate start-up period for several seconds.
4. After the reduced rate start time is over, the unit will be in normal operation. Firing rate will modulate based on the heating load via the temperature controller settings and readings.
5. When the call for heat is complete, or the unit reaches its setpoint temperature, the gas valve will close, and the fan will continue to run for its 20 second post-purge. If a pump delay time is used, the pump will continue to run for the specified amount of time (adjustable from 0.1 to 10 minutes).

12.2 Short Cycling

Because Keystone is a modulating boiler, and its input will decrease when there is a reduction in heating load, short cycling is greatly reduced. If the heating load drops below the minimum input of the boiler for an extended period, the boiler will have a tendency to short cycle. This can be a symptom of improper control strategy or setpoints, or a load distribution problem. Keystone has a built-in anti-short cycle (ASC) feature. ASC is a timed setting that will delay the boiler start for a specified time after one call for heat is completed. ASC time may be adjusted as desired (see Section 8 for more information).

12.3 Error Codes - See Table 18.

CODE#	PROBLEM	PROBABLE CAUSE	SOLUTION
COMMON LOCKOUT CODES			
27	Internal error	Flame rod to ground	Check wiring / probe grounded, dirty probe
47	Flame rod to ground leakage	Faulty flame detector	Clean or replace flame detector
49	24VAC voltage low/high	Faulty transformer	Check/correct supply line voltage; replace faulty transformer
52	Motor tachometer fault	Faulty fan / fan wiring fan circuit	Check fan harness wiring for continuity; replace faulty fan circuit
53	AC inputs phase reversed		Reverse 24V hot/neutral - use common ground
61	Anti short cycle	Call for heat will be held until timer resets	Change ASC timer setting
62	Fan speed not proved	Dirty / defective fan	Clean or replace fan; check wiring
63	LCI off	Safety chain interrupt	Check flow switch, aux high limit, LWCO, gas pressure switches, condensate level and correct problem
69	Outlet high limit	High limit tripped	Determine cause: low/no flow, valves closed, settings and correct
79	Outlet high limit		
80	DHW high limit	High limit reached	Check pump, time delay, valves closed, etc. and correct overtemp
81	Delta T inlet/outlet limit		
82	Stack limit	High limit reached	Could be caused by high ambient temperature, or high return water temperature
88	Outlet T-rise limit		
90	Heat exchanger high limit	High limit reached	Diagnose / repair cause of high temperature
91	Inlet sensor fault		
92	Outlet sensor fault		
93	DHW sensor fault	Faulty sensor or wiring	Check wiring / replace sensor; condition can be caused by short
95	Stack sensor fault		
96	OAT temperature sensor fault temperature sensor	Faulty outdoor air is open or shorted	Check wiring and sensor for short; replace sensor
105	Flame detected out of sequence	Flame exists at burner when it should not be	Clean burner of soot or other debris that could maintain flame
106	Flame lost in MFEP		
107	Flame lost early in Run	Unstable flame during lighting / flame proving sequence	Check venting, gas supply pressure, burner, fan, etc.
108	Flame lost in Run		
109	Ignition failed	Problem with ignitor, or other ignition-related device	Check / replace ignitor, wiring; check for shorting in ignitor cable
113	Flame circuit timeout	Flame not established within expected time limit	Check all combustion components; purge gas; check ignition source
122	Lightoff rate proving failed		
123	Purge rate proving failed		
128	Fan speed failed / prepurge	Fan did not reach expected RPM	Check fan wiring; replace fan
129	Fan speed failed / preignition		
130	Fan speed failed / ignition		
131	Fan movement detected during standby	Fan should not be moving when not powered	Check for common venting problems or otherwise forced air
132	Fan speed failed during run	Fan lost or gained speed during run sequence away from control spec	Fan overheating or otherwise failing; check cable; replace fan
137	ILK failed to close	No power at interlock ILK	Check J5 pin 1 for power - if no power, confirm safeties are closed

continued next page >

CODE#	PROBLEM	PROBABLE CAUSE	SOLUTION
ALERT CODES			
49	Maximum cycle count was reached	Control operates correctly, however the cycle count will not increment any higher than 999,999 cycles	Replace controller or adjust the count using blue display
50	Maximum hours count was reached	Control operates correctly, however the hours count will not increment any higher than 999,999 hours	
248	CH outdoor temperature was invalid	Confirm outdoor reset settings. An invalid adjustment has been made	Adjust setting to within appropriate range
251	CH ODR max outdoor temperature setpoint was invalid		
252	CH ODR min outdoor temperature setpoint was invalid		
253	CH ODR min water temperature setpoint was invalid		
254	CH ODR temperature range was too small (min. 12°C / 22°F)		
255	CH setpoint minus ODR min water temperature was too small (min. 12°C / 22°F) Increase setpoint or decrease min water temp.	Increase Outdoor water temperature min and max values to a difference greater than 22°F (12°C)	
565	Heat exchanger T-rise limit was exceeded	Heat exchanger temperature rise exceed	Check for correct water flow
MISCELLANEOUS			
	Boiler will not stay lit	Indicates lack of flame signal, check fault code on display	Check flame detector wiring; clean / replace flame detector
	Boiler bangs, knocks, hisses	Insufficient water flow / pump failure; improper piping	Check for proper flow, follow piping guidelines in manual; replace pump; improper glycol percentage (see Section 4.3)
	Flame pulsates, venting noise or has difficulty lighting	Insufficient / improper venting; dirty burner; air in gas line; dirty heat exchanger	Ensure venting complies with Section 2
980	Display error	Communication error between the control and display.	Check wiring and connectors. Possible software revision incompatibility.
981	Display error	Communication error between the control and display.	Check wiring and connectors. Possible software revision incompatibility.

