GENESIS® HYDRONIC BOILERS

Engineering and Design Manual

A.O.Smith
Water Heaters

Introduction
Engineering and Design Manual

Dear A. O. Smith Customer,

This Engineering and Design Manual has been written to aid in designing and specifying A. O. Smith Genesis hydronic heating boilers. This manual is intended to quickly and easily answer the most frequently asked questions regarding the Genesis product line.

This manual is intended for use by professional designers and engineers and is not meant to be all inclusive. Reference should be made to the instruction manual accompanying the product. This Engineering and Design Manual contains supplemental information to the Genesis Instruction and User's Information Manual. A copy of the complete instruction manual can be obtained from the A. O. Smith website (www.hotwater.com), from the A. O. Smith Customer Care Center at 1-800-527-1953, or from your local A. O. Smith Representative.

A. O. Smith is proud of our quality products, and we appreciate your interest in our products. We hope to be working with you soon.

Sincerely yours,
A. O. Smith Water Heaters

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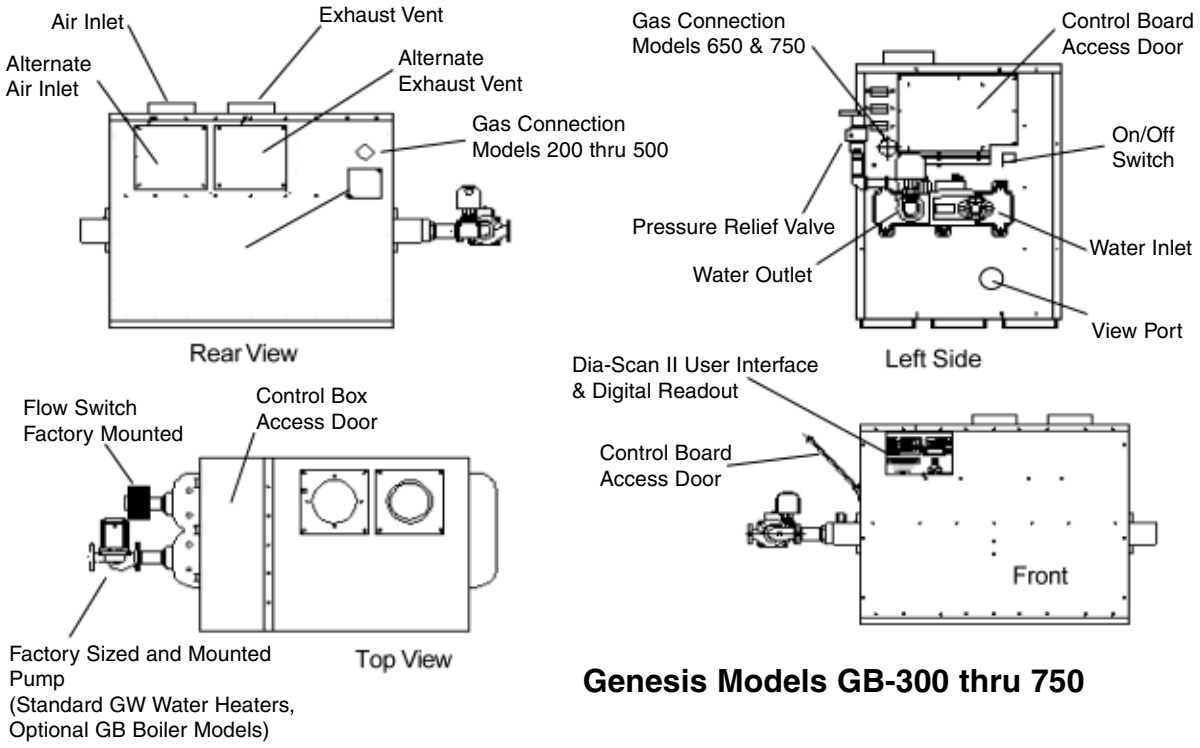
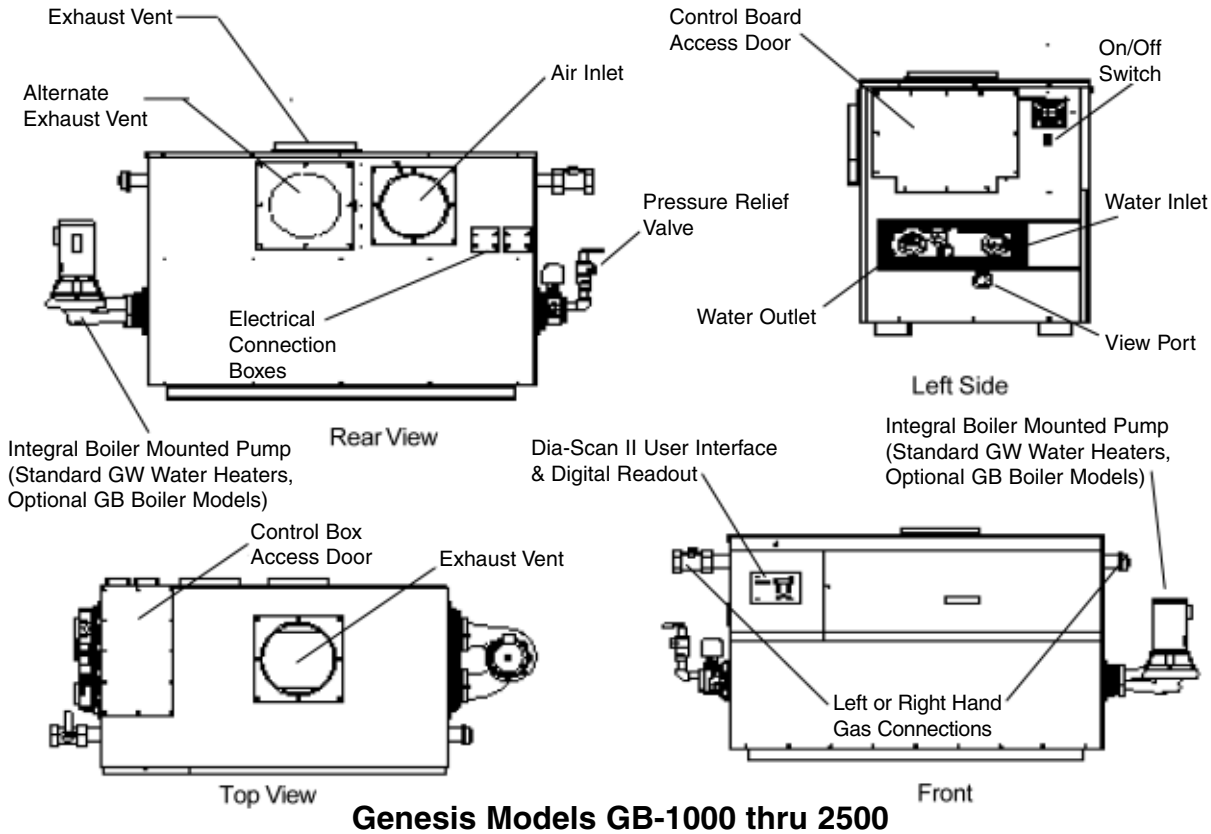


Genesis Models GB-300 thru 750

Genesis Boiler Points of Reference



Genesis Models GB-1000 thru 2500

Figure 1-1

CHAPTER 1. BASICS OF INSTALLATION

Code Compliance

The Genesis boiler design complies with the latest edition of the American National Standards Institute for gas-fired, low-pressure steam and hot water boilers, ANSI Z21.13 and CSA 4.9.

In addition to the information in the instruction manual, the boiler(s) shall be installed in strict accordance with those installation regulations in force in the local area where the installation is to be made. Authorities having jurisdiction should be consulted before installations begin. In the absence of local codes, the installation must comply with the latest editions of:

In the United States:
The National Fuel Gas Code, ANSI Z223.1/NFPA 54 and the National Electric Code, NFPA 70.

In Canada:
The installation Code CAN/CSA B149.1-00 and the Canadian Electric Code, CSA C22.1.

Location

Before installing any boiler, careful consideration must be given to proper location. The location selected should be as close to the stack or chimney as practical, offer adequate make-up air supply, and be as centralized within the piping system as possible. This location should also be such that the gas ignition system components are protected from external dripping and spraying of water during appliance operation and service.

Additional boiler location considerations:

- The boiler must not be installed on carpeting (See Chapter 2).
- The boiler should not be located in an area where it will be subject to freezing.
- The boiler should be located near a floor drain.
- The boiler should be located in an area where leakage from the boiler or connections will not result in damage to the adjacent area or to lower floors of the structure.

Note: When such locations cannot be avoided, a suitable drain pan should be installed under the boiler. Drain pans should be fabricated with sides at least 2½ inches deep, with length and width at least 2 inches greater than the dimensions of the boiler. The drain pan must be piped to an adequate drain and must not restrict combustion air flow.

Installation Clearances

Sufficient area should be provided at the front and sides of the unit for proper servicing. For ease of service, minimum clearances of 24 inches in the front and 18 inches on the water connection side are recommended.

Please note that the minimum clearances shown are the certified minimum clearances. Whenever possible, additional space is recommended. Genesis boilers are approved for installation on noncombustible flooring in an alcove with minimum clearance to combustibles. For installation on combustible flooring, see Chapter 2 Special Situations.

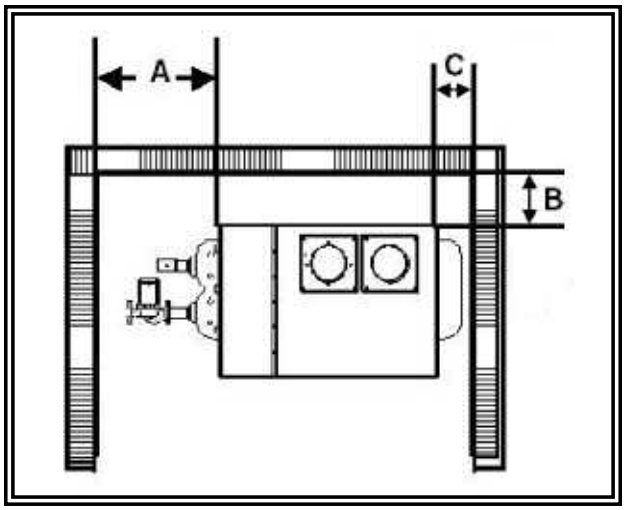


Figure 1-2

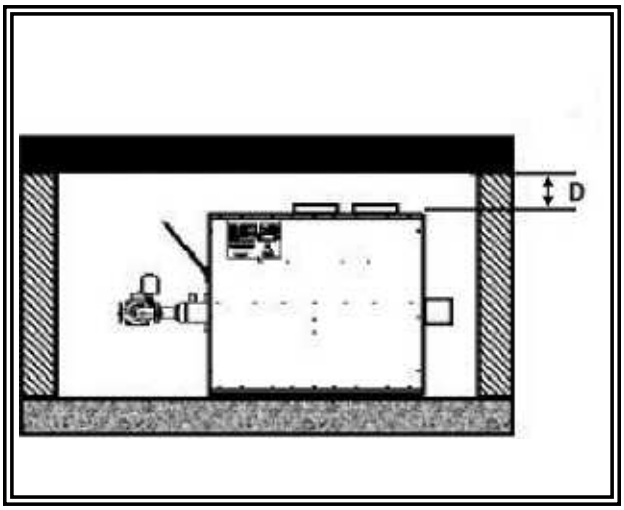


Figure 1-3

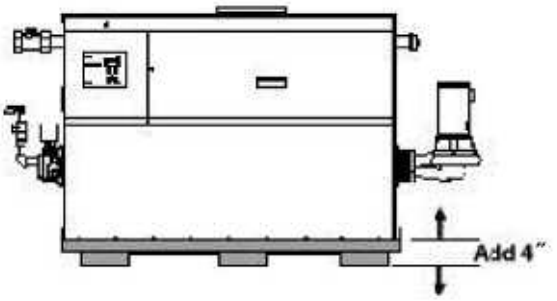
(Table A) Minimum Clearances to Combustibles

Clearances	Location Figure 2 & 3	Models GB/GW-400 - 750	Models GB/GW-1000 - 2500
Left Side	A	3" (18" for Service)	12" (18" for Service)
Rear	B	3"	3"
Right Side	C	3"	3"
Top	D	3"	6"
Front		Alcove (24" for Service)	Alcove (24" for Service)
Vent		6"	6"
Hot Water Pipes		2"	2"

CHAPTER 2. SPECIAL SITUATIONS

Installation on Combustible Flooring

For installation on combustible flooring, use the Combustible Floor Shield Kit. The combustible floor kit base adds 4˝ to the overall height of the boiler. See Figure 2-1. (See Table B for kit part #).



Genesis on Combustible Floor Shield

Outdoor Units

A. O. Smith Genesis boilers are approved for outdoor installation ONLY with approved outdoor kits. Outdoor units require additional considerations that will not be fully discussed in this engineering and design manual. Please see the Instruction Manual for full details. Only primary issues are addressed below.

Primary Outdoor Issues:

The outdoor boiler cannot be installed directly on the ground. The boiler must be installed on a concrete pad. The concrete pad must be at least 12 inches larger than the boiler footprint on all four sides of the boiler.

For rooftop installations use the combustible floor base (see Figure 2-1 and Table B for kit part #).

- An outdoor model Genesis boiler should not be located in an area where high winds can cause a down draft by rolling off walls, buildings, shrubbery, inside corners, or roof overhangs. The boiler should be a minimum of 6 feet away from such structures if high winds are prevalent in the area.

Table B - Combustible Floor Shield Kit #

Model #	A.O. Smith Part #
GB-300	9500007275
GB-400	210202-002
GB-500	9003670001
GB-650	210202-004
GB-750	9500007276
GB-1000	211093-000
GB-1300	211093-001
GB-1500	211093-002
GB-1850	211093-003
GB-2100	211093-004
GB-2500	211093-005

- Outdoor units should never be installed under roof overhangs where water from the roof can fall directly on the unit. Install at least 3 feet away from the drip line of the roof overhang.

- Special considerations apply in areas where freezing temperatures are encountered. Genesis boilers in hydronic heating applications must use a glycol mixture. In addition, for Genesis boilers used in a potable domestic hot water application, the boiler pump delay setting must be set to “constant run.”

Note: If any potable domestic hot water heating system must be shut down for service during cold weather, shut off the water supply, then drain the boiler, piping, and pump. Additional freeze protection measures such as automatic drain systems should also be considered.

CHAPTER 3. COMBUSTION AIR

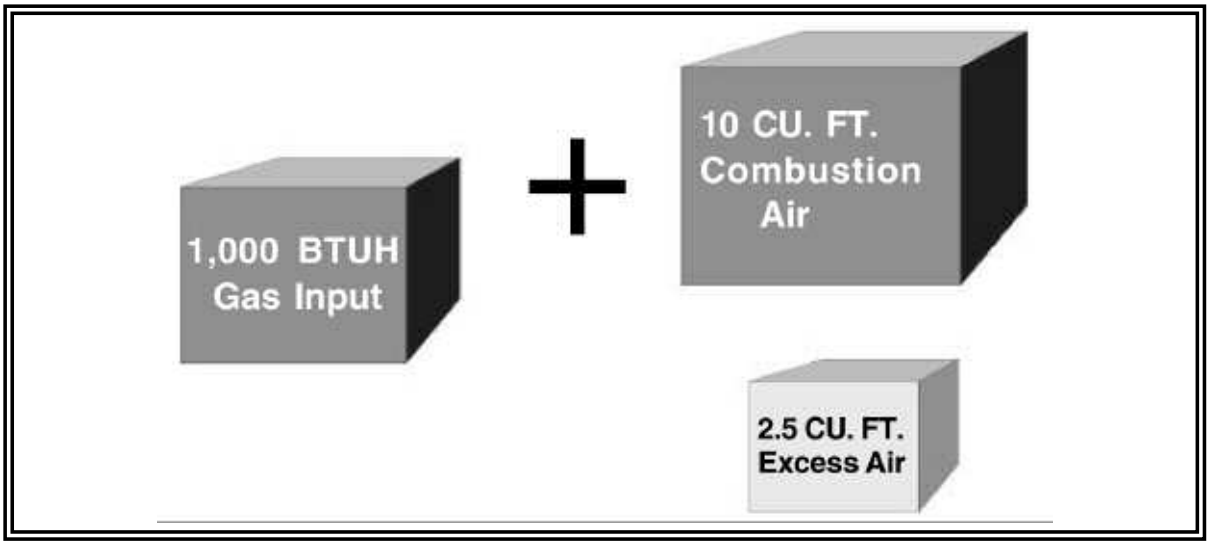


Figure 3-1 Combustion Air

Combustion Air

Complete combustion requires 10 cubic feet of air per 1000 BTU per hour gas input. The National Fuel Gas Code also recommends an additional 2.5 cubic feet of "excess" air. This 12.5 cubic feet of make-up air per 1000 BTU per hour gas input is the recommended minimum combustion air supply required to ensure complete combustion for natural and propane gas equipment. (See Figure 3-1).

The National Fuel Gas Code specifies minimum make-up air opening sizes for various building installations. (Ref: NFPA 54/ANSI Z223.1, sec. 5.3 or CAN/CSA B149.1-00).

Sizing Combustion Air Louvers

To calculate the free area of a vent opening, the blocking effect of screens, louvers, and grilles should be considered. Screens shall not be of mesh smaller than 1/4-inch square. If the free area is not known, the current edition of the National Fuel Gas Code ANSI Z223.1 recommends using figures of 20-25 percent free area for wood louvers, or 60-75 percent for metal grilles or louvers.

Combustion Air and the Genesis Boiler

When installing the Genesis in an area of tight construction or within a "confined" air space (less than 50 cubic feet of volume per 1,000 BTU/H of the total input rating of all appliances installed in that space), adequate combustion air must be supplied to the boiler. The following information from NFPA 54, ANSI Z223.1, 1996, Sec., 5.3 explains various methods of meeting the minimum air requirements for these installations.

Air for Combustion (Through the Wall)

The Genesis is installed as a Category I appliance when it is vented vertically and is using boiler room air for combustion. (Can use standard type “B” vent material when installed in this configuration.) A fresh supply of make-up air for combustion can be supplied to the boiler through make-up air ducts which directly communicate with the outdoors. Two openings are required: one within 12 inches of the top of the enclosure and one within 12 inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

Figure 3-2 Air for Combustion (Through the Wall)

The lower opening is primarily providing combustion air. The upper opening is providing vent dilution air and acts as a relief opening for flue gases in the event that the vent becomes obstructed or a downdraft condition occurs.

Air for Combustion (Vertical Ducts)

Figure 3-3 Air for Combustion (Vertical Ducts)

Often it is more practical to install vertical make-up air ducts, as shown in Figure 3-3, to the outdoors. Again, two openings are required: one within 12 inches of the top of the enclosure and one within 12 inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

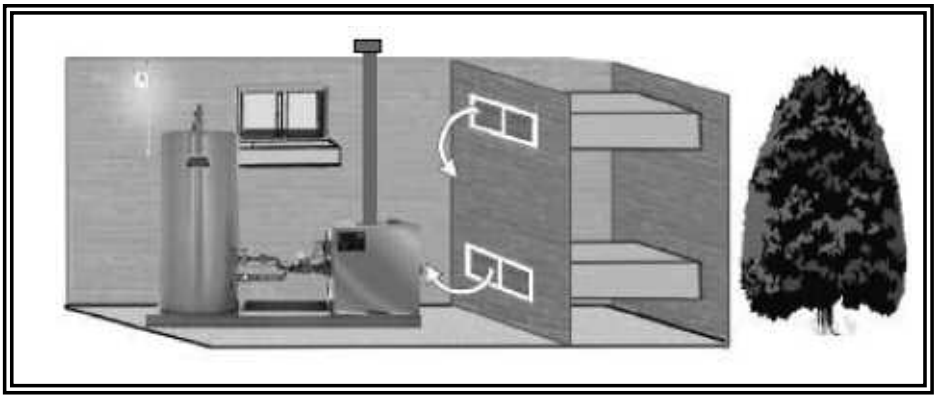


Figure 3-4 Air for Combustion (Horizontal Ducts)

Air for Combustion (Horizontal Ducts)

When the boiler is installed in an interior room with no roof access for vertical ducts, horizontal make-up air ducts should be installed. When using horizontal ducts, two openings are required: one within 12 inches of the top of the enclosure and one within 12 inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 2000 BTUH of the total input of all appliances within the enclosure.

Alternate Air for Combustion

Figure 3-5 Alternate Air for Combustion (Through the Wall)

Since the release of the 1996 edition, the National Fuel Gas Code has allowed a second method of supplying air for combustion using a single opening. This method uses a smaller opening and is intended to help prevent freeze damage to boiler room piping.

Alternate Air for Combustion (continued)

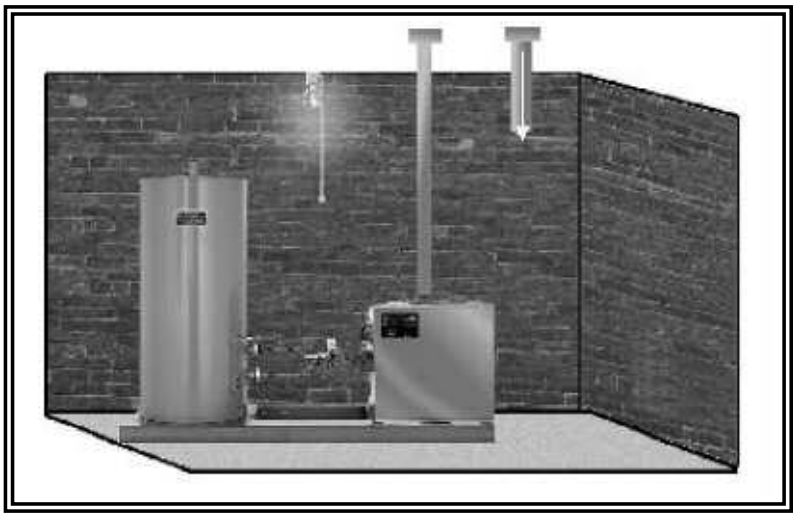


Figure 3-6 Alternate Air for Combustion (Vertical Duct)

One permanent opening, commencing within 12 inches (30 cm) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 inch (2.5 cm) from the sides and back and 6 inches (16 cm) from the front of the appliance. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and shall have a minimum free area of:

- 1 square inch per 3000 BTU/H (7cm^2 per kW) of the total input rating of all equipment located in the enclosure, and
- not less than the sum of the cross sectional areas of all vent connectors in the confined space.

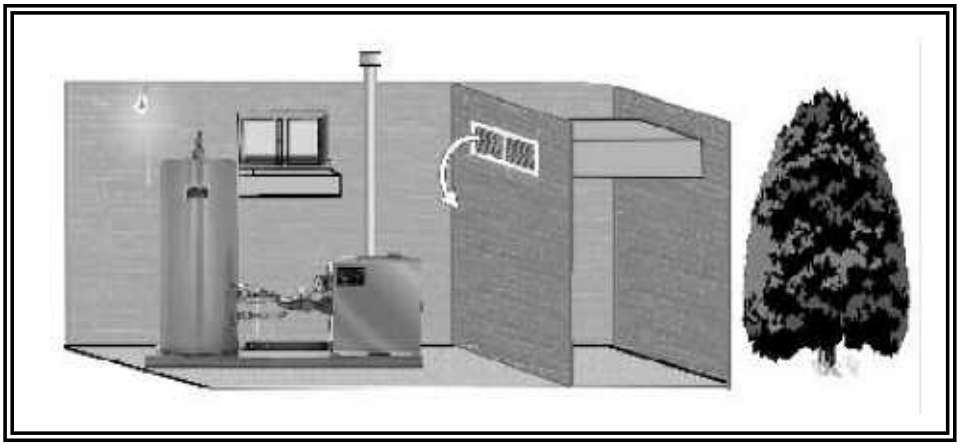


Figure 3-7 Alternate Air for Combustion (Horizontal Duct)

CHAPTER 4. SPECIAL PROBLEMS – COMBUSTION AIR

Boiler Room Exhaust Fans

Insufficient make-up air is a major cause of combustion problems. One common example is a mechanical room where exhaust vent equipment was not considered in sizing make-up air requirements. This may result in air being pulled down the exhaust vent of the Genesis causing flue gas spillage, flame roll out, improper combustion (sooting), and/or erratic boiler shut down.

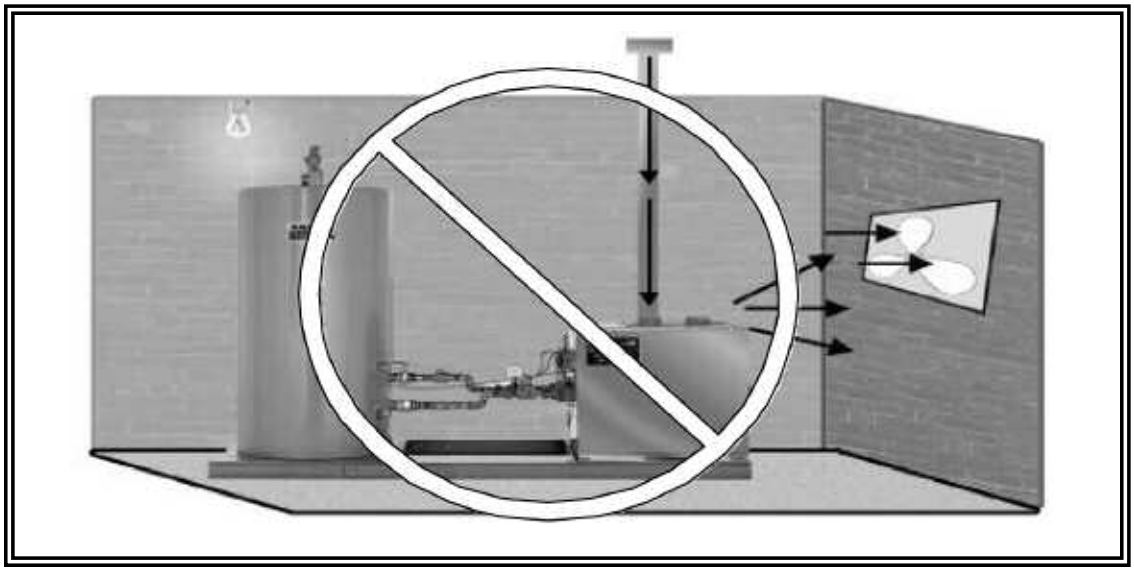


Figure 4-1 Boiler Room Exhaust Fans

Contaminated Combustion Air

The quality of the combustion air is important in all applications, including those involving direct venting. Contaminants in combustion air can lead to premature boiler failure. Vapors from bleaches, soaps, waxes, salts, freon, (See Figure 4-2) etc. are drawn into the combustion chamber with the make-up air and, once fired, mix with water vapor in the gases to form extremely corrosive hydrochloric or hydrofluoric acid and other corrosive by-products.

Figure 4-2

Flammable Items

Flammable items, pressurized containers or any other potentially hazardous articles must not be placed on or adjacent to the boiler. Open containers of flammable material should not be stored or used in the same room with the boiler.

CHAPTER 5. VENTING SECTION

General Venting Information

The Genesis boiler is a fan-assisted appliance, that offers many different venting and combustion make-up air options and methods. It has a sealed combustion chamber and can be installed as a true Category III Direct Vent Appliance. However, the Genesis unit can also be installed in less stringent Category I configurations. Whatever the configuration, you must understand the following definitions in order to properly specify the venting and combustion make-up air requirements for a particular application.

Definitions:

Fan Assisted Combustion

- A fan-assisted combustion appliance is one which has a fan-assisted burner.
- A fan-assisted burner is defined as: "a burner which uses either induced or forced draft."
- A draft hood appliance can only be a Category I appliance, while an appliance with a fan-assisted burner may fall into any of the four categories.

Gas Appliance Venting Categories Defined:

- Category I - A non-condensing gas appliance that operates with a non-positive vent pressure.
- Category II - A condensing gas appliance that operates with a non-positive vent pressure.
- Category III - A non-condensing gas appliance that operates with a positive vent pressure.
- Category IV - A condensing gas appliance that operates with a positive vent pressure.

Genesis Venting Categories and Venting Materials

The Genesis boiler operates at an efficiency of 83.7% (rounded to 84%), the highest efficiency possible in a non-condensing boiler. At 83.7%, the Genesis is operating near the threshold of condensing. When vented vertically, the natural draft and natural buoyancy of the hot flue gases move the flue gases up the vent rapidly before the gases can condense in the vent. This allows the use of standard Type "B" venting material.

However, when venting the unit horizontally, and without the aid of a natural draft, the flue gases move more slowly providing additional time for the flue gases to cool, increasing the likelihood of flue gases condensing in the vent. Therefore, when venting mid-efficiency boilers, (such as the Genesis) horizontally, AL29-4C stainless steel venting material must be used to prevent damage from corrosive condensate building up in the vent. Such buildup in non-approved vent piping will potentially result in deadly flue gases leaking into the building or facility.

Genesis venting will fall into one of the four configurations as shown on Table C.

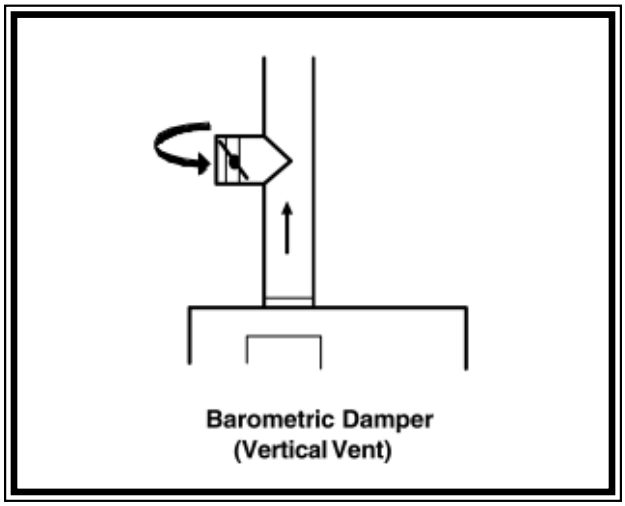
(Table C) Genesis Vent Categories and Materials

Source of Combustion Air	Venting Configuration	Certified Venting Category	Approved Venting Meterial	Approved Combustion Air
Using Boiler Room Air (Non - Direct Vent)	Vertical Venting Natural Draft	Category I	Type "B" or Equivalent	None
	Horizontal Sidewall Venting	Category III	AL29-4C Stainless Steel (Gas Tight)	
Using Outdoor Air Piped Directly to the Boiler (Dirct Vent)	Vertical Venting	Category I	Type "B" or Equivalent	PVC, ABS, CPVC, Galvanized Steel
	Horizontal Sidewall Venting	Category III	AL29-4C Stainless Steel (Gas Tight)	

Genesis Boiler Category I Venting

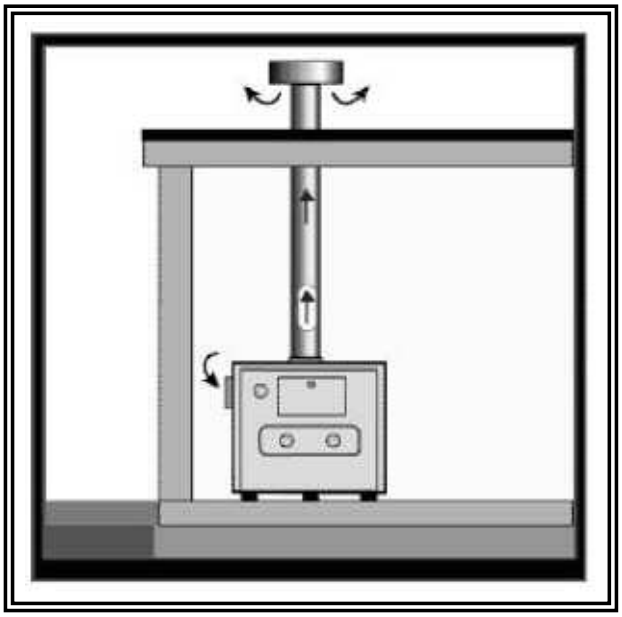
Single Unit

The Genesis boiler uses fan assisted combustion. When sizing the vent for a Genesis boiler in a natural draft vertical vent system, use the "Fan" columns in the venting tables (see pages 31-35). A single Genesis boiler may be vented vertically up to 35 feet without a barometric damper. Over 35 vertical feet a barometric damper is required. A barometric damper is also required if the draft in the vent exceeds negative 0.05 inches water column (W.C.). Adjust the barometric damper to maintain between negative 0.02 inches and negative 0.05 inches water column (W.C.). See Figure 5-1.



When retrofitting and venting the Genesis boiler through an oversize metal or masonry chimney, additional care must be exercised. As always, a minimum draft of negative 0.02 inches W.C. and a maximum draft of negative 0.05 inches W.C. must be maintained. This draft should be measured 2 feet above the boiler vent collar.

Natural Draft Vertical Venting Using Boiler Room Air for Combustion (Category I)



Genesis is using
Boiler Room Air
For Combustion

Figure 5-2 - Natural Draft Vertical Venting

(Table D) Genesis Natural Draft Vertical Vent

Model #	Vent Size (Inch)	Certified Venting Category	Approved Venting Material	Max. Distance W/O Barometric Damper / With Barometric
GB/GW-300	5	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-400 thru GB/GW-500	6	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-650 thru GB/GW-750	8	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-1000	10	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-1300 thru GB/GW-1500	12	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-1850 thru GB/GW-2100	14	Category I	Type "B" or Equivalent	35' / To Roof
GB/GW-2500	16	Category I	Type "B" or Equivalent	35' / To Roof

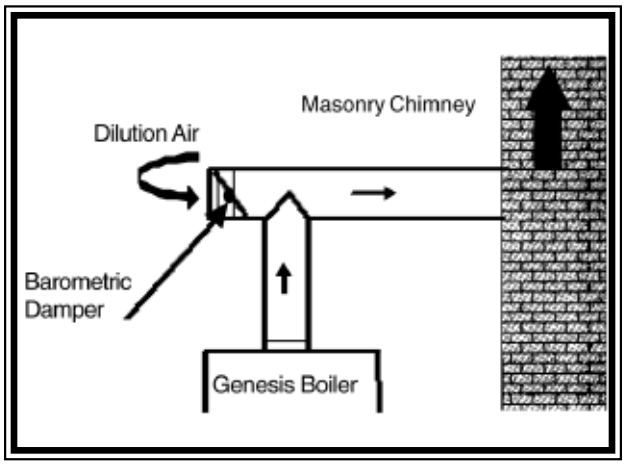


Figure 5-3 - Masonry Chimney

Masonry Chimneys - Atmospheric Draft

A masonry chimney must be properly sized for the installation of any gas fired appliance. Exterior masonry chimneys with one or more sides exposed to cold outdoor temperatures are more likely to have venting problems. The temperature of the flue products from a mid efficiency appliance may not be able to sufficiently heat the masonry structure of the chimney to generate proper draft. This will result in condensing of flue products, damage of the masonry flue tile, insufficient draft, and possible spillage of flue products into an occupied living space.