Table 18. Error Codes.

SECTION 13.

Replacement Parts

Use only genuine Triangle Tube replacement parts.

13.1 General Information

To order or purchase parts for the Triangle Tube Keystone, contact your nearest Triangle Tube dealer or distributor. If they cannot supply you with what you need, contact Customer Service (see back cover for address, telephone and fax numbers).

13.2 Parts List

ITEM DESCRIPTION	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
	KW 199	KW 285	KS 399 KW 399	KS 500 KW 500	KS 600 KW600	KS 750 KW750	KS 850 KW 850

Jacket Components – See Figure 33

1	Front Panel Assembly	KSR100	KSR100	KSR101	KSR102	KSR102	KSR102	KSR102
2	Front Panel Handle	KSR103	KSR103	KSR103	KSR103	KSR103	KSR103	KSR103
3	Rear Panel	KSR104	KSR104	KSR104	KSR104	KSR104	KSR104	KSR104
4	Left Side Panel	KSR105	KSR105	KSR106	KSR107	KSR107	KSR108	KSR109
	Right Side Panel	KSR110	KSR110	KSR111	KSR112	KSR112	KSR113	KSR114
6	Left Top Panel	KSR115	KSR116	KSR117	KSR118	KSR119	KSR120	KSR121
7	Middle Left Top Panel	KSR122	KSR123	KSR124	KSR125	KSR126	KSR127	KSR128
7A	Middle Right Top Panel	KSR129	KSR130					
8	Right Top Panel	KSR131	KSR132	KSR133	KSR134	KSR135	KSR136	KSR137
9	Jacket Angle Bracket, Right Hand	KSR138 (2)	KSR138 (2)	KSR139 (2)	KSR140 (2)	KSR140 (2)	KSR141 (2)	KSR142 (2)
9	Jacket Angle Bracket, Left Hand				KSR143 (2)			
10	Jacket Support, Left Stanchion	KSR144	KSR144	KSR144	KSR144	KSR144	KSR144	KSR144
11	Jacket Support, Rt. Stanchion	KSR145	KSR145	KSR145	KSR145	KSR145	KSR145	KSR145
12	Front Bezel	KSR146	KSR146	KSR146	KSR146	KSR146	KSR146	KSR146

Internal Components – See Figure 34

20	Base Assembly	KSR200	KSR200	KSR201	KSR202	KSR203	KSR204	KSR205
21	Left Rear Support Stanchion	KSR206	KSR206	KSR206	KSR206	KSR206	KSR206	KSR206
22	Left Front/Right Rear Stanchion	—	KSR207	KSR207	KSR207	KSR207	KSR207	KSR207
			(2)	(2)	(2)	(2)	(2)	(2)
23	Cantilevered Base Stanchion	KSR208	KSR208	KSR208	KSR208	KSR209	KSR210	KSR210
24	Brace, Front, HX Stanchion	KSR211	KSR212	KSR212	KSR212	KSR215	KSR212	KSR212
24A	Brace, Rear, HX Stanchion	KSR213	KSR214	KSR212	KSR212	KSR212	KSR212	KSR212
25	Mounting Rail	KSR216	KSR216	KSR217	KSR218	KSR218	KSR219	KSR220
		(2)	(2)	(2)	(2)	(2)	(2)	
26	Diagonal Brace						KSR221 (2)	KSR221 (2)
27	Condensate Trap Assembly	KSR222	KSR223	KSR223	KSR223	KSR224	KSR224	KSR224
28	Heat Exchanger Rail Clip	—	KSR225	—	—	—	—	—
			(2)					
30	PVC Reducer	KSR226	KSR227	KSR228	KSR229	KSR230	KSR230	KSR230
30A	CPVC Reducer or Coupling	KSR231	—	KSR232	—	KSR232	KSR232	KSR232
30B	2" Dia. Pipe, CPVC	KSR233	—	—	—	—	—	—
31	Hose Barbed Adapter	KSR234	KSR234	—	—	—	—	—
33	Air Inlet/ Exhaust Bracket	KSR235	KSR236	KSR237	KSR238	KSR238	KSR238	KSR238