Very tall and or large chimneys may have excessively high and hard to control draft, resulting in poor combustion, nuisance control lockouts, overheating of the combustion chamber, and premature boiler failure.

Carefully inspect all chimney systems during the project design phase. If there is any doubt about the sizing or condition of a masonry chimney, reline the chimney with a properly sized and approved chimney liner system. Metal liner systems Type "B" double wall or flexible metallic liners are recommended. Consult with local code officials to determine code requirements.

Category I Common Venting Multiple Units

When common venting multiple Genesis boilers, barometric dampers will be required at each unit to regulate the draft. The negative draft must be within the range of negative 0.02 inches W.C. to negative 0.05 inches of W.C. to ensure proper draft and good boiler operation. It is recommended that a barometric damper be installed in the vent connector between the boiler vent outlet and the main breeching. (See Figure 5-4).

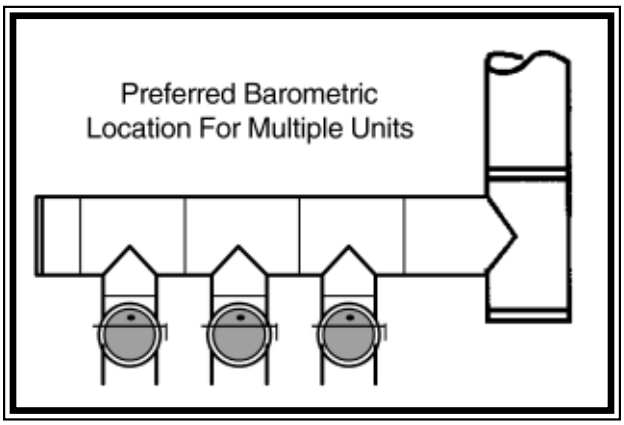


Figure 5-4 - Multiple Units Preferred Method

If ceiling heights are restricted and it is not possible to install the barometric damper in the vent connector, install a barometric damper in the breeching between each appliance as shown in Figure 5-5.

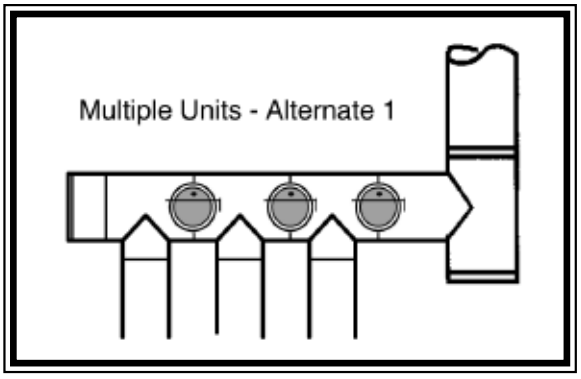


Figure 5-5

If it is not possible to install individual barometric dampers as previously discussed then install a single large barometric damper equal to the main breeching. This large barometric damper must be installed between the last appliance in the vent and the chimney see Figure 5-6.

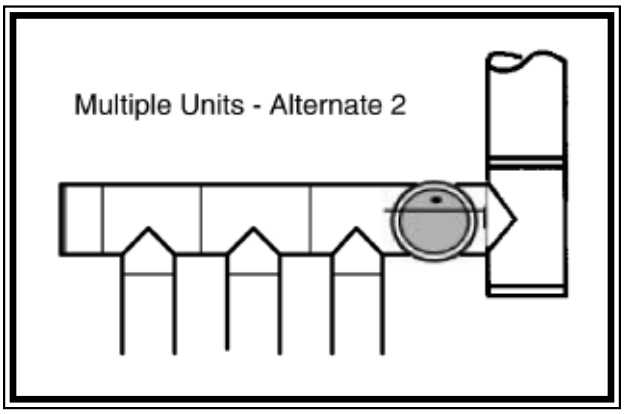


Figure 5-6

Common Venting Genesis Boilers When Using A Stack-Rack

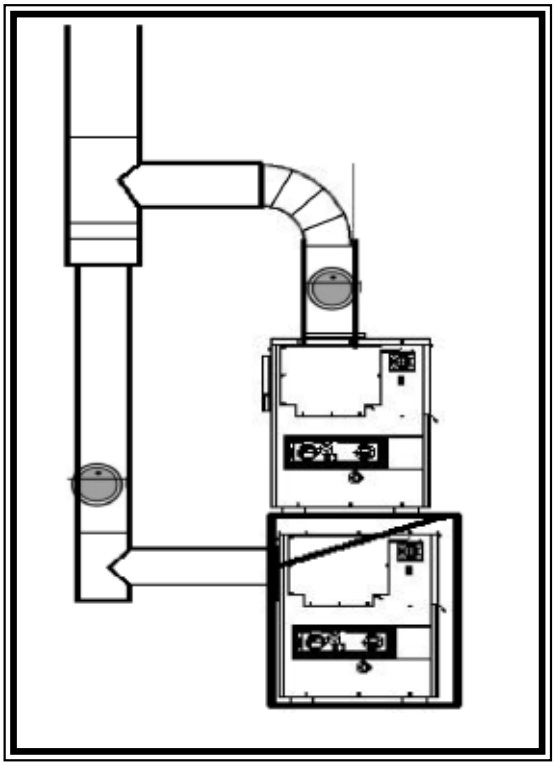


Figure 5-7
Genesis Stack-Rack Venting Configuration

For proper common vent size, see Table E on page 20.

Quick Sizing Table for Stack-Rack Vent Sizing

(Table E) Stack-Rack Common Vent Sizes					
Model #	#of Boiler	Combined BTUH	Boiler Vent	Common Vent Pipe	Overall Vent Min Feet / Max
GB-300	2	600,000	5"	10"	6' / 20'
				8"	Over 20'
GB-400	2	798,000	6"	12"	6' / 10'
				10"	Over 10'
GB-500	2	1,000,000	6"	14"	6' / 10'
				12"	Over 10'
GB-650	2	1,300,000	8"	16"	6' / 8'
				14"	Over 8'
GB-750	2	1,500,000	8"	16"	6' / 10'
				14"	Over 10'
GB-1000	2	2,000,000	10"	18"	6' / 10'
				16"	Over 10'
GB-1300	2	2,600,000	12"	20"	6' / 10'
				18"	Over 10'
GB-1500	2	3,000,000	12"	22"	6' / 8'
				20"	Over 8'
GB-1850	2	3,700,000	14"	24"	6' / 8'
				22"	Over 8'
GB-2100	2	4,200,000	14"	24"	6' / 10'
				22"	Over 10'
GB-2500	2	5,000,000	16"	24"	Over 10'

Category I Natural Draft Vertical Vent Termination

The vent terminal should be vertical and exhaust outside the building at least 3 feet (0.9m) above the highest point of the roof within a 10-foot (3.05m) radius. Vertical terminations must be a minimum of 3 feet (0.9m) above the roofline and when less than 10 feet (3.05m) from a parapet wall must be a minimum of 3 feet (0.9m) higher than the parapet wall, see Figure 5-8. Vent caps should have a minimum clearance of 4 feet (1.2m) horizontally from, and in no case be located above or below electric meters, gas meters, regulators, and gas relief equipment. Maintain a distance at least 3 feet (0.9m) above any forced air inlet within 10 feet (3.05m) and a distance of at least 4 feet (1.2m) below, 4 feet (1.2m) horizontally from, or 1 foot (30cm) above any door, window or gravity air inlet. The bottom of the vent terminal shall be located at least 12 inches (30cm) above anticipated snow line.

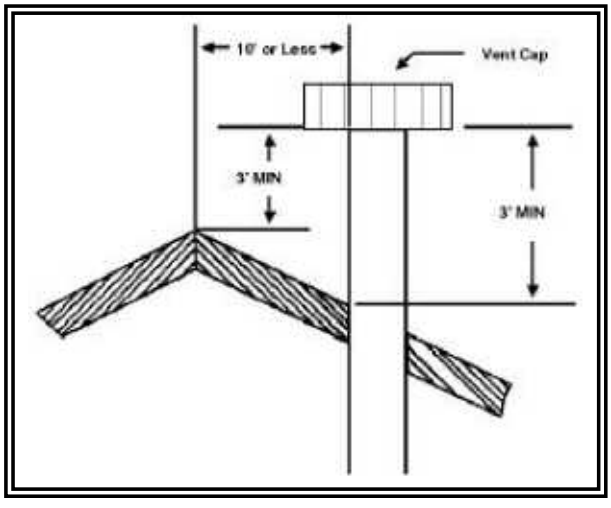


Figure 5-8

Category I Vertical Venting
(Two Pipe System Using Outdoor Air)

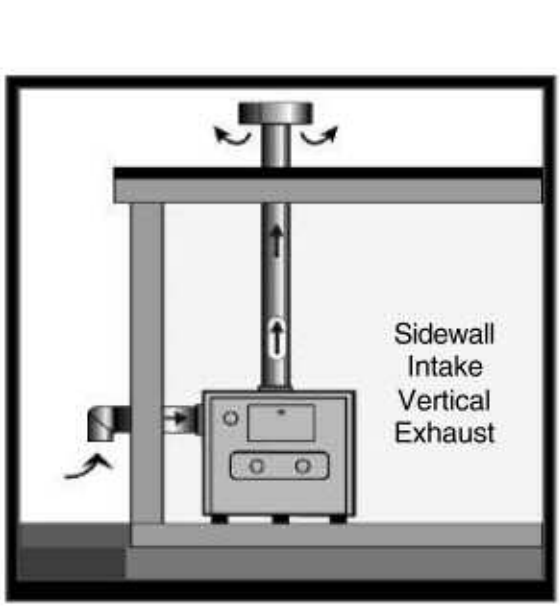


Figure 5-9

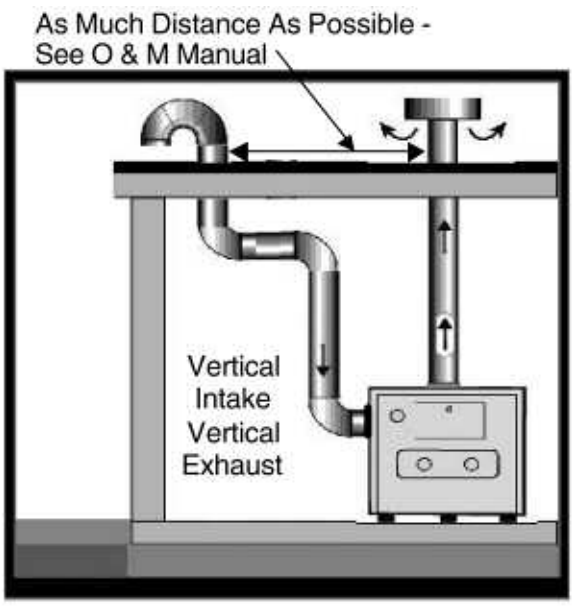


Figure 5-10

(Table F) Vertical Direct Vent							
Model #	Vent Size (Inch)	Certified Venting Category	Approved Venting Material	Max. Equivelent Feet of	Combustion Air Intake Pipe Size	Approved Combustion Air Intake	Max. Equivelent Feet of
GB-300	5	Category I	Type "B" or	60'	5	Galvanized	60'
GB-400 thru	6	Category I	Type "B" or	35'	6	Galvanized	35'
GB-650 thru	8	Category I	Type "B" or	35'	8	Galvanized	35'
GB-1000	10	Category I	Type "B" or	35'	8	Galvanized	35'
GB-1300 thru	12	Category I	Type "B" or	35'	10	Galvanized	35'
GB-1850	14	Category I	Type "B" or	20'	10	Galvanized	20'
GB-2100	14	Category I	Type "B" or	20'	12	Galvanized	20'
GB-2500	16	Category I	Type "B" or	20'	12	Galvanized	20'

Notes:
90° elbows = 10 equivalent feet of piping.
45° elbows = 5 equivalent feet of piping.

Category I Vertical Direct Venting (Two Pipe System Using Outdoor Air)

The Genesis boiler can be vertically direct vented. These direct vent systems utilize the boiler-mounted blower to draw combustion air directly from the outdoors through the air intake vent and use the natural buoyancy of the heated flue gases and the natural draft of the vertical vent to exhaust flue gases through the exhaust vent directly to the outdoors. When venting single boiler installations with a dedicated stack, and not exceeding the maximum distances shown in Table F no barometric damper is required in the exhaust vent.

Vent distances can exceed those shown in Table F if a barometric damper is used and a negative draft is maintained between negative 0.02 inches W.C. to negative 0.05 inches W.C (see Figure 5-1) Barometric Damper. However, in no case can the combustion air intake piping distances exceed those shown in Table F.

Common vented multiple boiler installations require that each boiler must have a barometric damper and a negative draft of negative 0.02 inches W.C. to negative 0.05 inches W.C must be maintained (see Figures 5-4 thru 5-6) Barometric Dampers. The common vent and connectors from multiple boilers must be sized per the requirements of the venting tables for Type B double wall vents in the latest edition of the National Fuel Gas Code, ANSI Z223.1 or CAN/CSA B149.1-00. See Category I Common Venting Multiple Units on Page 18. (Also see Vent Tables Pages 34 and 35).

The direct venting method eliminates the need for combustion air intake louvers or ducts in the boiler room wall. Often direct venting is preferred in very cold climates where combustion air louvers, which communicate directly with the outdoors, pose a freezing danger to the boiler room piping and other boiler room equipment. Combustion air can be acquired from the sidewall or from the roof whichever is nearest. See Table F for maximum combustion air intake piping distances.

In cold climate areas, the use of PVC or Type "B" double wall piping as a combustion air intake piping material will limit the accumulation of condensation on the exterior walls of the piping.

The combustion air inlet terminal has been tested and certified in 40 miles per hour winds. In

(Table G) Combustion Air Intake

Model #	Combustion Air Intake Pipe Size (Inch)	A.O. Smith Part #
GB-300	5	9005282205
GB-400/500	6	9005280205
GB-650/750/1000	8	9005281205
GB-1300/1500/1850	10	9005337205
GB-2100/2500	12	9005338205

accordance with CSA, A. O. Smith must supply this approved combustion air inlet terminal fitting. See Table G for the Approved Inlet Termination Kit #.

Meeting Special State and Local Codes Requiring Direct Vent Sealed Combustion

As noted in the previous Vertical Direct Venting Section, when venting the Genesis boiler in a vertical venting configuration the natural draft provides a negative category I vent that generally allows the use of type “B” vent pipe for most applications. However, some local and state codes require Direct Vent Sealed Combustion when meeting certain boiler room fire ratings and construction requirements. One such state is Wisconsin.

Genesis boilers have sealed combustion chambers and meet the requirements of these codes when gas tight venting material and air tight combustion air intake piping is used. To meet these special code requirements all venting material must be AL29-4C stainless steel gas tight venting material and all combustion air intake piping must be PVC with all joints glued and sealed. The venting distances for this direct vent sealed combustion configuration are the same as those shown in (Table F) only the venting and combustion air piping materials change. Common venting in this configuration is not allowed.

Code requires that the manufacturer supply the combustion air intake and exhaust vent terminations. Table G2 provides the part numbers for the Vertical Direct Vent Kits.

Table G2 Vertical Direct Venting Kits

Model #	Vent Outlet Pipe Size (Inch)	Combustion Air Inlet Pipe Size (Inch)	A.O. Smith Part #
GB-300	**5**	**5**	**9003671001**
GB-400/500	**6**	**6**	**9003671002**
GB-650/750	**8**	**8**	**9003671003**
GB-1000	10	8	9003679000
GB-1300/1500	12	10	9003679001
GB-1850	14	10	9003679004
GB-2100	14	12	9003679002
GB-2500	16	12	9003679003

Category III One Pipe Sidewall Venting Using Boiler Room Air

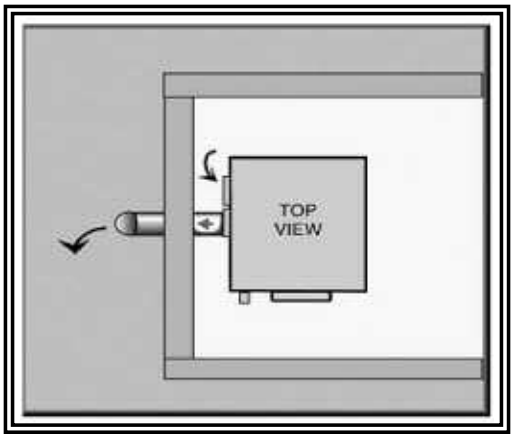


Figure 5-11

(Table H) Single Pipe Sidewall Venting				
Model #	**Vent Size (Inch)**	**Certified Venting Category**	**Approved Venting Material**	**Max. Equivelent Feet of Vent**
GB-300	**5**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**110'**
GB-400 thru GB-500	**6**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**50'**
GB-650 thru GB-750	**8**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**50'**
GB-1000	**10**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**70'**
GB-1300 thru GB-1500	**12**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**70'**
GB-1850 thru GB-2100	**14**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**40'**
GB-2500	**16**	**Category III**	**AL29-4C Stainless Steel (Gas Tight)**	**40'**

Notes: 90° elbows = 10 equivalent feet of piping.
45° elbows = 5 equivalent feet of piping.
For distances greater than those shown: See extended venting section.

Category III One Pipe Sidewall Venting Using Boiler Room Air

When venting the Genesis boiler horizontally in a Category III configuration AL29-4C, stainless steel exhaust vent material must be used to prevent the corrosive condensate from damaging the venting. A condensate tee and drain line must be installed in the horizontal run of the vent as close to the boiler as possible in order to drain the condensate. See Figure 5-12. For locating the vent termination, see page 29 "Locating Exhaust and Combustion Air Terminations."

The A. O. Smith exhaust vent termination is the only AGA/CGA approved termination for the Genesis boiler. The kits include exhaust vent termination, condensate tee, and condensate drain tubing. This exhaust vent terminal has been tested and certified in 40 mph winds. See Table I.

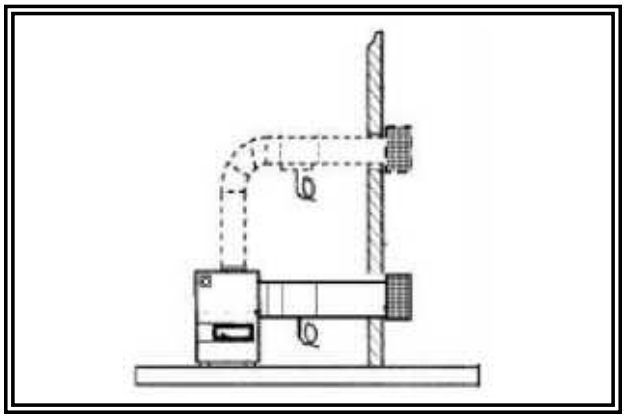


Figure 5-12

Category III Horizontal Two Pipe Direct Vent using Outdoor Air

When venting the Genesis boiler in a two-pipe direct vent application using outdoor air (See Figures 5-13 & 5-14), use Table J to select the approved direct vent kit. These kits include the appropriate exhaust vent terminal, the PVC ell

(Table I) Sidewall Vent Kit

Model #	Vent Outlet Pipe Size (Inch)	A.O. Smith Part #
GB-300	5	9003672001
GB-400/500	6	9003672002
GB-650/750	8	9003672003
GB-1000	10	9003682000
GB-1300/1500	12	9003682001
GB-1850/2100	14	9003682002
GB-2500	16	9003682003

(Table J) Horizontal Direct Venting Kits

Model #	Vent Outlet Pipe Size (Inch)	Combustion Air Inlet Pipe Size	A.O. Smith Part #
GB-300	5	5	9003672001
GB-400/500	6	6	9003672002
GB-650/750	8	8	9003672003
GB-1000	10	8	9003680002
GB-1300/1500	12	10	9003680000
GB-1850	14	10	9003680001
GB-2100	14	12	9500007282
GB-2500	16	12	9500007283

Category III Horizontal Two Pipe Direct Vent using Outdoor Air

intake vent terminal with screen, the condensate tee and drain with tubing. The exhaust vent and combustion air terminals have been tested and certified in 40 mph winds. See Table K for approved material and maximum venting and combustion air intake distances. For locating the exhaust vent and combustion air intake terminations, see page 29 "Locating Exhaust and Combustion Air Terminations."

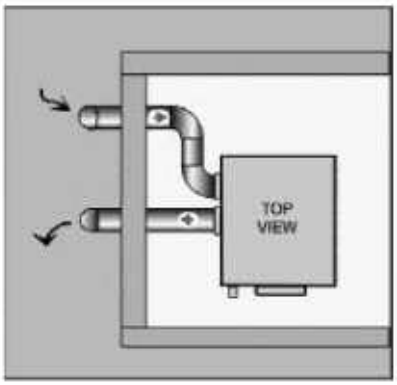


Figure 5-13

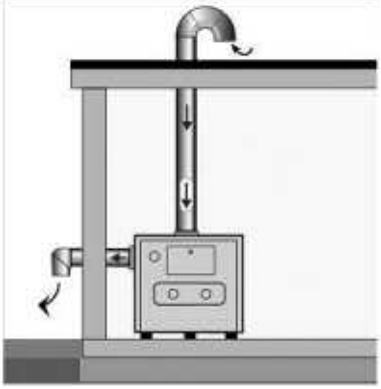


Figure 5-14

Table K Horizontal Direct Venting (Two Pipe System)

Model #	Vent Size (Inch)	Certified Venting Category	Approved Venting Material	Max. Equivalent Feet of	Combustion Air Intake Pipe Size	Approved Combustion Air Intake	Max. Equivalent Feet of
GB-300	5	Category III	AL29-4C Stainless	60´	5	Galvanized Steel, PVC,	60´
GB-400 thru GB-500	6	Category III	AL29-4C Stainless	35´	6	Galvanized Steel, PVC,	35´
GB-650 thru GB-750	8	Category III	AL29-4C Stainless	35´	8	Galvanized Steel, PVC,	35´
GB-1000	10	Category III	AL29-4C Stainless	35´	8	Galvanized Steel, PVC,	35´
GB-1300 thru GB-1500	12	Category III	AL29-4C Stainless	35´	10	Galvanized Steel, PVC,	35´
GB-1850	14	Category III	AL29-4C Stainless	20´	10	Galvanized Steel, PVC,	20´
GB-2100	14	Category III	AL29-4C Stainless	20´	12	Galvanized Steel, PVC,	20´
GB-2500	16	Category III	AL29-4C Stainless	20´	12	Galvanized Steel, PVC,	20´

Notes: 90° elbows = 10 equivalent feet of piping.
45° elbows = 5 equivalent feet of piping.

For distances greater than those shown:
See extended venting section.

Category III Extended Horizontal Sidewall And Direct Venting (Power Assist)

Horizontal sidewall and horizontal direct venting distances can be increased with the use of a power venter (See Figures 5-15 & 5-16). This is very helpful when boiler/equipment rooms are not located near an outside wall, or when venting distances must be increased to avoid obstacles such as windows and doors. The power venter interlocks with the boiler blower. This allows the power venter to cycle with the boiler blower for pre-purge and post-purge operations. The power venter includes an additional blower prover switch mounted directly on the power venter, interlocking with the boiler safety switch. Should the power venter fail or the vent become blocked, this prover switch ensures that the boiler will not ignite. The power venter mounts on the inside of the exterior wall. All blowers and fans make some noise. When selecting the vent termination location, select a termination site where blower noise poses the least problem. For locating the exhaust vent and combustion air intake terminations. See page 29 “Locating Exhaust and Combustion Air Terminations.”

See Tables L and M for extended horizontal sidewall and horizontal direct venting kits. Table L and M also show maximum extended venting distances.

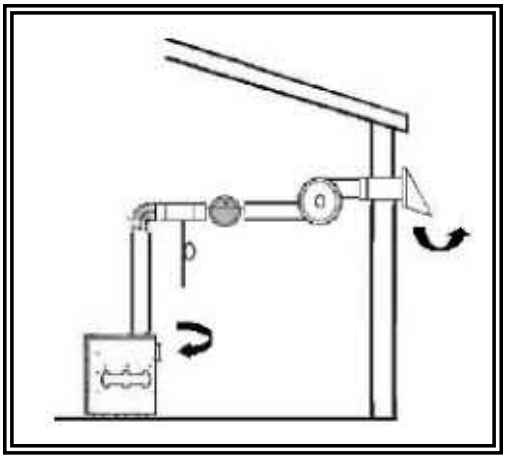


Figure 5-15 Extended Sidewall Venting

See Table L for Extended Sidewall Venting

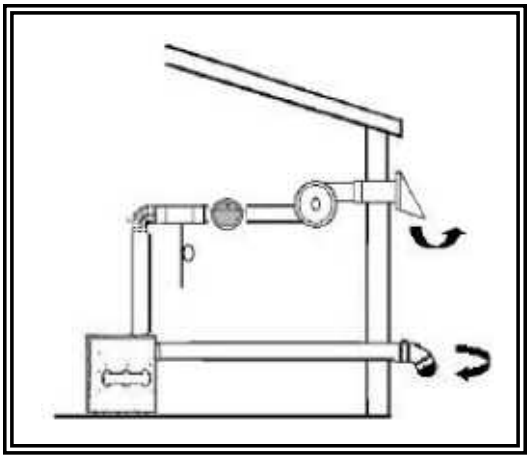


Figure 5-16 Extended Horizontal Direct Venting

See Table M for Extended Horizontal Direct Venting

Extended Horizontal Sidewall Venting

(Table L) Extended Horizontal Sidewall Venting

Model #	Vent Outlet Size	Vent Pipe Size	Max. Equivalent Feet of Vent	Certified Venting Category	Approved Venting Material	A.O. Smith Sidewall Venting Kit
GB-300	5	5	110	Category III	AL29-4C Stainless Steel	No Kit
GB-400, 500	6	6	110	Category III	AL29-4C Stainless Steel	9003675000
GB-650, 750	8	6	110	Category III	AL29-4C Stainless Steel	9003675000
GB-1000	10	10	110	Category III	AL29-4C Stainless Steel	9003683000
GB-1300, 1500	12	8	100	Category III	AL29-4C Stainless Steel	9003683002
GB-1850	14	10	100	Category III	AL29-4C Stainless Steel	9003683003
GB-2100	14	10	100	Category III	AL29-4C Stainless Steel	9006168205
GB-2500	16	10	100	Category III	AL29-4C Stainless Steel	9003683001

Extended Horizontal Direct Venting

(Table M) Extended Horizontal Direct Venting

Model #	Vent Outlet Size	Vent Pipe Size	Max. Equivalent Feet of	Certified Venting Category	Approved Venting Material	Combustion Air Inlet Pipe	Approved Combustion Air Inlet	A.O. Smith Sidewall
GB-300	5	5	60'/60'	Category III	AL29-4C Stainless	5	Galvanized Steel, PVC,	No Kit Require
GB-400, 500	6	6	60'/60'	Category III	AL29-4C Stainless	6	Galvanized Steel, PVC,	9003675000
GB-650, 750	8	6	60'/60'	Category III	AL29-4C Stainless	8	Galvanized Steel, PVC,	9003675000
GB-1000	10	10	60'/60'	Category III	AL29-4C Stainless	8	Galvanized Steel, PVC,	9003683000
GB-1300, 1500	12	8	60'/60'	Category III	AL29-4C Stainless	10	Galvanized Steel, PVC,	9003683002
GB-1850	14	10	60'/60'	Category III	AL29-4C Stainless	10	Galvanized Steel, PVC,	9003683003
GB-2100	14	10	60'/60'	Category III	AL29-4C Stainless	12	Galvanized Steel, PVC,	9006168205
GB-2500	16	10	60'/60'	Category III	AL29-4C Stainless	12	Galvanized Steel, PVC,	9003683001

Notes: 90° elbows = 10 equivalent feet of piping.
45° elbows = 5 equivalent feet of piping.

Locating Exhaust and Combustion Air Terminations

Special Vent Terminal Location Considerations

When terminating a boiler vent on an outside wall of a building or structure, it is essential to give special attention to the location of the vent termination so as to avoid the possibility of property damage or personal injury. Considerations in locating Genesis horizontal vent terminations.

- **Vapor Cloud** - The Genesis operates at efficiencies close to condensing. Flue gases may form a white vapor plume in cold weather, possibly obstructing a window view or entryway if the termination is installed in close proximity to windows and doors.
- **Recirculating Flue Gases** - Direct venting into dead air spaces such as alleys, atriums, and inside corners may cause recirculation of flue gases, resulting in sooting, premature failure of the heat exchanger, and icing of the combustion air intake during severe cold weather. To prevent the recirculation of flue gases, maintain as much distance as possible between the combustion air intake and the exhaust vent terminal.
- **Public Walkways** - Due to normal formation of water vapor in the combustion process, horizontal terminations must not be located over areas of pedestrian or vehicular traffic, or above gas meters or electric disconnect boxes where condensate could create a nuisance or hazard. In colder climates ice buildup is likely to occur. The freezing of condensate from the flue gases can cause ice build-up on building walls, plants, patios, roofs, etc...
- **Cold Climates** - Non-insulated single-wall metal vent pipe shall not be used outdoors in cold climates for venting. Condensate can freeze and block the flue.
- **People** - Locate and guard the vent termination to prevent accidental contact by people or pets.
- **Places** - Locate and guard the vent to prevent condensate from damaging exterior finishes. Use a 2' x 2' rust resistant sheet metal backing plate against brick or masonry surfaces.

Category III Genesis Venting

Vent sizing, installation and termination shall be in accordance with the NATIONAL FUEL GAS CODE, ANSI Z223.1 OR CAN/CGA-B149 CURENT EDITION. If applicable, all local, utility, state/provincial regulations on venting must be followed.

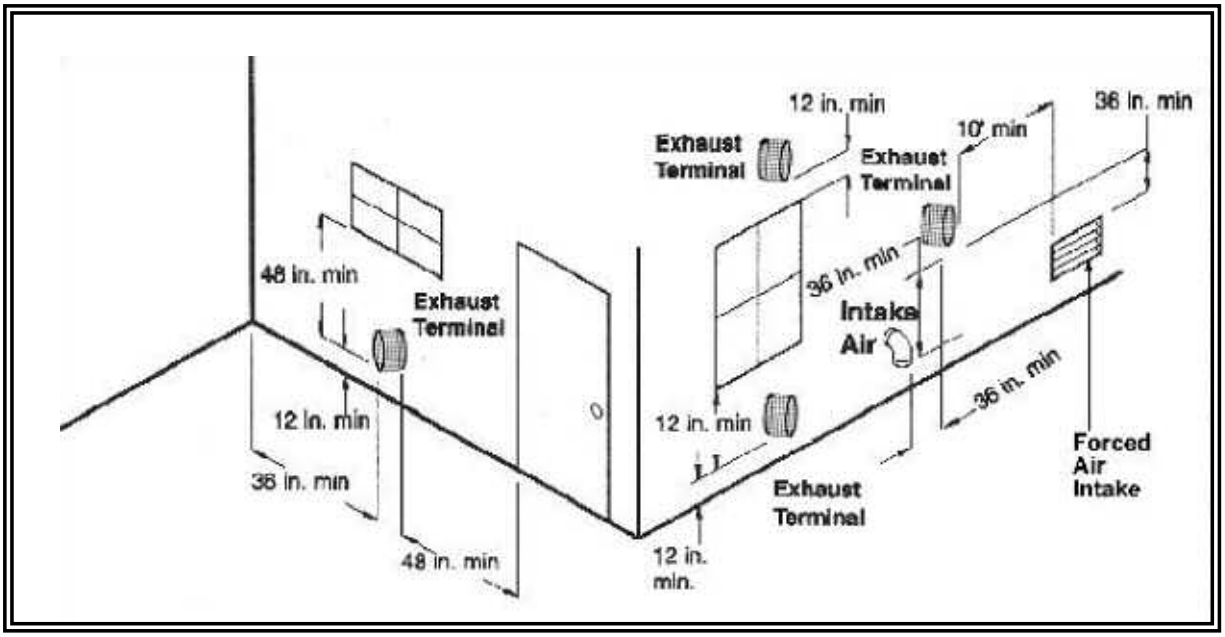


Figure 5-17 Termination Locations

Termination Considerations

- Vent must terminate at least four (4) feet below, four (4) feet horizontally, or one (1) foot above any door, window or gravity air inlet to the building.
- The vent must not be less than seven (7) feet above grade when located adjacent to public walkways.
- Terminate vent at least three (3) feet above any forced air inlet located within ten (10) feet.
- Vent must terminate at least four (4) feet horizontally, and in no case above or below unless four (4) feet horizontal distance is maintained, from electric meters, gas meters, regulators, and relief equipment.
- The minimum distance from the exhaust terminal to an inside corner formed by two exterior walls is 6 feet but 10 feet is recommended where possible.
- Maintain a minimum distance of 4 feet from any soffit or eave vent to the exhaust terminal.
- To prevent recirculation of flue gases from an adjacent vent cap, the point of termination for the combustion air inlet terminal must be at least 3 feet (0.91m) below and 3 feet (0.91m) away from the exhaust vent cap, if it is located within 10' (3.05m) of the exhaust vent cap. Remember that these are the minimum distances, additional distance is recommended when possible.
- The exhaust and intake air termination must be a minimum of 12 inches above anticipated snow or grade level, which ever is higher.