ITEM DESCRIPTION	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
	KW 199	KW 285	KS 399 KW 399	KS 500 KW 500	KS 600 KW600	KS 750 KW750	KS 850 KW 850
Gas Train Components – See Figure 35							
40 Combustion Air Blower	KSR300	KSR300	KSR301	KSR301	KSR302	KSR302	KSR302
41 Gas Valve / Venturi	KSR303	KSR304	—	—	—	—	—
42 Gas Valve	—	—	KSR305	KSR306	KSR307	KSR307	KSR307
43 Gas / Air Venturi	—	—	—	KSR308	KSR309	KSR309	KSR309
44 Manual Shut off	—	—	KSR310	KSR311	KSR311 (2 for KS600)	KSR312	KSR312
44A Manual Shut off	—	—	—	KSR310	—	KSR311	KSR311
45 Gas Valve Flange Kit	—	—	—	KSR313	KSR313	KSR313	KSR313
46 Gas Valve/ Venturi Cork Gasket	—	—	—	KSR314	KSR314	KSR314	KSR314
47 Gas Valve O-ring	KSR315	KSR315	—	—	—	—	—
48 Venturi O-ring	—	—	KSR316	KSR316	KSR316	KSR316	KSR316
49 High Gas Pressure Switch	—	—	—	KSR317	KSR318	KSR319	KSR319
50 Low Gas Pressure Switch	—	—	—	KSR320	KSR321	KSR322	KSR322
51 Duct / Venturi Transition	KSR323	KSR324	—	KSR325	KSR326	KSR326	KSR327
52 Gas Supply Pipe	KSR328	KSR329	KSR330	KSR331	KSR331	KSR332	KSR332
53 Gas Pipe, 3/4" NPT Formed Nipple	—	—	KSR333	—	—	—	—
55 Air Inlet Flex Hose	KSR334	KSR334	KSR335	KRS336	KSR337	KSR338	KSR338
56 Air Inlet Collector	KSR339	KSR339	KSR340	—	—	—	—
57 Electrical Connector w/ Cable	—	—	KSR341	KSR341	—	—	—
58 Elbow Adaptor	—	—	KSR342	KSR342	—	—	—
59 Blower Gasket w/ Fasteners	—	—	—	—	KSR343	KSR343	KSR343
Heat Exchanger Components – See Figure 36							
60 Heat Exchanger	KSR400	KSR401	KSR402	KSR403	KSR404	KSR405	KSR406
62 Low Water Cutoff Switch	—	—	—	KSR407	KSR407	KSR407	KSR407
63 Water temp sensor	KSR408	KSR408	KSR408	KSR408	KSR408	KSR408	KSR408
64 Duplex water temp sensor	KSR409	KSR409	KSR409	KSR409	KSR409	KSR409	KSR409
65 Duplex Stack temp sensor	KSR410	KSR411	KSR411	KSR411	KSR411	KSR411	KSR411
66 Pressure relief valve KS (175psi)	—	—	KSR412	KSR412	KSR412	KSR412	KSR412
66 Pressure relief valve KW (125psi)	KSR413	KSR413	KSR413	KSR413	KSR413	KSR413	KSR413
67 Air vent	KSR414	KSR414	KSR414	KSR414	KSR414	KSR414	KSR414
68 Burner door w/ gaskets	KSR415	KSR415	KSR415	KSR415	KSR415	KSR415	KSR415
68A Gaskets-only (burner door)	KSR416	KSR416	KSR416	KSR416	KSR416	KSR416	KSR416
69 Burner gasket	KSR417	KSR417	KSR417	KSR417	KSR417	KSR417	KSR417
69A Gasket set (burner, ignitor, sensor & door gaskets)	KSR418	KSR418	KSR418	KSR418	KSR418	KSR418	KSR418
70 Front refractory tile	KSR419	KSR419	KSR419	KSR419	KSR419	KSR419	KSR419
71 Rear refractory tile	KSR420	KSR420	KSR420	KSR420	KSR420	KSR420	KSR420
72 Main burner w/ gasket	KSR421	KSR422	KSR423	KSR423	KSR424	KSR425	KSR426
73 Flame sensor w/ gasket	KSR427	KSR427	KSR427	KSR427	KSR427	KSR428	KSR428
74 Ignitor w/ gasket	KSR429	KSR429	KSR429	KSR429	KSR429	KSR430	KSR430
74A Ignitor gasket	KSR431	KSR431	KSR431	KSR431	KSR431	KSR431	KSR431
Ignition cable (not shown)	KSR432	KSR432	KSR432	KSR432	KSR432	KSR433	KSR433
74B Screw, ignitor / flame sensor	KSR434	KSR434	KSR434	KSR434	KSR434	KSR434	KSR434
74C Flame / sensor gasket	KSR435	KSR435	KSR435	KSR435	KSR435	KSR435	KSR435
75 Air/gas Channel	KSR436	KSR436	KSR436	KSR437	KSR437	—	—
Air Adaptor	—	—	—	—	—	KSR438	KSR438

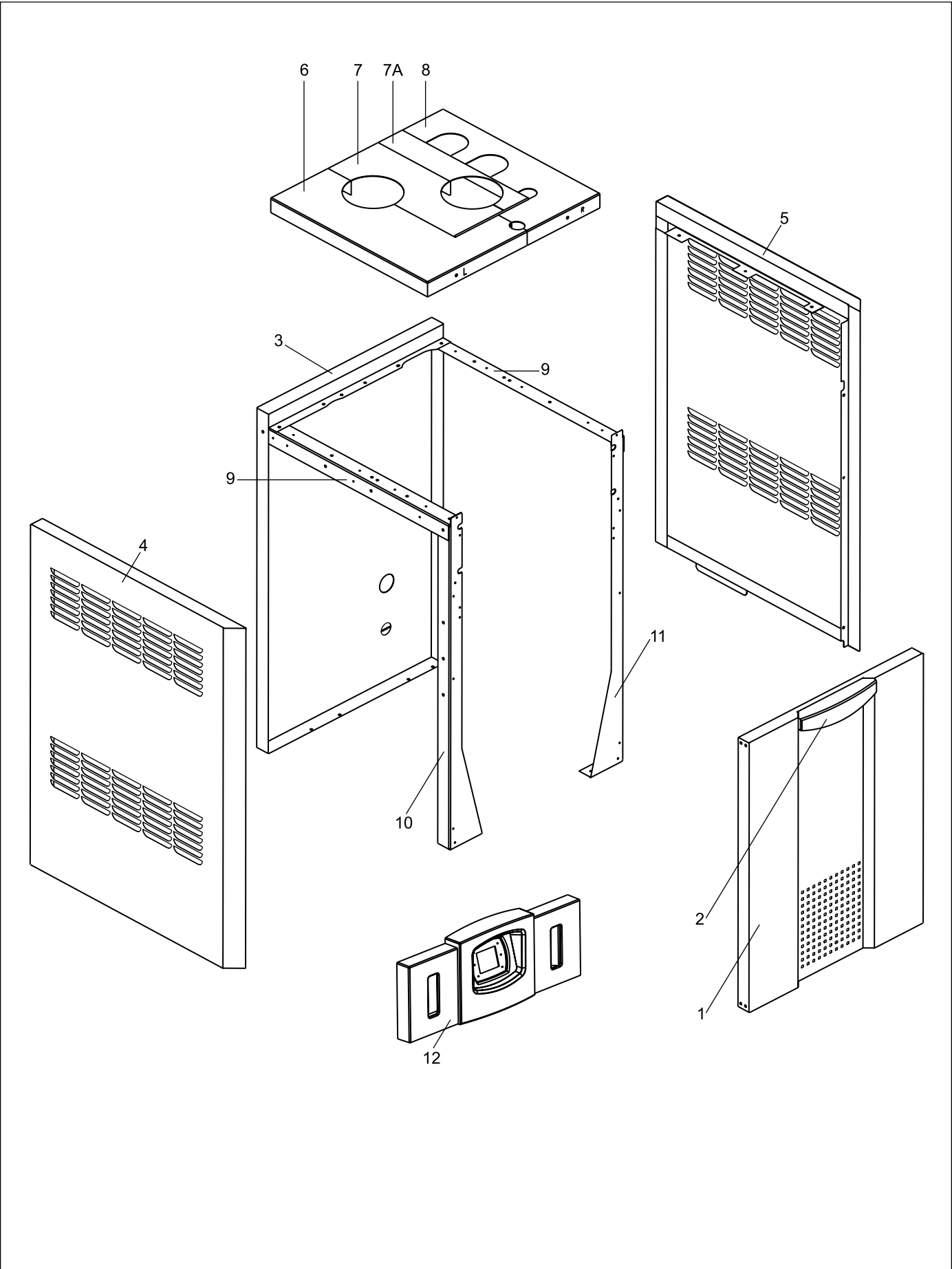


Figure 33. Jacket Components.

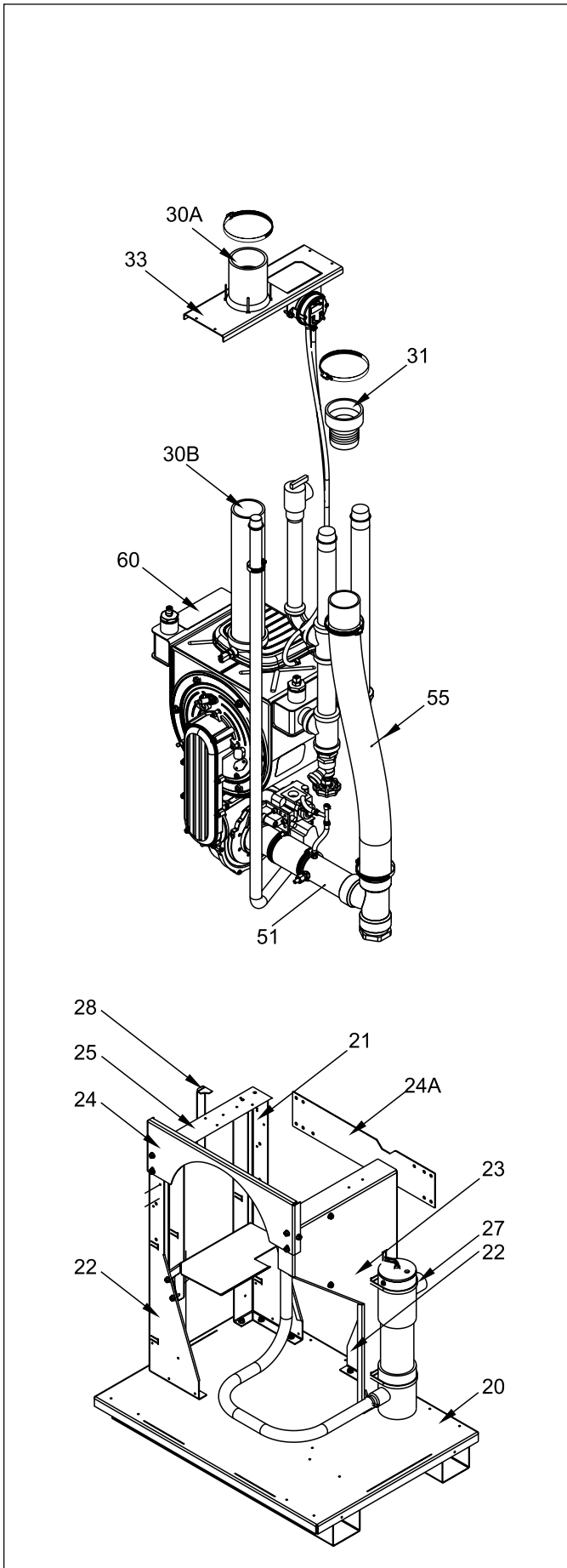


Figure 34A. Internal Components, Size 199.