TYPE “B” DOUBLE WALL VENT SIZING TABLES

Single Boiler Vent Tables

Capacity of "Type B" Double Wall Vent Pipe Connected to A Single Boiler

(Does Not Apply to Combined Or Common Vents)

		Type B Gas Vent Diameter, Inches																	
		4″			5″			6″			7″			8″			10″		
		Appliance Input Rating in Thousands of BTU Per Hour																	
Height H (ft)	Lateral L (ft)	Fan		Nat Max	Fan		Nat Max	Fan		Nat Max	Fan		Nat Max	Fan		Nat Max	Fan		Nat Max
		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max	
6	0	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	1121	570
	2	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	75	675	455
	4	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	110	668	445
	6	36	91	61	47	149	100	59	223	149	78	310	205	93	413	273	128	661	435
8	0	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1261	660
	2	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	71	770	515
	5	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	115	758	503
	8	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	137	746	490
10	0	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1377	720
	2	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	68	852	560
	5	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	112	839	547
	10	41	104	70	54	176	115	67	267	175	88	376	245	204	504	330	142	817	525
15	0	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1596	840
	2	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	63	1019	675
	5	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	105	1003	660
	10	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	135	977	635
	15	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	155	953	610
20	0	0	202	119	0	349	202	0	540	307	0	776	430	0	1057	575	0	1756	930
	2	14	149	100	18	250	166	20	377	249	33	531	346	41	711	470	59	1150	755
	5	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460	101	1133	738
	10	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443	130	1105	710
	15	46	124	84	59	217	142	73	337	217	94	481	308	111	654	427	150	1078	688
	20	55	116	78	69	206	134	84	322	206	107	464	295	125	634	410	167	1052	665
30	0	0	213	128	0	374	220	0	587	336	0	853	475	0	1173	650	0	1977	1060
	2	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	54	1351	865
	5	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524	96	1332	851
	10	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	125	1301	829
	15	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	143	1272	807
	20	53	132	90	66	237	154	80	374	237	102	542	343	119	743	473	160	1243	784
	30	73	113	NR	88	214	NR	104	346	219	131	507	321	149	702	444	195	1189	745
50	0	0	216	134	0	397	232	0	633	363	0	932	518	0	1297	708	0	2231	1195
	2	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	41	1620	1010
	5	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	90	1600	996
	10	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	118	1567	972
	15	42	158	NR	54	287	180	66	455	288	85	662	413	100	911	572	136	1536	948
	20	50	149	NR	63	275	169	76	440	278	97	642	401	113	888	556	151	1505	924
	30	69	131	NR	84	250	NR	99	410	259	123	605	376	141	844	522	183	1446	876
100	0	0	218	NR	0	407	NR	0	665	400	0	997	560	0	1411	770	0	2491	1310
	2	10	194	NR	12	354	NR	13	566	375	18	831	510	21	1155	700	30	1975	1170
	5	26	189	NR	33	347	NR	40	557	369	52	820	504	60	1141	692	82	1955	1159
	10	33	182	NR	43	335	NR	53	542	361	68	801	493	80	1118	679	108	1923	1142
	15	40	174	NR	50	321	NR	62	528	353	80	782	482	93	1095	666	126	1892	1124
	20	47	166	NR	59	311	NR	71	513	344	90	763	471	105	1073	653	141	1861	1107
	30	NR	NR	NR	78	290	NR	92	483	NR	115	726	449	131	1029	627	170	1802	1071
	50	NR	NR	NR	NR	NR	NR	147	428	NR	180	651	405	197	944	575	241	1688	1000

Notes: Use "Fan" columns for Genesis boiler vent sizing.
Always design the vent for the sea level input shown on the rating plate of the appliance.
Do not derate vent size for altitude.

Single Boiler Vent Tables

Capacity of "Type B" Double Wall Vent Pipe Connected to A Single Boiler

(Does Not Apply to Combined Or Common Vents)

		Type B Gas Vent Diameter, Inches																					
		12″			14″			16″			18″			20″			22″			24″		
		Appliance Input Rating in Thousands of BTU Per Hour																					
		Fan		Nat	Fan		Nat	Fan		Nat	Fan		Nat	Fan		Nat	Fan		Nat	Fan		Nat
Height H (ft)	Lateral L (ft)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	0	1645	850	0	2267	1170	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	103	982	650	138	1346	890	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	147	975	640	191	1338	880	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	171	967	630	219	1330	870	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	1858	970	0	2571	1320	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010
	2	98	1124	745	130	1543	1020	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	154	1110	733	199	1528	1010	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	180	1097	720	231	1514	1000	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	2036	1060	0	2825	1450	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	93	1244	850	124	1713	1130	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	149	1229	829	192	1696	1105	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371
	10	187	1204	795	238	1669	1040	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	2380	1240	0	3323	1720	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10393	5300
	2	86	1495	985	114	2062	1350	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080
	5	140	1476	967	182	2041	1327	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	177	1446	936	227	2009	1289	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
	15	202	1418	905	257	1976	1250	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980
20	0	0	2637	1350	0	3701	1900	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11753	6000
	2	81	1694	1100	107	2343	1520	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	135	1674	1079	174	2320	1498	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	172	1641	1045	220	2282	1460	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
	15	195	1609	1018	248	2245	1425	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575
	20	217	1578	990	273	2210	1390	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550
30	0	0	3004	1550	0	4252	2170	0	5725	2920	0	7420	3770	0	9341	4750	0	11483	5850	0	13848	7060
	2	74	2004	1310	98	2786	1800	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600
	5	127	1981	1289	164	2759	1775	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5552
	10	164	1944	1254	209	2716	1733	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471
	15	187	1908	1220	237	2674	1692	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391
	20	207	1873	1185	260	2633	1650	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310
	30	246	1807	1130	305	2555	1585	369	3433	2130	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225
50	0	0	3441	1825	0	4934	2550	0	6711	3440	0	8774	4460	0	11129	5635	0	13767	6940	0	16694	8430
	2	66	2431	1513	86	3409	2125	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10788	6860
	5	188	2406	1495	151	3380	2102	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10737	6818
	10	154	2366	1466	196	3332	2064	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10652	6749
	15	177	2327	1437	222	3285	2026	274	4409	2721	330	5701	3534	396	7155	4511	465	8779	5546	542	10570	6710
	20	195	2288	1408	244	3239	1987	300	4356	2675	361	5641	3481	433	7086	4479	506	8704	5506	586	10488	6670
	30	232	2214	1349	287	3150	1910	347	4253	2631	412	5523	3431	494	6953	4421	577	8557	5444	672	10328	6603
100	0	0	3925	2050	0	5729	2950	0	7914	4050	0	10485	5300	0	13454	6700	0	16817	8600	0	20578	10300
	2	44	3027	1820	72	4313	2550	95	5834	3500	120	7591	4600	138	9577	5800	169	11803	7200	204	14264	8800
	5	107	3002	1803	136	4282	2531	172	5797	3475	206	7548	4566	245	9528	5769	293	11748	7162	341	14204	8756
	10	142	2961	1775	180	4231	2500	223	5737	3434	268	7478	4509	318	9447	5717	374	11658	7100	436	14105	8683
	15	163	2920	1747	206	4182	2469	252	5678	3392	304	7409	4451	358	9367	5665	418	11569	7037	487	14007	8610
	20	181	2880	1719	226	4133	2438	277	5619	3351	330	7341	4394	387	9289	5613	452	11482	6975	523	13910	8537
	30	215	2803	1663	265	4037	2375	319	5505	3267	378	7209	4279	446	9136	5509	514	11310	6850	592	13720	8391
	50	292	2657	1550	350	3856	2250	415	5289	3100	486	6956	4050	572	8841	5300	659	10979	6600	752	13354	8100

Notes: Use "Fan" columns for Genesis boiler vent sizing.
Always design the vent for the sea level input shown on the rating plate of the appliance.
Do not derate vent size for altitude.

Multiple Boiler Common Vent Tables

Vent Connector Table

Vent Height H (ft)	Connector Rise R (ft)	Type B Gas Vent Diameter, Inches: 3″ Fan Min	3″ Fan Max	3″ Nat Max	4″ Fan Min	4″ Fan Max	4″ Nat Max	5″ Fan Min	5″ Fan Max	5″ Nat Max	6″ Fan Min	6″ Fan Max	6″ Nat Max	7″ Fan Min	7″ Fan Max	7″ Nat Max	8″ Fan Min	8″ Fan Max	8″ Nat Max	10″ Fan Min	10″ Fan Max	10″ Nat Max
		Appliance Input Rating in Thousands of BTU Per Hour																				
6	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142	92	296	185	128	466	289
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168	95	333	220	131	526	345
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189	97	363	248	134	575	386
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148	100	320	194	138	507	303
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175	103	356	230	141	564	358
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	143	612	402
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154	106	341	200	146	542	314
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182	109	374	238	149	596	372
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205	111	402	268	152	642	417
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163	110	389	214	162	609	333
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193	112	419	253	165	658	394
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218	115	445	286	167	700	444
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171	107	436	224	158	681	347
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202	110	463	265	161	725	414
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228	113	486	300	164	764	466
30	1	20	62	33	31	113	53	45	181	93	60	288	134	83	391	182	103	512	238	151	802	372
	2	21	64	39	33	118	70	47	190	110	62	299	158	85	408	215	105	535	282	155	840	439
	3	22	66	44	34	123	79	48	198	124	64	309	178	88	423	242	108	555	317	158	874	494
50	1	19	71	36	30	133	64	43	216	101	57	349	145	79	477	197	97	627	257	144	984	403
	2	21	73	43	32	137	76	45	223	119	59	358	172	81	490	234	100	645	306	148	1014	478
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263	103	661	343	151	1043	538
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204	91	810	266	135	1285	417
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242	94	822	316	139	1306	494
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272	97	834	355	142	1327	555

Note: Use the above table to size vent connector (the pipe between the appliance and the common vent).

Common Vent Table

Vent Height H (ft)	Type B Gas Vent Diameter, Inches: 4″ Fan + Fan	4″ Fan + Nat	4″ Nat + Nat	5″ Fan + Fan	5″ Fan + Nat	5″ Nat + Nat	6″ Fan + Fan	6″ Fan + Nat	6″ Nat + Nat	7″ Fan + Fan	7″ Fan + Nat	7″ Nat + Nat	8″ Fan + Fan	8″ Fan + Nat	8″ Nat + Nat	10″ Fan + Fan	10″ Fan + Nat	10″ Nat + Nat
	Combined Appliance Input Rating in Thousands of BTU Per Hour																	
6	92	81	65	140	116	103	204	161	147	309	248	200	404	314	260	672	520	410
8	101	90	73	155	129	114	224	178	163	339	275	223	444	348	290	740	577	465
10	110	97	79	169	141	124	243	194	178	367	299	242	477	377	315	800	627	495
15	125	112	91	195	164	144	283	228	206	427	352	280	556	444	365	924	733	565
20	136	123	102	215	183	160	314	255	229	475	394	310	621	499	405	1035	826	640
30	152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	1209	975	740
50	167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1451	1188	860
100	175	163	NR	311	277	NR	489	421	NR	751	658	479	1025	873	625	1784	1502	975

Notes: Use “Fan” columns for Genesis boiler vent sizing.
Always design the vent for the sea level input shown on the rating plate of the appliance.
Do not derate vent size for altitude.
Use Fan + Fan when all appliances are fan assisted.
Use Fan + Natural when fan assisted and draft hood equipment are commonly vented together.
Use Nat + Nat when all appliances are drafthood type equipment.

Multiple Boiler Common Vent Tables

Vent Connector Table

Vent Height H (ft)	Connector Rise R (ft)	Type B Gas Vent Diameter, Inches: 12″ Fan Min	12″ Fan Max	12″ Nat Max	14″ Fan Min	14″ Fan Max	14″ Nat Max	16″ Fan Min	16″ Fan Max	16″ Nat Max	18″ Fan Min	18″ Fan Max	18″ Nat Max	20″ Fan Min	20″ Fan Max	20″ Nat Max	22″ Fan Min	22″ Fan Max	22″ Nat Max	24″ Fan Min	24″ Fan Max	24″ Nat Max
		Appliance Input Rating in Thousands of BTU Per Hour																				
6	2	174	764	496	223	1046	653	281	1371	853	346	1772	1080	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	180	897	616	230	1231	827	287	1617	1081	352	2069	1370	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	2	186	822	516	238	1126	696	298	1478	910	365	1920	1150	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	192	952	644	244	1307	884	305	1719	1150	372	2211	1460	471	2737	1800	560	3319	2180	662	3957	2590
	6	198	1050	772	252	1445	1072	313	1902	1390	380	2434	1770	478	3018	2180	568	3665	2640	669	4373	3130
10	2	196	870	536	249	1195	730	311	1570	955	379	2049	1205	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	201	997	664	256	1371	924	318	1804	1205	387	2332	1535	486	2887	1890	581	3502	2280	636	4175	2710
	6	207	1095	792	263	1509	1118	325	1989	1455	395	2556	1865	494	3169	2290	589	3849	2760	694	4593	3270
15	2	214	967	568	272	1334	790	336	1760	1030	408	2317	1305	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	221	1085	712	279	1499	1006	344	1978	1320	416	2579	1665	523	3197	2060	624	3881	2490	734	4631	2960
	6	228	1181	856	286	1632	1222	351	2157	1610	424	2796	2025	533	3470	2510	634	4216	3030	743	5035	3600
20	2	223	1051	596	291	1443	840	357	1911	1095	430	2533	1385	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	230	1162	748	298	1597	1064	365	2116	1395	438	2778	1765	554	3447	2180	661	4190	2630	772	5005	3130
	6	237	1253	900	307	1726	1288	373	2287	1695	450	2984	2145	567	3708	2650	671	4511	3190	785	5392	3790
30	2	216	1217	632	286	1664	910	367	2183	1190	461	2891	1540	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	223	1316	792	294	1802	1160	376	2366	1510	474	3110	1920	619	3840	2365	728	4681	2860	847	5606	3410
	6	231	1400	952	303	1920	1410	384	2524	1830	485	3299	2340	632	4080	2875	741	4976	3480	860	5961	4150
50	2	203	1479	689	273	2023	1007	350	2659	1315	435	3548	1665	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	213	1561	860	281	2139	1291	359	2814	1685	447	3730	2135	580	4601	2633	709	5569	3185	851	6633	3790
	6	221	1631	1031	290	2242	1575	369	2951	2055	461	3893	2605	594	4808	3208	724	5826	3885	867	6943	4620
100	2	192	1923	712	254	2644	1050	326	3490	1370	402	4707	1740	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	200	1984	888	263	2731	1346	336	3606	1760	414	4842	2220	523	5982	2750	639	7254	3330	769	8650	3950
	6	208	2035	1064	272	2811	1642	346	3714	2150	426	4968	2700	539	6143	3350	654	7453	4070	786	8892	4810

Note: Use the above table to size vent connector (the pipe between the appliance and the common vent).

Common Vent Table

Vent Height H (ft)	Type B Gas Vent Diameter, Inches: 12″ Fan + Fan	12″ Fan + Nat	12″ Nat + Nat	14″ Fan + Fan	14″ Fan + Nat	14″ Nat + Nat	16″ Fan + Fan	16″ Fan + Nat	16″ Nat + Nat	18″ Fan + Fan	18″ Fan + Nat	18″ Nat + Nat	20″ Fan + Fan	20″ Fan + Nat	20″ Nat + Nat	22″ Fan + Fan	22″ Fan + Nat	22″ Nat + Nat	24″ Fan + Fan	24″ Fan + Nat	24″ Nat + Nat
	Combined Appliance Input Rating in Thousands of BTU Per Hour																				
6	900	696	588	1284	990	815	1735	1336	1065	2253	1732	1345	2838	2180	1660	3488	2677	1970	4206	3226	2390
8	994	773	652	1423	1103	912	1927	1491	1190	2507	1936	1510	3162	2439	1860	3890	2998	2200	4695	3616	2680
10	1076	841	712	1542	1200	995	2093	1625	1300	2727	2113	1645	3444	2665	2030	4741	3278	2400	5123	3957	2920
15	1247	986	825	1794	1410	1158	2440	1910	1510	3184	2484	1910	4026	3133	2360	4971	3862	2790	6016	4670	3400
20	1405	1116	916	2006	1588	1290	2722	2147	1690	3561	2798	2140	4548	3552	2640	5573	4352	3120	6749	5261	3800
30	1658	1327	1025	2373	1892	1525	3220	2558	1990	4197	3326	2520	5303	4193	3110	6539	5157	3680	7940	6247	4480
50	2024	1640	1280	2911	2347	1863	3964	3183	2430	5184	4149	3075	6567	5240	3800	8116	6458	4500	9837	7813	5475
100	2569	2131	1670	3732	3076	2450	5125	4202	3200	6749	5509	4050	8597	6986	5000	10681	8648	5920	13004	10499	7200

Notes: Use “Fan” columns for Genesis boiler vent sizing.
Always design the vent for the sea level input shown on the rating plate of the appliance.
Do not derate vent size for altitude.
Use Fan + Fan when all appliances are fan assisted.
Use Fan + Natural when fan assisted and draft hood equipment are commonly vented together.
Use Nat + Nat when all appliances are drafthood type equipment.

CHAPTER 6. GAS SUPPLY

General Genesis Gas Supply Considerations

All gas supply piping connections to the Genesis boiler(s) shall be installed in accordance with the latest editions of the National Fuel Gas Code, ANSI Z223.1 or in Canada CAN/CGA-B149.1-00. In addition, any applicable local gas company or municipality code requirements must be met.

It is recommended that a drip leg and a manual gas shutoff valve with pressure test plug be installed in the gas piping supply line.

The maximum gas pressure specified in Table N must not be exceeded. If the supply pressure exceeds 14 inches W.C., an intermediate gas pressure regulator of the lockup type must be installed. The minimum gas pressures shown in Table N must be maintained under both load and no load conditions (static and dynamic) without fluctuation of more than 1 inch W.C.

(Table N) Genesis Minimum and		
Natural Gas		
Model #	**Minimum Supply Pressure**	**Maximum Supply**
GB-300 thru	4.5" W.C. (01.22	14" W.C. (3.49
GB-1000 thru	6" W.C. (1.22	14" W.C. (3.49
Propane Gas		
Model #	**Minimum Supply Pressure**	**Maximum Supply**
GB-300 thru	11" W.C.	14" W.C. (3.49

The following gas supply sections cover single boiler gas pipe sizing, multiple appliance gas system sizing, and gas supply in high altitude situations.