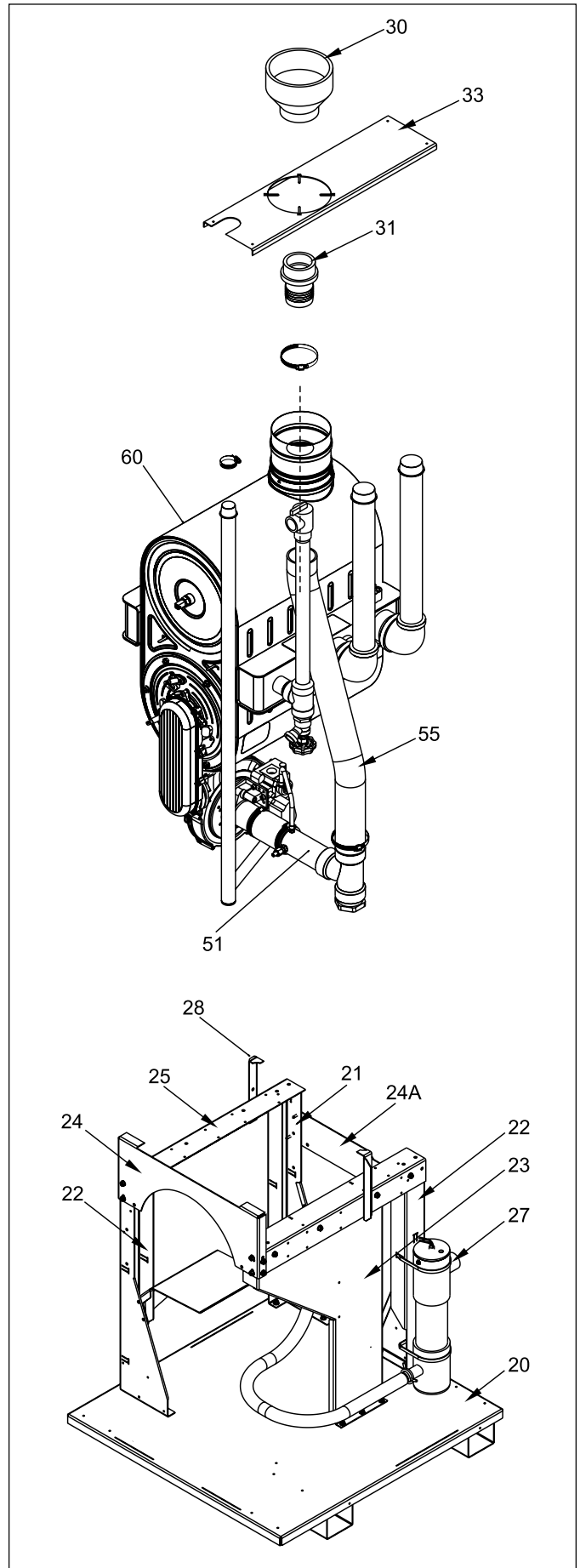


Figure 34B. Internal Components, Sizes 285-600.

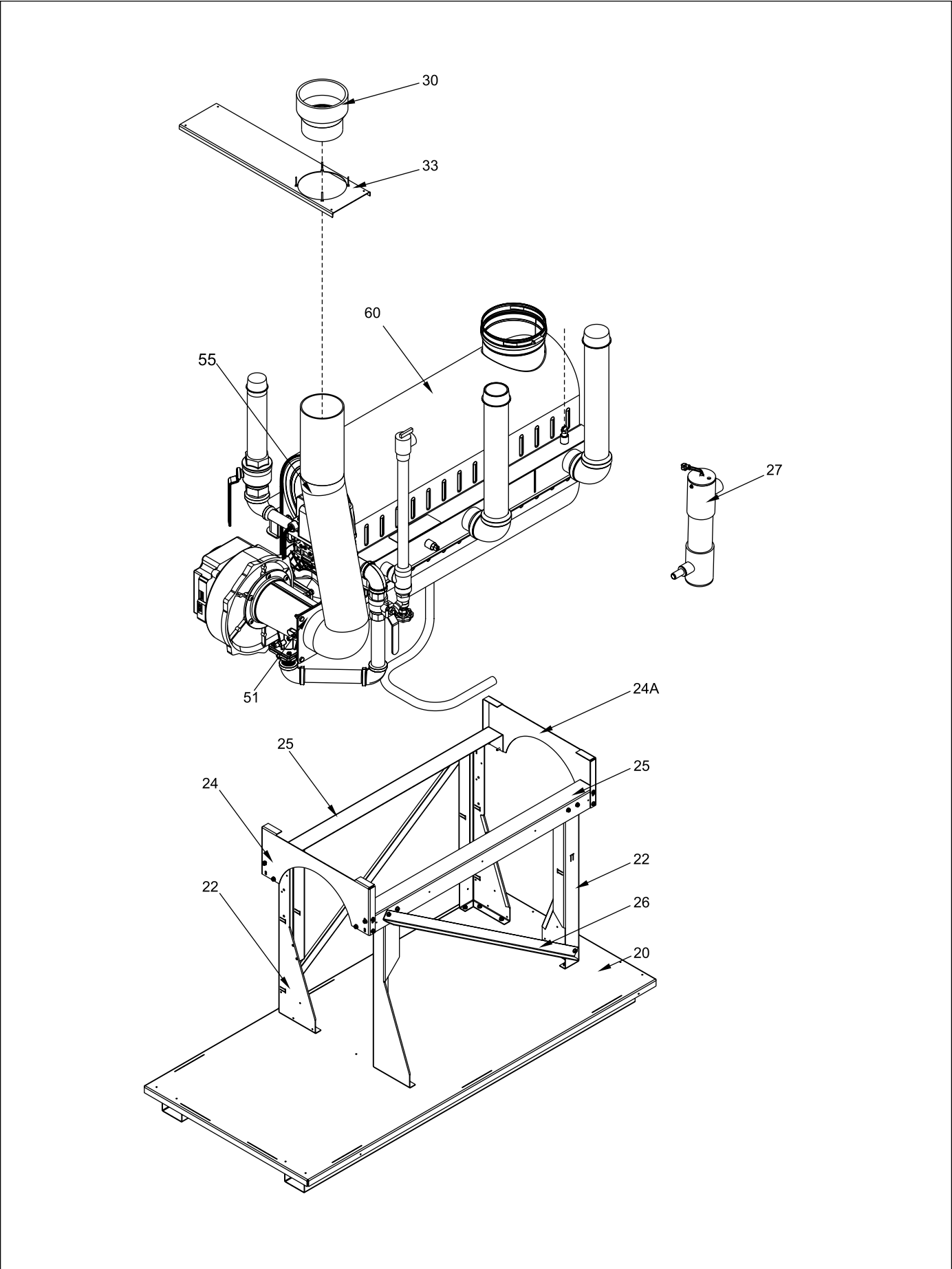


Figure 34C. Internal Components, Sizes 750-850.

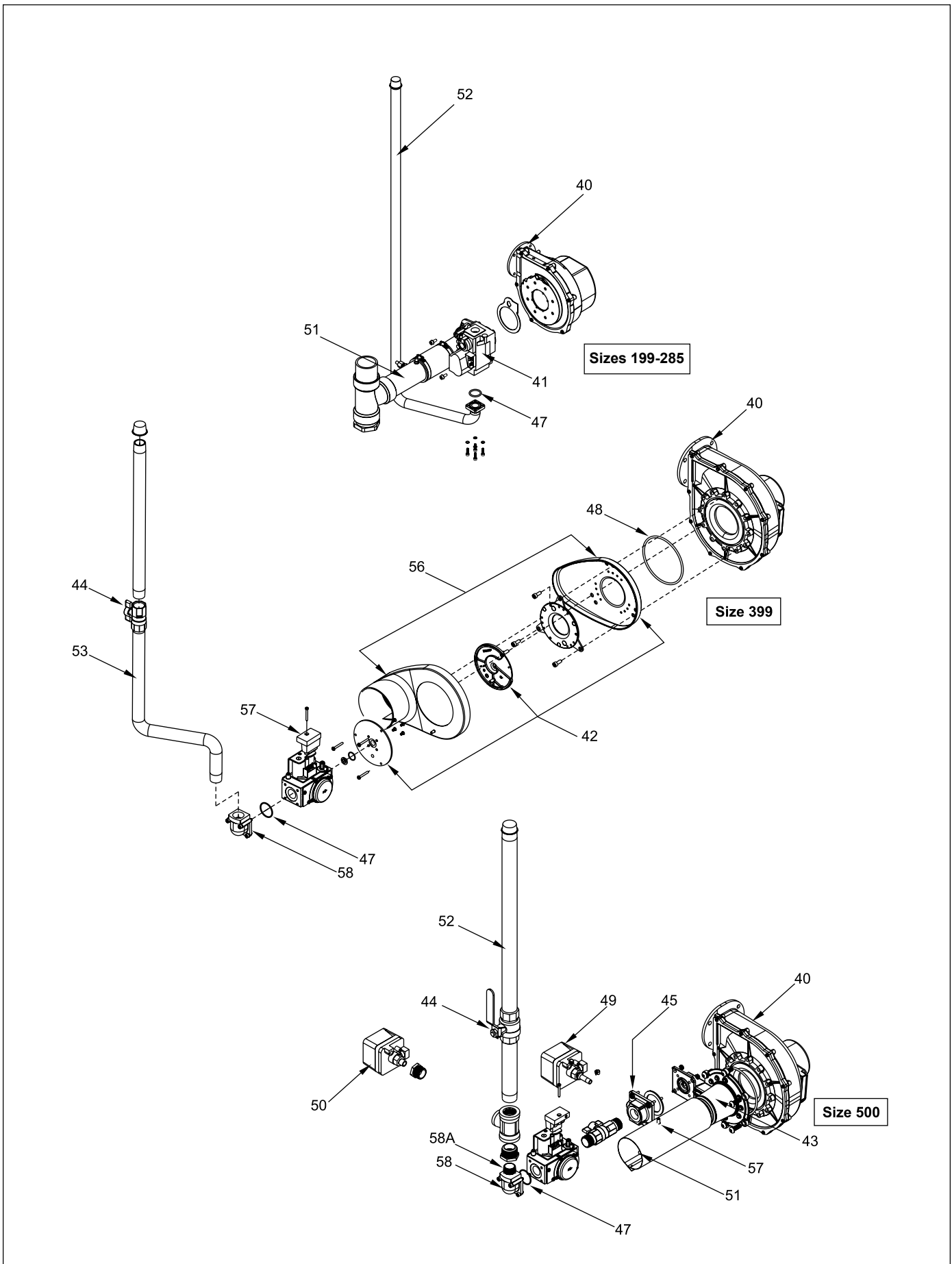


Figure 35A. Gas Train Components, Sizes 199-500.