(Table O) Maximum Equivalent Pipe Length

Model #	Pipe Size													
	3/4"		1"		1-1/4"		1-1/2"		2"		2-1/2"		3"	
	N	P	N	P	N	P	N	P	N	P	N	P	N	P
GB/GW-	30	60	90	150	250	560	-	-	-	-	-	-	-	-
GB/GW-	15	25	35	85	150	380	360	-	-	-	-	-	-	-
GB/GW-	-	15	25	60	100	260	250	-	-	-	-	-	-	-
GB/GW-	-	10	15	35	65	150	130	360	500	-	-	-	-	-
GB/GW-	-	-	10	25	45	100	95	250	340		-	-	-	-
GB/GW-	-	-	-	20	35	80	75	180	260	600	-	-	-	-
GB/GW-	-	-	-	10	15	35	35	80	120	300	300	-	-	-
GB/GW-	-	-	-	-	-	25	20	55	75	180	170	325	560	-
GB/GW-	-	-	-	-	-	15	15	35	50	120	125	250	400	-
GB/GW-	-	-	-	-	-	15	10	30	40	95	100	225	340	-
GB/GW-	-	-	-	-	-	10	10	25	30	80	70	175	260	-

Single Boiler Gas Pipe Sizing

Table O provides the correct pipe size for the individual Genesis boiler based on the number of equivalent feet of piping from the gas supply meter to the boiler. The chart allows for the average number of pipe fittings. Where it is necessary to use more, use one pipe size larger than specified to compensate for any increased pressure drop.

A complete gas supply system (meter, pipings, valves, regulators, etc.) should be sized for all appliances connected to the system. Ensure that the system is capable of maintaining a steady non-fluctuating gas pressure with all connected gas appliances firing.

(Table P) Maximum Capacity of Pipe in Thousands of BTU's Per Hour of 0.5"

Norminal Iron Pipe Size	Length of Pipe (Feet)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1	697	477	384	328	292	267	256	246	210	200	179	164	149	138
1 1/4	1,400	974	789	677	595	543	502	472	441	410	369	333	308	287
1 1/2	2,150	1,500	1,210	1,020	923	830	769	707	666	636	564	513	472	441
2	4,100	2,820	2,260	1,950	1,720	1,560	1,440	1,330	1,250	1,180	1,100	974	871	820
2 1/2	6,460	4,460	3,610	3,100	2,720	2,460	2,310	2,100	2,000	1,900	1,700	1,540	1,400	1,300
3	11,20	7,900	6,400	5,400	4,870	4,410	4,000	3,800	3,540	3,300	3,000	2,720	2,500	2,340
4	23,50	16,10	13,10	11,10	10,00	9,000	8,300	7,690	7,380	6,870	6,150	5,640	5,130	4,720

Gas System Sizing

When sizing for multiple boilers use Table P for natural gas systems and Table Q for propane gas systems. These tables show the BTU/H gas capacity for iron pipe at specified distances. When sizing multiple boiler systems, the common pipe (starting at the meter) must be sized for the maximum capacity of all appliances connected to the system. As the system progresses and each appliance is connected, the pipe size must be re-evaluated and resized if necessary for the demand.

Multiple Appliance Gas System Sizing - Propane Gas

of 0.5" W.C. (Based on Propane Gas, 2,500 BTU's per Cubic Foot of Gas and 1.53														
Norminal Iron Pipe	Length of Pipe (Feet)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1	1,106	757	610	521	463	424	405	390	333	317	284	260	237	219
1 1/4	2,222	1,546	1,252	1,075	944	862	797	749	700	651	586	529	489	456
1 1/2	3,413	2,381	1,921	1,619	1,465	1,317	1,221	1,122	1,057	1,010	895	814	749	700
2	6,508	4,476	3,587	3,095	2,730	2,476	2,286	2,111	1,984	1,873	1,746	1,546	1,383	1,302
2 1/2	10,25	7,079	5,730	4,921	4,317	3,905	3,667	3,333	3,175	3,016	2,698	2,444	2,222	2,063
3	17,77	12,54	10,15	8,571	7,730	7,000	6,349	6,032	5,619	5,238	4,762	4,317	3,968	3,714
4	37,30	25,55	20,79	17,61	15,87	14,28	13,17	12,20	11,71	10,90	9,762	8,952	8,143	7,492

High Altitude Installations

Special considerations apply to high altitude installations.

General Altitude Information

Atmospheric pressure diminishes as the altitude rises. At high altitude a cubic foot of gas will hold less BTUs than a cubic foot of gas at sea level. Consequently, the heating value of (or number of BTUs contained in) a cubic foot of natural or propane gas will decrease as the altitude increases. As altitude increases, there is less oxygen per cubic foot of air. Therefore, the BTU input rate of gas appliances must be reduced at altitudes above 2000 feet (600m). The BTU input ratings specified by manufacturers on their rating plates apply to elevations from sea level up to 2000 feet (600 m). For elevations above 2000 feet (600 m), these factory ratings must be reduced by a rate of 4% for each 1000 feet (300 m) above sea level. Generally, this is achieved by reducing the gas orifice size. Some gas utility companies serving high altitude areas de-rate their gas (BTU content) for altitude. This makes it unnecessary to change orifices. In fact, gas appliances that have been ordered for high altitude or de-rated at the job site and installed in these areas, are in effect double de-rated. De-rated units operating on de-rated gas will not perform as expected and may be undersized for the application. Contacting the local gas utility or supplier to verify the BTU content of the gas being supplied is recommended.

High Altitude Sizing Considerations

Because the boiler is being derated for high altitude, boilers installed in high altitude areas are often mistakenly undersized. When sizing a boiler for a high altitude application, the boilers BTU input should be increased at a rate equal to the altitude de-rate.

Genesis Pre-Jet Orifices

Genesis boilers (Series 200 and up) are equipped with unique Pre-Jet orifices. These orfices are self-regulating for high altitude installations up to 5,000 feet. (Consult the factory for higher altitudes).

Example: A Genesis boiler is rated at 750,000 Btu/hr. input at sea level. At an altitude of 5,000 (1500m), the Pre-Jet orifices will decrease the input rate by 4% for every 1,000 feet (300m) to a new rating of 611,530 BTU/H (750,000 x .96 x .96 x .96 x .96 x .96 = 611,530) The input reduction is achieved by the Pre-Jet orifices through self-regulation. Remember, the input/output rating of the boiler is being reduced by close to 20%. When initially sizing the boiler, its size must also be increased by about 20% to compensate for the higher altitude.

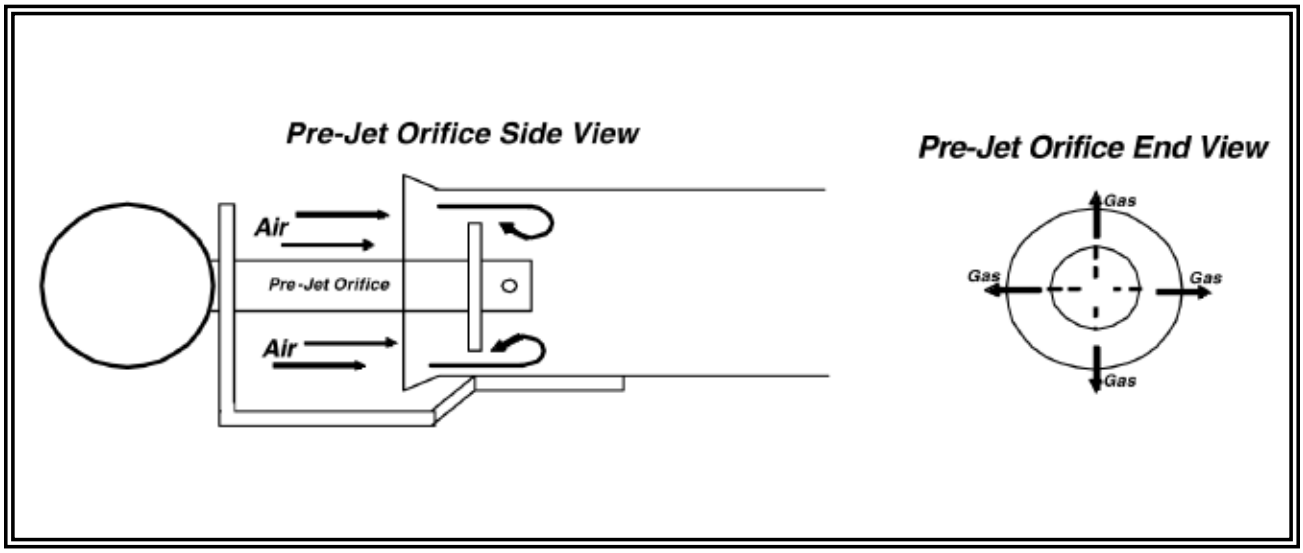


Figure 6-1 Pre-Jet Orifice

CHAPTER 7. GENESIS ELECTRICAL REQUIREMENTS

Electrical connections to the Genesis must comply with the following codes:

- National Electrical Code
- Electrical grounding as required by N.E.C. NFPA 70-latest edition.
- In Canada, C.S.A. C22. 1 C.E.C. Part 1.
- Any other state, provincial or local codes or regulations having jurisdiction.

All electrical connections for the Genesis boiler are made at the 4x4 boxes located on the rear of the boiler. (See Figure 1-1 on Page 4.) These 4x4 electrical junction boxes provide connections for:

- 120V power supply
- earth ground
- remote tank temperature probe
- alternate 24V thermostat
- 120V secondary pump connections

The 120-volt pump connections are for secondary pumps in hydronic-heating systems. The pump connections can handle up to a maximum of a 1/3 hp pump on Genesis models GB-200 thru 750, and up to a maximum of a 1 hp pump on Genesis models GB-1000 thru 2500. Even larger pumps can be used with an optional relay, consult the factory for assistance.

Electrical Requirements

The Genesis must be connected to a single-phase 120 VAC, 60 Hz, 20 or 30 Amp independent line source on a dedicated breaker and run in a dedicated conduit. The Genesis is polarity sensitive and has to be wired correctly. (A green LED located on the Control Board verifies correct polarity.) The boiler also must be properly grounded.

Do not share the breaker to the boiler with other appliances. Do not share Neutral or Ground wires between boilers or with other appliances. Each Genesis Boiler should have a dedicated hot, neutral and ground wire installed in a dedicated conduit to that boiler.

Temperature sensor wiring or external 24 VAC control wiring also must be installed in its own dedicated conduit to guard against EMI.

EMI and RFI (EMI = electro-magnetic interference; RFI = radio frequency interference), also known as “line noise,” can cause erratic boiler operation. If this condition is suspected, an electrical line filter/conditioner (available from electrical suppliers) may be necessary to eliminate line noise interference.

Solid state controls are vulnerable to damage from electrical spikes in the power supply. A commercial-grade surge protection device should be installed.

Genesis boilers are available with optional dry contacts for:

- any boiler failure
- combustion air louvers
- power venters and draft inducers

(Table R) Genesis Electrical Requirements

Model #	Volts/Hz	Amperes
GB-200 thru 750	120/60	20
GB-1000 thru 2500	120/60	30

CHAPTER 8. HYDRONIC HEATING SYSTEMS & COMPONENTS

Genesis Boilers

A. O. Smith copper boilers are low volume, low mass, mid-efficiency boilers. Copper boilers have a total water capacity of only a few gallons of water (between 1 and 11 gallons). These boilers require water flow through the boiler any time the boiler is firing. Water will turn to steam almost instantly if the water in the boiler stops moving. The proper flow of water through the boiler is critical to the boilers efficiency and life expectancy.

Copper boilers have many advantages over their larger and heavier cast iron and steel counterparts:

- Because of their low volume and low mass, as soon as a copper boiler fires, heat is moved from the boiler directly into the heating system, speeding the movement of heat into the building. In high mass cast iron and steel boilers, much of the initial heat is used to bring the boiler up to temperature slowing the building heating process.
- In addition, stand-by heat losses in copper boiler flues are almost nonexistent.
- Copper boilers are much lighter and easier to install.
- Copper boilers have much smaller footprints than cast iron and steel boilers.

Boiler & System Water Flow Requirements

Maintaining the proper flow through a copper boiler is necessary to carry the heat out to the system. When the boiler is firing and there is inadequate water flow moving through the boiler, the boiler will overheat or short cycle on the boiler's high limits. Where the recommended flow

Model #	Input Rating BTU/Hr. Natural & Propane (LP) Gas	Output Rating BTU/Hr. Natural & Propane (LP) Gas	Temperature Rise and Pressure Drop						Maximum/Minimum Flow Rate					
			20 Deg. F Rise (Delta T)		30 Deg. F Rise (Delta T)		40 Deg. F Rise (Delta T)		Maximum Flow Rate			Minimum Flow Rate		
			GPM	PD-FT. Head	GPM	PD-FT. Head	GPM	PD-FT. Head	GPM	PD-FT. Head	Deg.F Rise (Delta T)	GPM	PD-FT. Head	Deg.F Rise (Delta T)
GB-300	300,000	252,000	25	1.3	17	0.6	13	0.4	25	1.3	20	13	0.4	40
GB-400	399,000	335,160	34	2.2	23	0.9	17	0.6	34	2.2	20	17	0.6	40
GB-500	500,000	420,000	42	3.4	28	1.8	21	0.9	42	3.4	20	21	0.9	40
GB-650	650,000	546,000	55	3.5	37	2.0	27	1.8	55	3.5	20	27	1.8	40
GB-750	750,000	630,000	63	8.3	42	4.3	32	2.1	63	8.3	20	32	2.1	40
GB-1000	990,000	831,600	83	5.1	55	2.7	41	1.5	154	12.2	11	41	1.5	40
GB-1300	1,300,000	1,092,000	109	7.2	72	4.2	54	3.2	154	14.5	14	54	3.2	40
GB-1500	1,500,000	1,260,000	126	10.1	84	6.3	63	4.3	154	16.3	17	63	4.3	40
GB-1850	1,850,000	1,554,000	154	18.5	103	10.1	77	6.4	154	18.5	20	77	6.4	40
GB-2100	2,100,000	1,764,000	N/A	N/A	117	14.5	88	8.3	154	21.3	23	88	8.3	40
GB-2500	2,490,000	2,091,600	N/A	N/A	139	18.5	104	11.6	154	23.2	28	104	11.6	40

rates are maintained, smooth and efficient system operation can be expected. (See Table S) for the recommended Genesis boiler flow rates, input/output, temperature rise (Delta T), and the pressure drop through the boiler at the specified flow rates.

There are many types of heating systems such as: multiple boiler systems, process or industrial systems, heat pump systems and etc. The required flow rates of these systems do not always match the boiler exactly. With these other types of systems; pump sizing, pipe sizing, and piping system design become more important.

Boiler Temperature Settings

A. O. Smith recommends a 20° to 40° Delta T through the boiler. The boiler's maximum temperature setting (High Limit/ECO) is 240°F. A. O. Smith recommends that the High Limit/ECO be set 10° to 20° higher that the expected boiler outlet water temperature. The expected boiler outlet water temperature equals: The system set point temperature plus the current boiler Delta T. Setting the boiler's High Limit/ECO too close to the outlet water temperature will result in short cycling and/or nuisance lockouts.

"A. O. Smith recommends that the High Limit/ECO be set 10° to 20° higher than the expected boiler outlet water temperature. The expected boiler outlet water temperature equals: The system set point temperature plus the current boiler Delta T."

Hydronic Heating System Components

Expansion Tanks

All closed loop hydronic-heating systems must include a properly sized and installed expansion tank. Due to their ease of installation and flexibility, diaphragm-type tanks are recommended. The expansion tank should always be installed on the suction side of the pump.

Air Separator

All closed loop hydronic-heating systems must include an air separator of adequate size and capacity for the application. The air separator removes air from the system by creating turbulence and rapid pressure changes within the unit. The air separator should have an automatic air vent installed in the top of the air separator device. The air separator should always be installed on the suction side of the pump.

Automatic Air Vents

One automatic air vent is built into the top of the air separator. In addition, automatic air vents should be installed at the highest points of the system and anywhere air may collect.

Flow Switches & Low Water Cut-Offs

All A. O. Smith Genesis boilers are furnished with a factory mounted and wired flow switch. A. O. Smith requires a low water cut-off only when the boiler is installed higher than the heating system. Most codes and local authorities accept the factory mounted flow switch in lieu of a low water cut-off for low mass copper tube boilers which require forced circulation. A. O. Smith does offer optional factory installed and wired low water cuts offs for all Genesis models. At no time can a low water cut-off be used in lieu of the factory installed flow switch.

Relief Valves

All A. O. Smith Genesis boilers are factory equipped with an ASME code approved relief valve as per ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers.” All ASME approved relief valves furnished by A. O. Smith have a 50 psi pressure rating.

Dual Valve - Feed Water Regulator

A. O. Smith recommends that a feed water regulator be installed and set at a minimum of 12 psi at the highest point of the system. Install a check valve or back flow prevention device and a manual shut off valve upstream of the regulator. A. O. Smith recommends a dual valve feed water make-up assembly that includes all of the above.

CHAPTER 9. HYDRONIC HEATING SYSTEM PIPING

Primary/Secondary Piping

A. O. Smith recommends primary/secondary piping as the preferred piping method for almost all hydronic-heating applications. It is easy to adapt to retrofit applications as well as new system designs. It is the most efficient method of piping copper boilers. The primary/secondary piping method uses two types of pumps. A primary (or system) pump is sized for the heat loop and it includes fan coils, radiators, air handlers, etc. The secondary (boiler) pump is sized for the ideal flow through each individual boiler. See Figure 9-1.

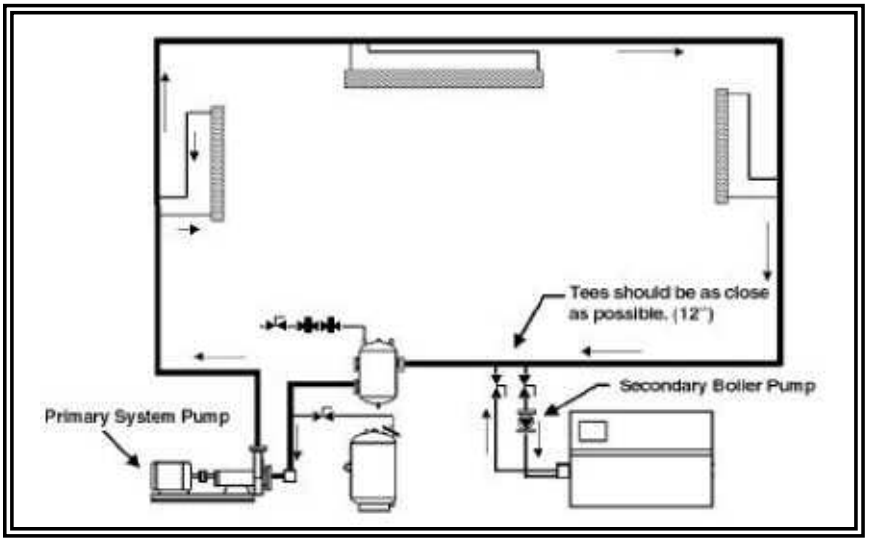


Figure 9-1

In primary/secondary piping systems, the primary pump is used to circulate the main building or system loop. This pump is sized for a flow rate capable of carrying all the BTU load needed by the building and the total pressure drop through the system.

Example: One gallon per minute of flow can carry about 12,500 BTUH out to the system at a 25°F Delta T. A system has a BTU load of 1,092,000 BTUH: 1,092,000 /12,500 = 87.4 gpm. The system should have a flow rate of 87 gpm; this will provide a system delta T of 25°F.

The secondary pump is used to maintain the ideal water flow through the boiler by pulling water off the primary loop. See Table S for secondary pump sizing information. All Genesis boilers are available with an optional factory mounted secondary boiler pump. This pump is sized for the boiler and up to 50 equivalent feet of secondary piping.

As noted in the piping diagram (Figure 9-1) the two tees for the secondary loop should be installed as close together as possible (12" to 18" maximum) in the primary loop. This results in minimal pressure loss between the two tees, allowing all the flow from the primary loop to by-pass the boiler when the secondary pump is not running. Eliminating flow through the boiler during stand-by periods virtually stops all stand-by heat loss from the boiler.

Note: Whenever hot water is pumped through a non-firing boiler, it becomes, in effect, a water cooler.

The Dia-Scan II boiler control, standard on all Genesis models, has an integral pump control with adjustable delay that allows the secondary pump to run for a short period after each firing cycle. For maximum system efficiency, this delay cools the boiler down to an equal temperature with the loop, removes any usable residual heat left in the boiler, moves this usable heat out to the system, and then turns the secondary pump off thereby eliminating all stand-by heat loss up the flue.

Primary/Secondary Piping Multiple Boilers

Primary/secondary piping is ideal for multiple Genesis boiler applications. Multiple boiler systems provide redundancy and are ideal for those applications that cannot afford to be without heat. Redundant systems allow units to be shut down for service while other units are maintaining the system.

Boilers are sized for the coldest day of the year. On milder days, a single on/off fired boiler is too big for the load and will short cycle. Short cycling causes unnecessary wear on the boiler, resulting in wide temperature swings and decreased overall system efficiency.

Multiple boilers or multi-staged fired boilers that size themselves to the demand are superior to large single stage on/off units, providing higher overall system efficiency.

Systems that employ four boilers have proven to be the most efficient heating systems. Four boilers, firing as four separate stages at 25% increments allow maximum system control by matching the BTU output of the boilers to the current and ever changing system load. This eliminates boiler short cycling and provides maximum building comfort in all weather conditions. Systems that utilize more than four boilers (While providing extremely smooth system operation, and often needed to meet heavy BTU demands.) do not appear to offer any clear additional energy savings.

Boiler Operating Temperature Controls

Single Boiler Systems

Fixed temperature single boiler systems can be controlled by a simple aquastat installed in the heating loop. If indoor/outdoor reset is required, an electronic control is recommended. Do not use the boiler's internal high limit control as the operating control. Always use a remote system loop temperature control to operate any hydronic heating system.

Multiple Boiler Systems

A. O. Smith offers a line of optional Tekmar controls for two, four, and eight boilers, which provide both boiler sequencing and indoor/outdoor reset. These controls are recommended for multi-boiler systems. Tekmar controls raise and lower the loop temperature based on the outdoor temperature by cycling and staging the boilers or the control can simply be set to maintain a fixed loop set point temperature. By maintaining the loop at the lowest temperature possible while providing maximum building comfort, these controls hold energy costs to a minimum.

Systems should operate according to temperature, not time. Energy Management Systems (EMS) that bring on a single boiler during a cold start and wait a fixed time to see if the boiler can increase the loop temperature before bringing on additional boilers are not acceptable. During cold starts, all available boilers should be firing.

Minimum System/Boiler Temperature

A. O. Smith recommends maintaining a minimum boiler inlet water temperature of 120°F on all Genesis products. Most hydronic heating system applications will require much higher operating temperatures. Systems using indoor/outdoor reset controls/EMS Systems must be set to prevent the system temperature from dropping below the recommended minimum boiler inlet water temperature.

Locating the System Temperature Sensor

Locating the system temperature sensor in the supply side of the heating loop is typical in systems with high flow rates, large water capacity, and/or with controls that include wide programmable differentials. However, in systems with moderate flow or low water capacity, as compared to the total system BTU input, boiler short cycling can be expected.

To prevent short cycling in these applications, A. O. Smith recommends locating the temperature sensor in the system return. By sensing the return water temperature, the boiler(s) see longer firing times and longer off cycles. In this return location, the system control will generally require a lower temperature set point to achieve the desired outlet water temperature. For example, a boiler operating with a 180°F system design discharge temperature and a 30°F Delta T will require a 150°F set point with the temperature sensor located in the system return. The exact temperature set point generally requires some final adjustments at start-up when the system reaches the desired operating temperature.

"In almost every case, copper boilers will operate smoother and cycle less when the system loop temperature sensor is installed in the return piping."

Primary/Secondary - Multiple Boiler Piping Configurations

Design Temperatures of 180°F or Less

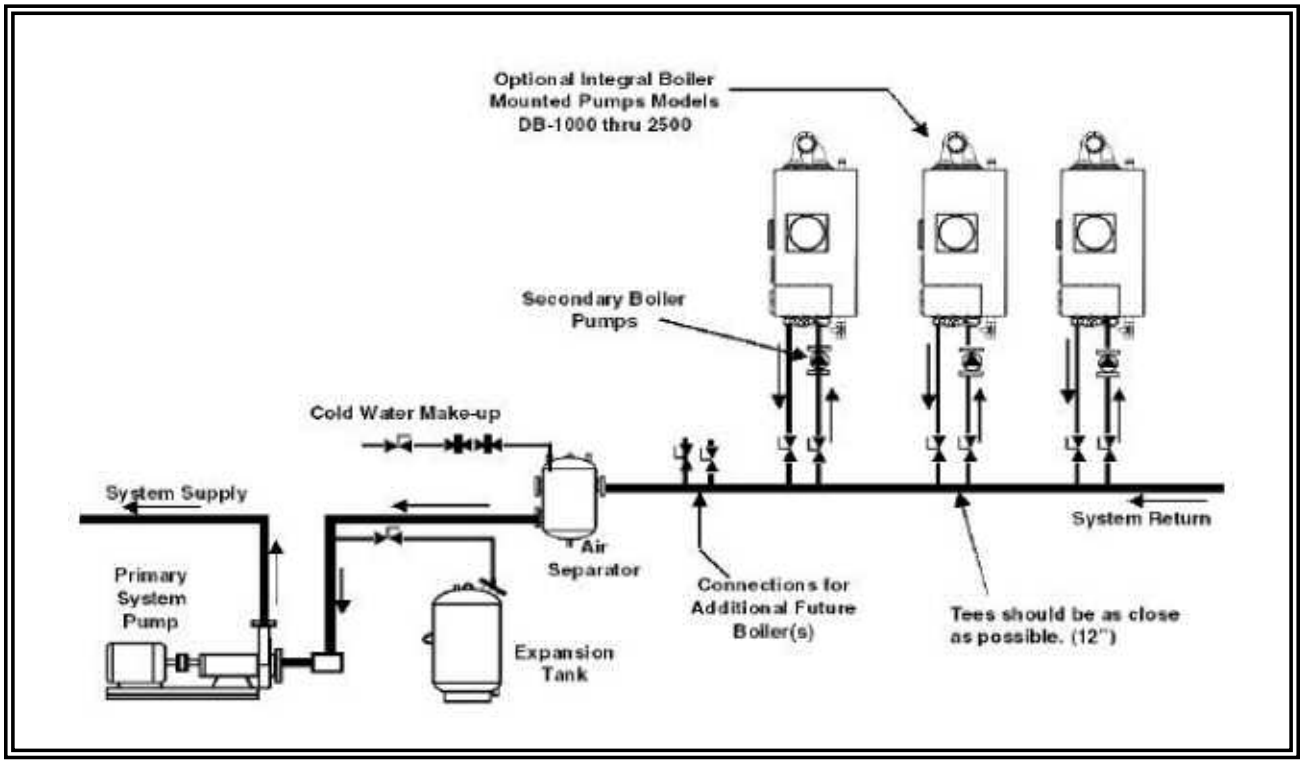


Figure 9-2

For Design Temperatures of 180°F or Less

Figure 9-2 illustrates a common primary/secondary piping method for multiple boilers where space is an issue. This configuration is ideal for systems with maximum system design temperatures of 180°F or less, high primary water flow rates, and low system Delta Ts of 25°F or less.

In this configuration, if all boilers are firing, each down stream boiler sees a slightly higher inlet water temperature than the preceding boiler. As a result, each down stream boiler will have a slightly higher outlet temperature and will be operating closer to the boilers maximum high limit setting. All common piping in the secondary boiler loops should be sized for the maximum flow of all down stream boilers.

Systems with wide Delta Ts or high system design temperatures could see nuisance high limit lockouts in this piping configuration. For high temperature systems, see Figure 9-3.

Design Temperatures Over 180°F

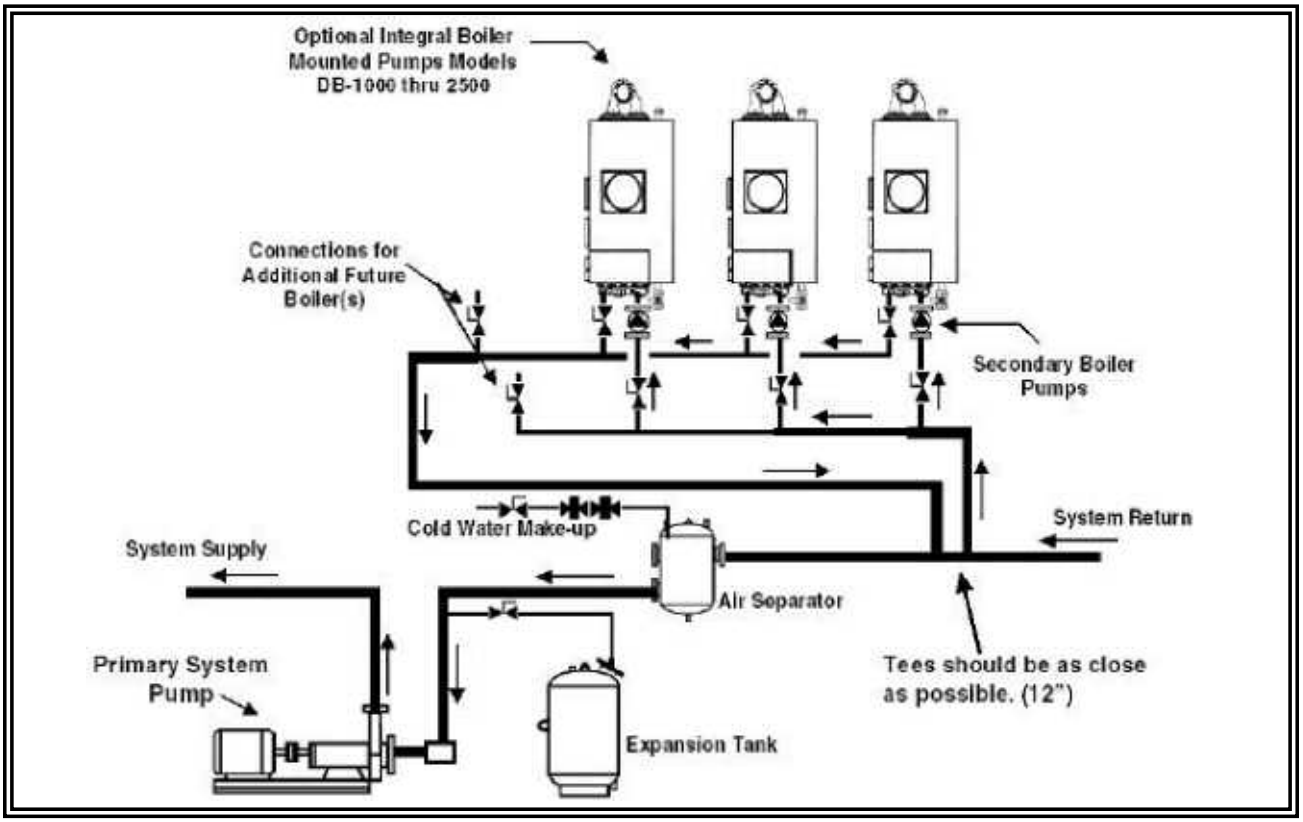


Figure 9-3 - Primary/Secondary Piping - Multiple Boilers Reverse Return

For Design Temperatures Over 180°F

A primary/secondary piping system using a reverse return secondary boiler loop is illustrated in Figure 9-3. This piping method is recommended for systems with design temperatures over 180°F and/or systems with Delta Ts up to 40°F.

In this piping method, each boiler sees the same inlet water temperature coming from the system return. All common piping in the secondary boiler loops should be sized for the maximum flow of all down stream boilers. It is very important to carefully follow the primary/ secondary piping diagrams for reverse return multiple boilers. The secondary tees need to be as close together as possible. Ensure that there is one long return run of common piping along the full length of the boilers. Do not modify this piping configuration.

Design Temperatures Below 120°F

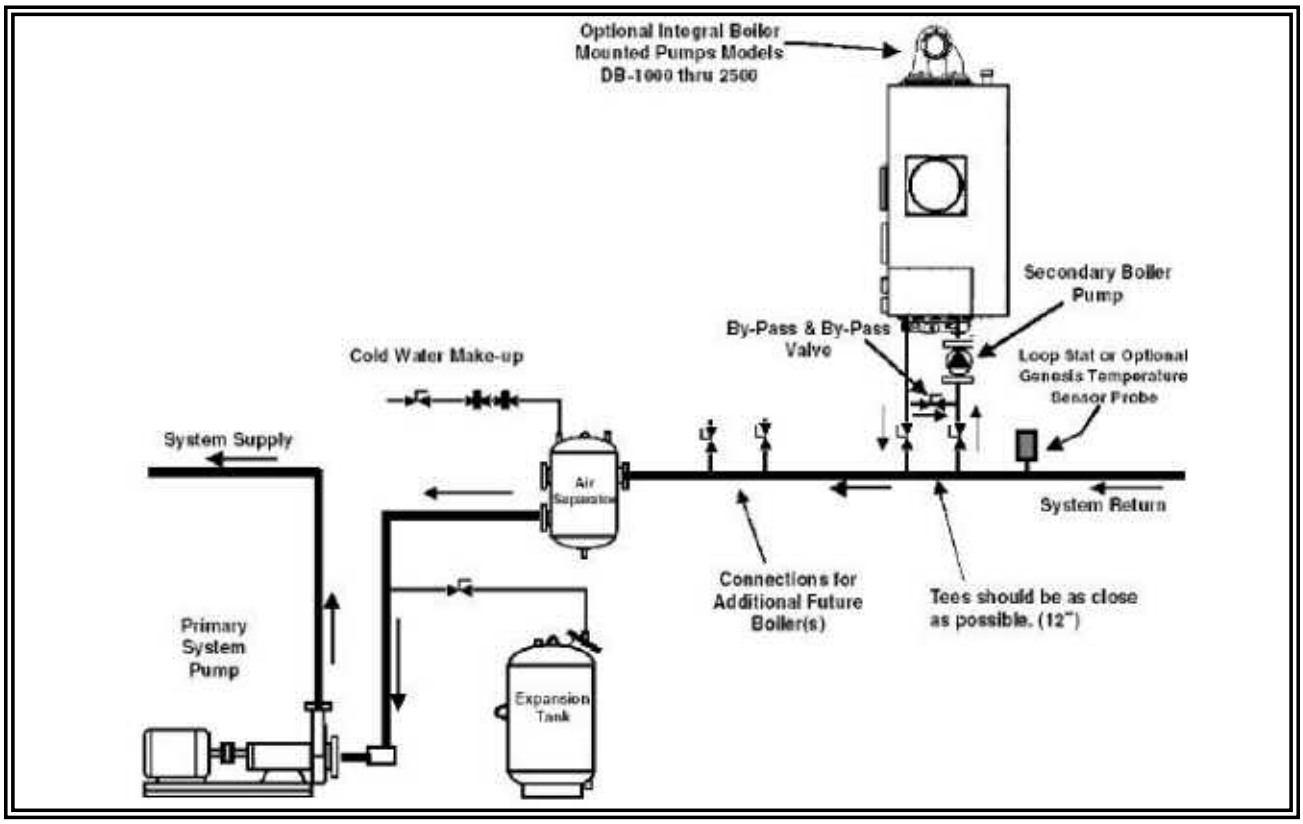


Figure 9-4 - Low Temperature System

For Design Temperatures Below 120°F

System designs that operate below 120°F include closed loop water source heat pump systems, low temperature industrial and manufacturing applications, greenhouse plant bed heating systems, snow melting systems, and floor or slab heating. However, for systems requiring lower loop temperatures, special design considerations are required to prevent the damaging effects of condensation on the boiler.