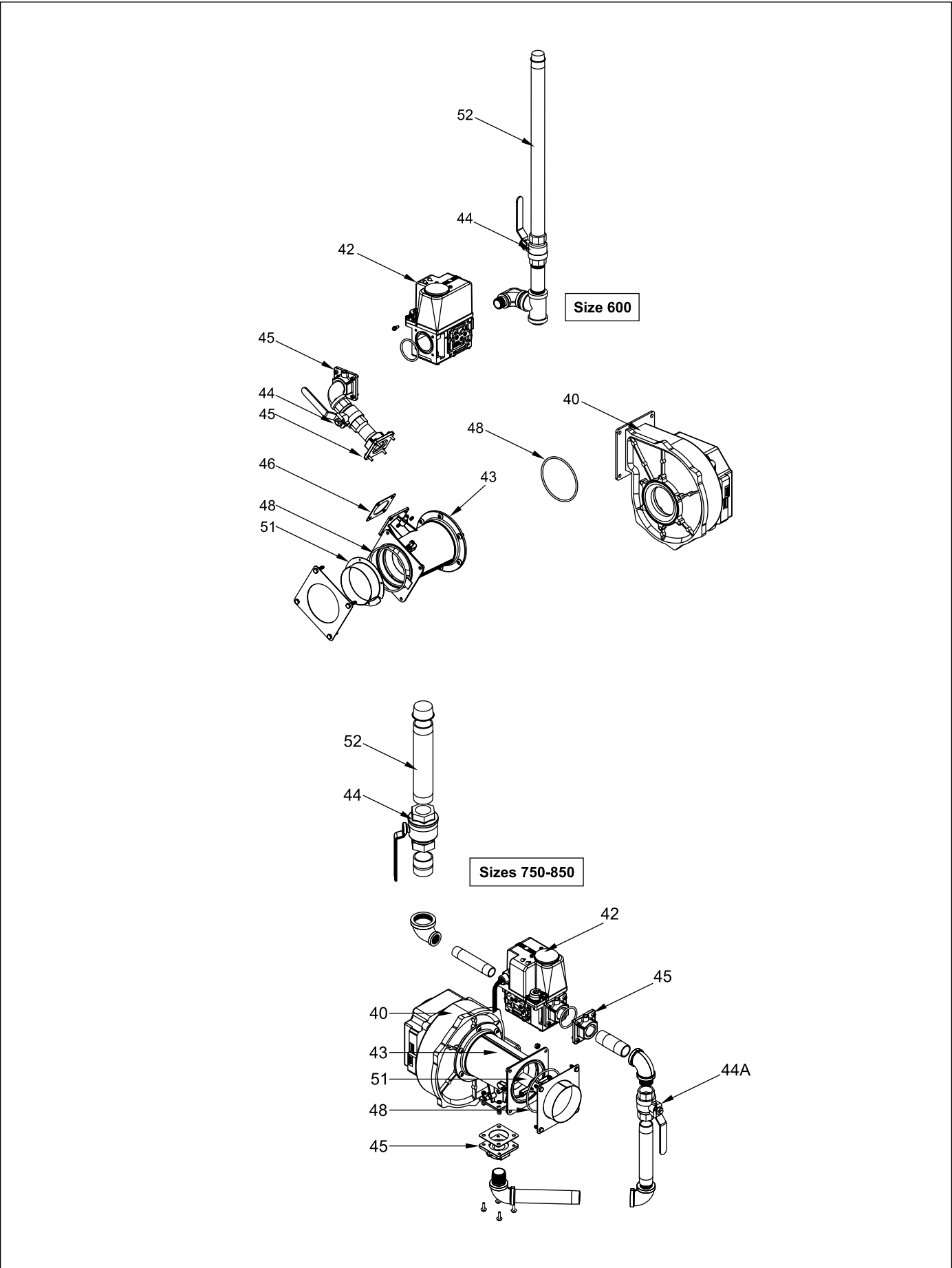


Figure 35B. Gas Train Components, Sizes 600-850.

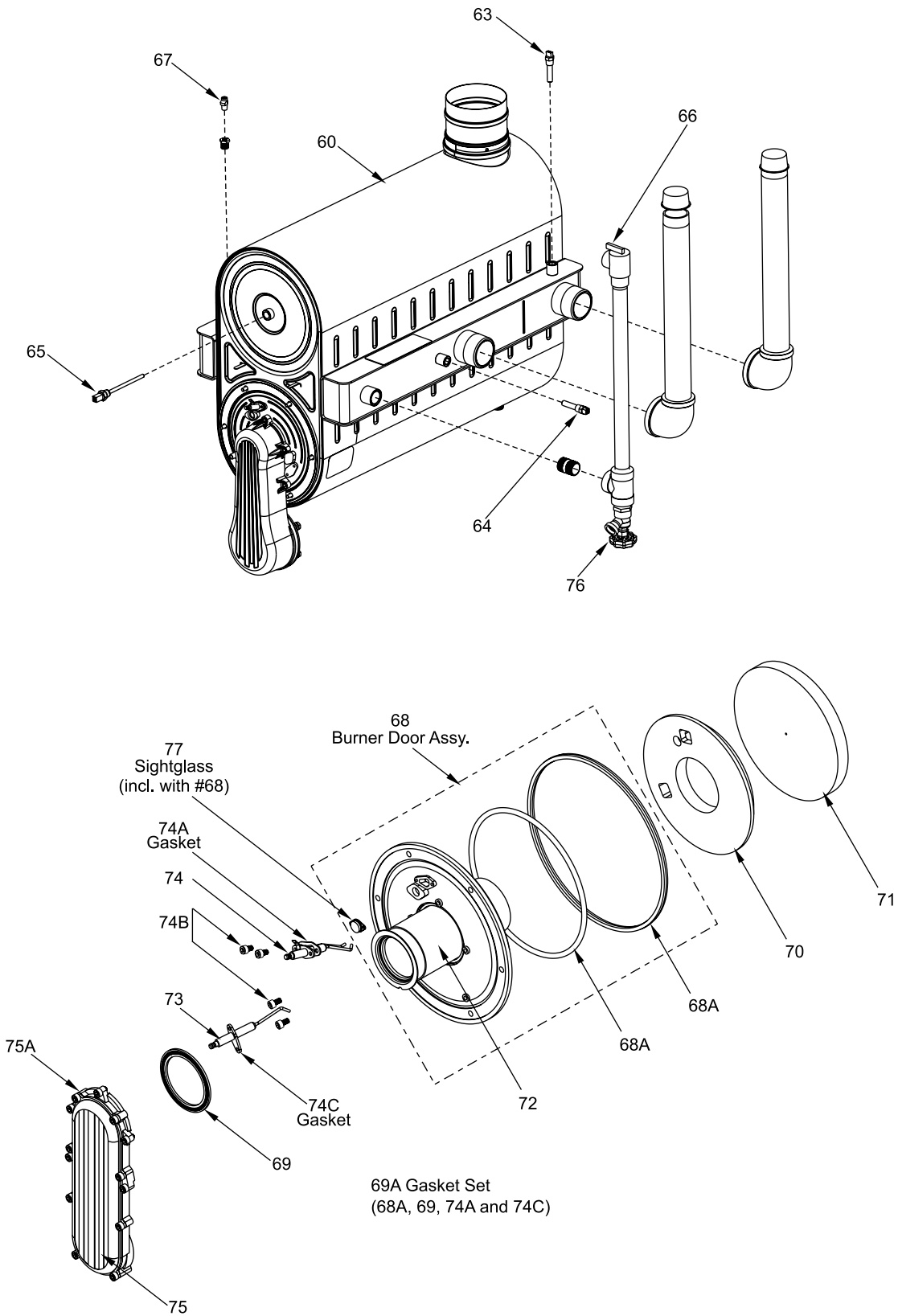


Figure 36. Heat Exchanger Components.

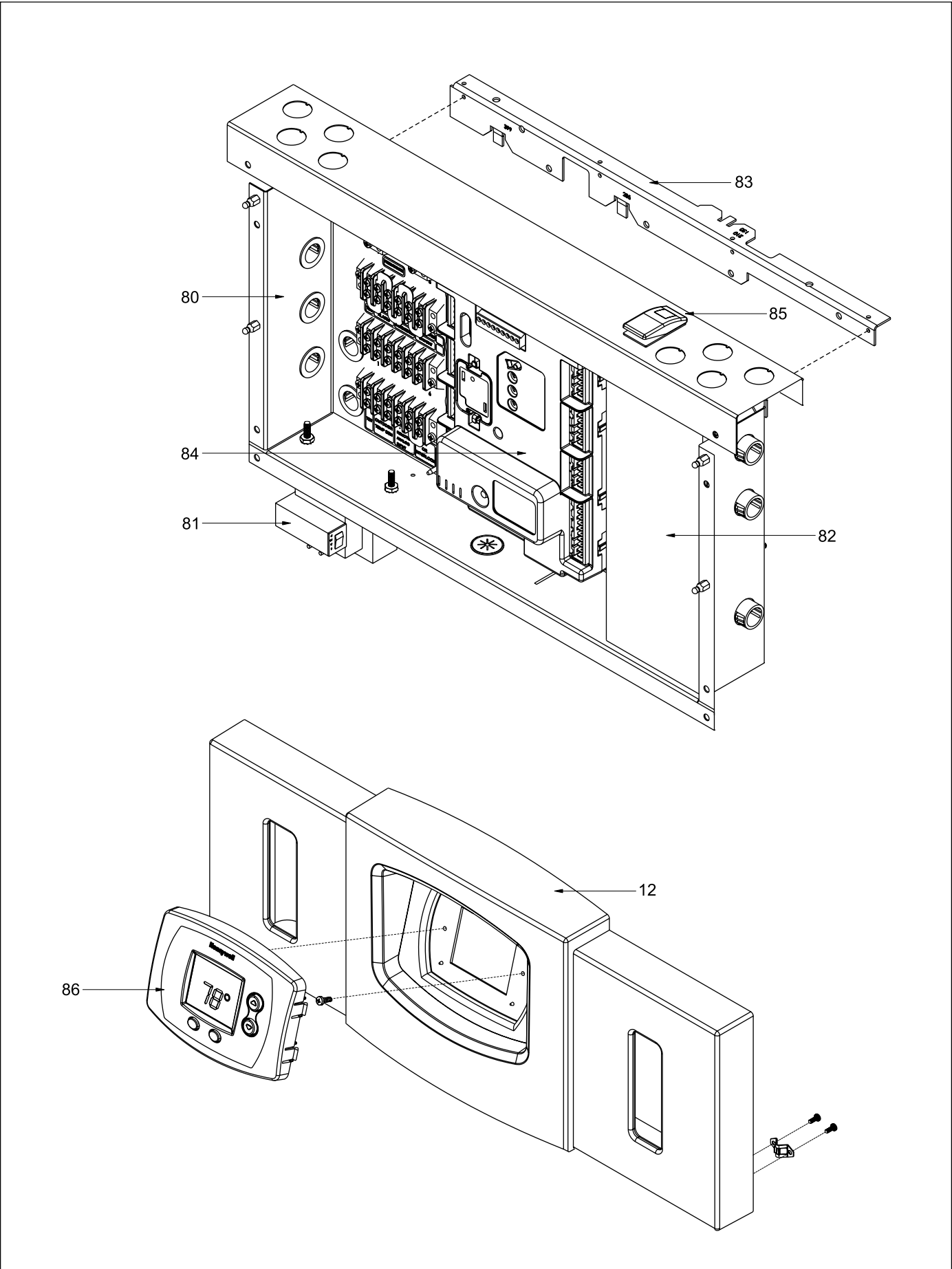


Figure 37. Electrical Components.

Dimensions and specifications subject to change without notice in accordance with our policy of continuous product improvement.



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