A low temperature primary/secondary-piping configuration is illustrated in Figure 9-4. This piping diagram is very similar to the basic primary/secondary piping arrangement, but with the addition of a by-pass and valve. By adjusting the by-pass valve, heated outlet water from the boiler is blended with cooler returning water and re-circulated to the inlet of the boiler. This allows the boiler to be operated internally at a higher non-condensing temperature while maintaining the desired lower loop temperature without damaging condensation.

Understanding Cast Iron and Steel Boiler Systems with Three-Way Mixing Valves

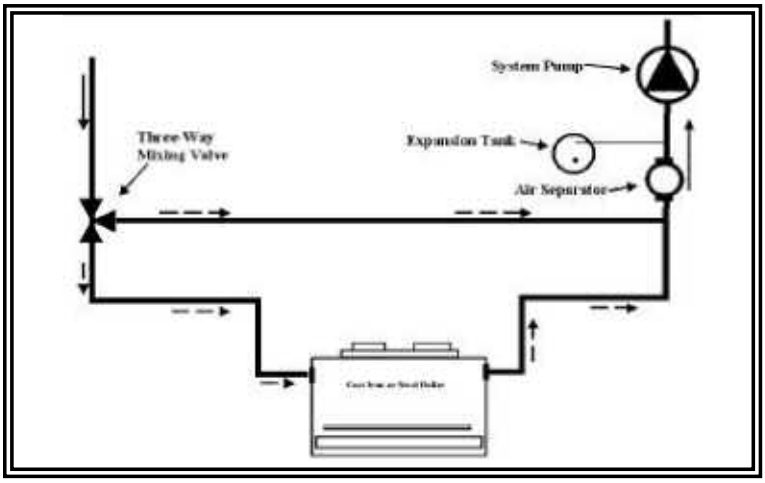


Figure 9-5 - System with Three-Way Mixing Valve

Hydronic systems using three-way mixing valves (shown in Figure 9-5) are common with systems using cast iron or steel boilers. With this type of system the boiler temperature is set and operated at maximum design temperature. The three-way valve is used to blend system return water with boiler outlet water, to provide the varied temperatures as required by the system based on the outdoor temperature.

So, on a mild day, the boiler may be operating at a 200°F design temperature, but the mixing valve is maintaining the system at only 140°F. Three-way mixing valves, when used as shown in Figure 9-5, control all flow through the heating system. If the system needs heat, the three-way valve directs flow through the boiler to add heat to the loop and system. However, if the heating loop is up to temperature and no heat is required by the system, then all flow is directed past the boiler and re-circulated back to the system, and no flow will be passing through the boiler. In contrast, copper boilers must have a constant flow of water through the boiler any time the boiler is firing.

Efficiency of Low Mass vs. High Mass Boilers

Maintaining a high mass boiler at 200°F output, when only 140°F is needed, is not the most efficient way of operating a heating system. Highest system efficiency is achieved when the boiler(s) and the system are at the lowest temperatures possible, while still maintaining maximum building comfort. An overall system efficiency increase of up to 25% can be expected by converting from a high mass cast iron or steel boiler to a copper Genesis boiler using the primary/secondary piping method.

Retrofitting A Cast Iron Boiler With Three-Way Mixing Valve To A Copper Boiler System

It is relatively easy to convert a high mass cast iron or steel system with three way mixing valves as shown in Figure 9-5 to a low mass copper Genesis boiler system incorporating a primary/secondary piping configuration.

Step 1. Remove the three-way mixing valve and replace it with a short piece of pipe as shown in Figure 9-6 - Step 1.

Step 2. Remove the boiler by-pass piping and cap the boiler by-pass tee. See Figure 9-7 - Step 2.

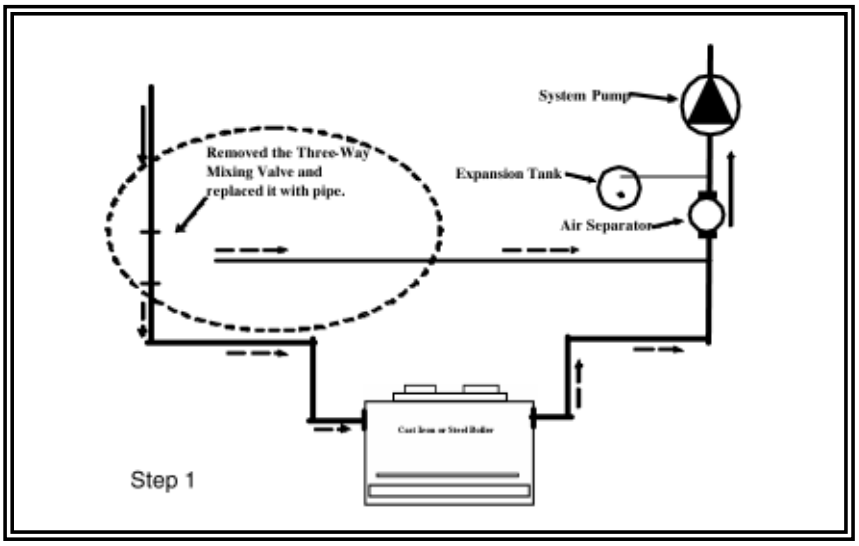


Figure 9-6 - Step 1 - Removing Mixing Valve

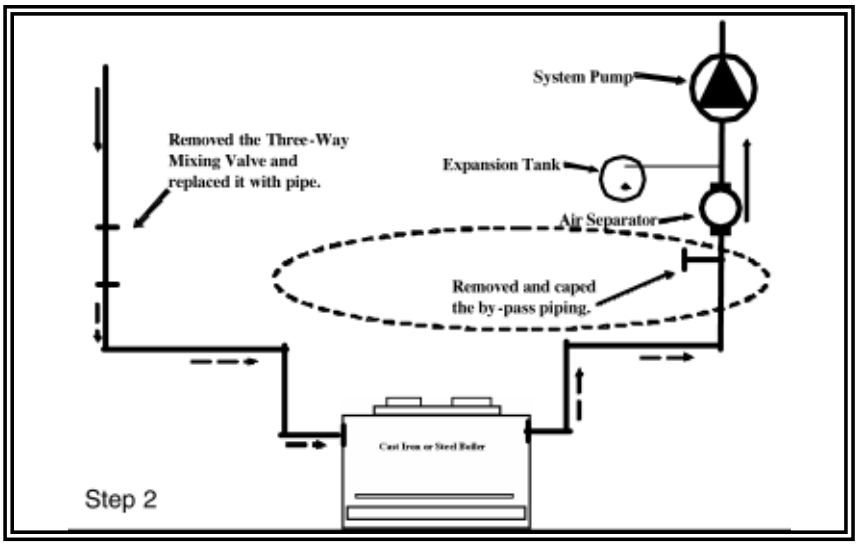


Figure 9-7 - Step 2 - Remove and Cap By-Pass Piping

Step 3. Remove the old cast iron boiler. Install a new piece of pipe with 3/4˝ stat opening and two new tees between the old boiler's system return or inlet piping and the old boiler's outlet piping. This will complete the primary loop. See Figure 9-8 Step 3.

Step 4. Install the new A. O. Smith copper boiler and connect the boiler inlet and outlets to the new tees. (As always, the two tees should be as close as possible.) This completes the secondary boiler loop. The system conversion is now complete. See Figure 9-9 for completed system view.

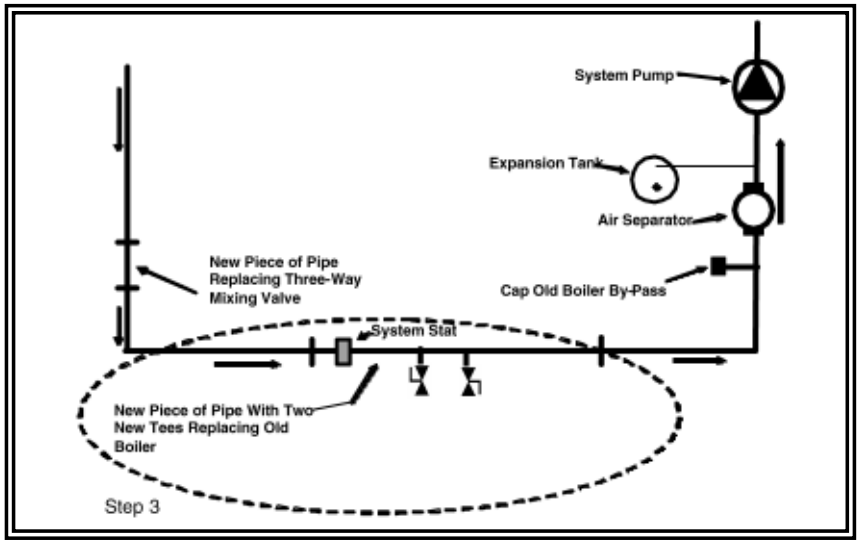


Figure 9-8 - Step 3 - Remove Old Cast Iron Boiler

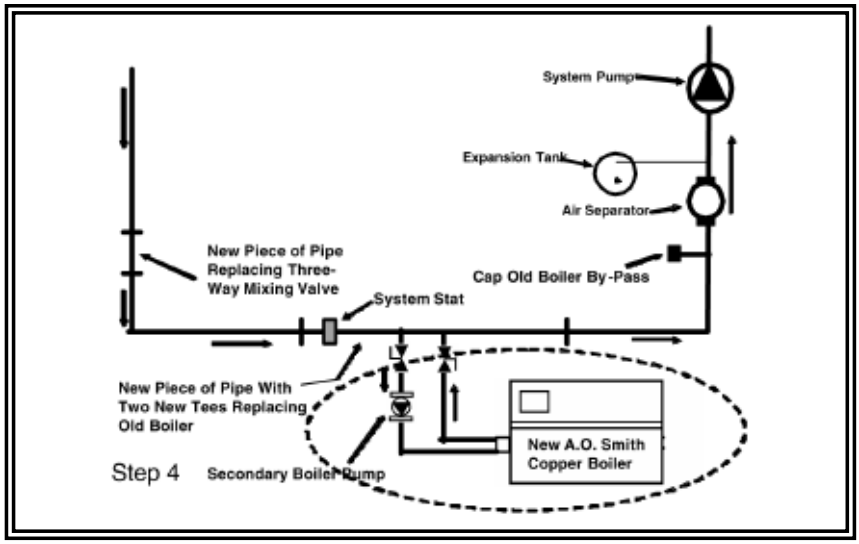


Figure 9-9 - Step 4 - Install a New A. O. Smith Copper Boiler

Retrofitting (continued)

To complete the system and for best overall system efficiency, A. O. Smith recommends installing an electronic temperature reset/sequencer control. This control adjusts the loop temperature by cycling the boiler. Now the boiler operates at a temperature, that is no higher than what is required to maintain the system at the ideal building temperature. Operating the boiler at the lowest temperature possible, while maintaining build comfort, provides best overall system efficiency.

Special Cases - Piping Low or Varied Flow Systems

The piping method illustrated in Figure 9-10 is ideal for systems with varied or changing flows. These include hydronic systems where the three-way mixing valve cannot be removed, systems using zone pumping, systems using variable speed pumps, systems using only two-way valves at the fan coils, and for systems with minimal system water volume (very short loops, single air handler systems, etc.).

This piping method will allow Genesis boilers to replace the existing large volume/large mass boilers with no other system changes. An A. O. Smith thermal accumulator (buffer tank) is used to provide the required volume that allows the copper boiler to operate smoothly, regardless of the flow through the system. With this system, the copper boiler's secondary pump circulates water on demand between the boiler(s) and the thermal accumulator. The boiler(s) maintain the temperature in the thermal accumulator at the set point temperature. See Figures 9-10, 9-11, and 9-12.

In this piping system, the high mass cast iron or steel boiler is replaced with a thermal accumulator and the copper boiler(s) are then piped to the accumulator. This accumulator should be sized for the BTU input of the lead boiler.

For applications less than 1 million BTUs use an 80-gallon accumulator. For applications over 1 million and up to 1.8 million BTUs use a 120 gallon accumulator. For applications over 1.8 million BTUs a 200 gallon accumulator is required.

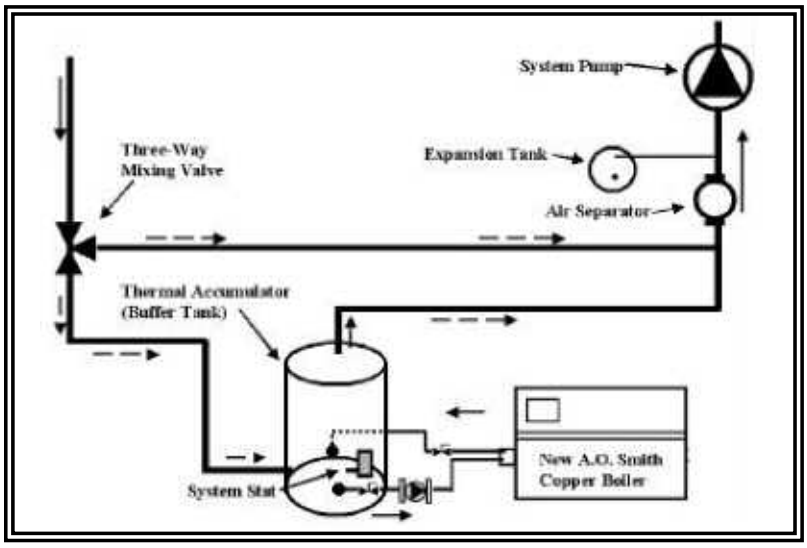


Figure 9-10 - Low/Varied Flow System

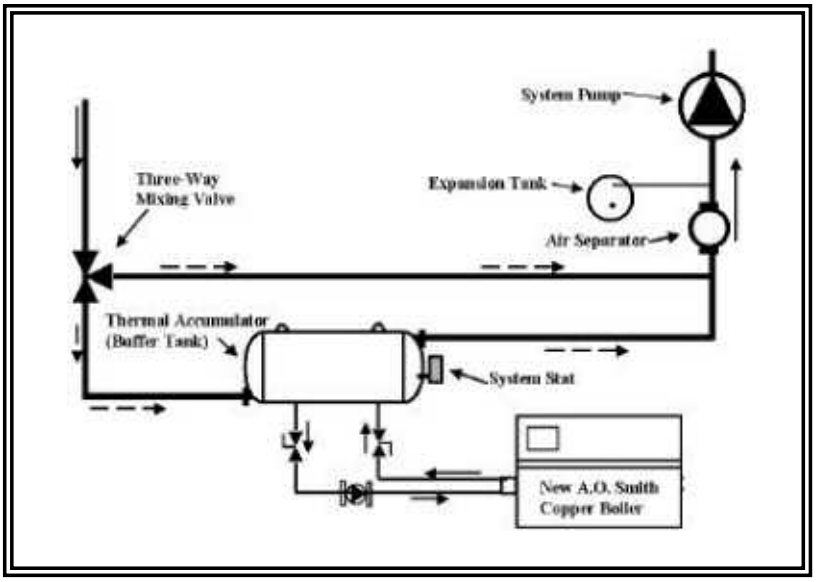


Figure 9-11 - Low/Varied Flow System With Horizontal Thermal Accumulator

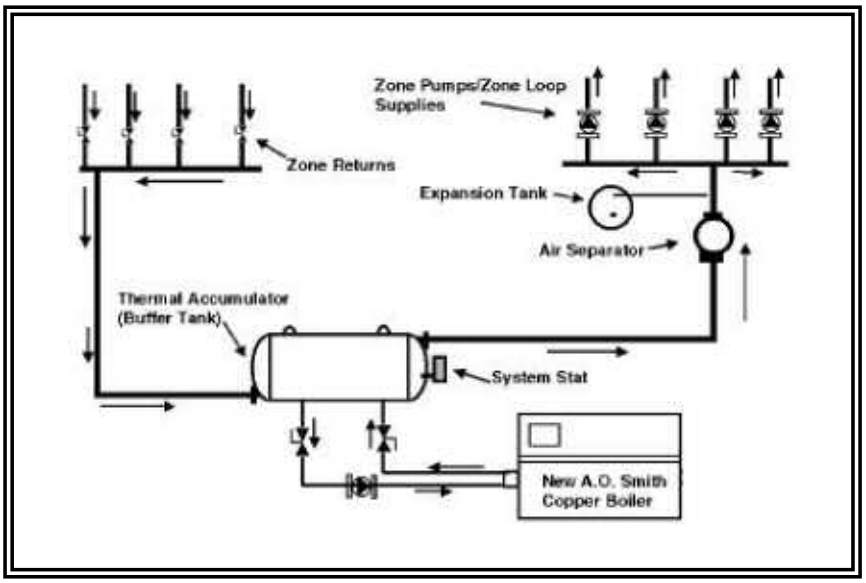


Figure 9-12 - Zone Pumping - Low/Varied Flow System With Horizontal Thermal Accumulator

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Notes:

A. O. SMITH WATER HEATERS
500 Tennessee Waltz Parkway
Ashland City, TN 37015
www.hotwater.com

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