Installation, Operating and Service Instructions for

FORCESTM™

- Steam Boiler
- Cast Iron
- Chimney Vent
- Gas Fired

Models:

- **FORCESTM03**
- **FORCESTM04**
- **FORCESTM05**
- **FORCESTM06**
- **FORCESTM07**
- **FORCESTM08**



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⚠ WARNING

Attention Installer - Affix these instructions adjacent to boiler. Provide model number and serial number when seeking information and support.

Attention Building Owner - Retain these instructions for future reference. Contact a qualified installer, service agency or gas supplier for all issues and support.

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⚠ WARNING

Read these instructions carefully before installing. This boiler must only be installed, serviced, or repaired by a qualified installer, service agency or gas supplier. Improper installation, adjustment, alteration, service, or maintenance can cause severe personal injury, death, or substantial property damage. For assistance or additional information, consult a qualified installer, service agency or gas supplier.

DURASTAR®
FORCE
BOILERS

106324-08 - 6/26

The Massachusetts Board of Plumbers and Gas Fitters has approved these boilers. See the Massachusetts Board of Plumbers and Gas Fitters website for the latest Approval Code or ask your local Sales Representative.

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

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

⚠ DANGER

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

⚠ CAUTION

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

⚠ WARNING

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

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

⚠ DANGER

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

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

⚠ WARNING

This boiler must only be serviced and repaired by skilled and experienced service technicians.

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

1 Qualified Installer, Service Agency or Gas Supplier Read Before Proceeding

⚠ WARNING

Asphyxiation Hazard. Fire Hazard. Explosion Hazard. This boiler requires regular maintenance and service to operate safely. Follow the instructions contained in this manual.

- Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Read and understand the entire manual before attempting installation, start-up operation, or service. Installation and service must be performed only by an experienced, skilled, and knowledgeable installer or service agency.
- This boiler must be properly vented.
- This boiler needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
- **Asphyxiation Hazard.** The interior of the venting system must be inspected and cleaned before the start of the heating season and should be inspected periodically throughout the heating season. A clean and unobstructed venting system is necessary to allow noxious fumes that could cause injury or loss of life to vent safely and will contribute toward maintaining the boiler's efficiency.
- Installation is not complete unless a safety relief valve is installed in the supply piping. - See the Water Piping Section of this manual for details.
- This boiler is supplied with safety devices which may cause the boiler to shut down and not re-start without service. If damage due to frozen pipes is a possibility, the heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on the heating system to prevent damage if the boiler is inoperative.
- Do not obstruct the combustion or ventilation air supply to the boiler.

⚠ WARNING

- **Burn Hazard.** This boiler contains very hot water under high pressure. Do not unscrew any pipe fittings nor attempt to disconnect any components of this boiler without positively assuring the water is cool and has no pressure. Always wear protective clothing and equipment when installing, starting up or servicing this boiler to prevent scald injuries. Do not rely on the pressure and temperature gauges to determine the temperature and pressure of the boiler. This boiler contains components which become very hot when the boiler is operating. Do not touch any components unless they are cool.
- **Respiratory Hazard.** Boiler materials of construction, products of combustion and the fuel contain alumina, silica, heavy metals, carbon monoxide, nitrogen oxides, aldehydes and/or other toxic or harmful substances which can cause death or serious injury and which are known to the state of California to cause cancer, birth defects and other reproductive harm. Always use proper safety clothing, respirators and equipment when servicing or working nearby the appliance.
- Failure to follow all instructions in the proper order can cause personal injury or death. Read all instructions, including all those contained in component manufacturers manuals which are provided with the boiler before installing, starting up, operating, maintaining or servicing.
- All cover plates, enclosures and guards must be in place at all times.

⚠ DANGER

Explosion Hazard. Electrical Shock Hazard. Burn Hazard. This boiler uses flammable gas, high voltage electricity, moving parts, and very hot water under high pressure.

Assure that all gas and electric power supplies are off and that the water temperature is cool before attempting any disassembly or service. Do not attempt any service work if gas is present in the air in the vicinity of the boiler. Never modify, remove or tamper with any control device.

2 User/Homeowner Read Before Proceeding

⚠ WARNING

Asphyxiation Hazard. Fire Hazard.

• A qualified installer, service agency or gas supplier should annually inspect boiler.

• If you are not qualified to install or service boilers, do not install or service this one.

• Carbon monoxide is an odorless, deadly gas that may be introduced into your home by any malfunctioning fuel burning product or vent system failure. **The installer must verify that at least one carbon monoxide alarm has been installed within a residential living space or home following the alarm manufacturer's instructions and applicable local codes before putting the appliance into operation. Consider installing CO alarms near bedrooms in all levels of building to warn you and your family of potential CO exposure.**

• Do not block air flow into or around boiler or opening for fresh air into boiler room. Insufficient air may cause the boiler to produce carbon monoxide or start a fire.

NOTICE: Protect your home in freezing weather. A power outage, operating control, or component failure will prevent your boiler from lighting. In winter your pipes may freeze and cause extensive property damage. Do not leave heating system unattended during cold weather unless alarms or other safeguards are in place to prevent such property damage.

⚠ CAUTION

Burn Hazard.
Keep children and pets away from hot surfaces of the boiler including boiler piping, vent piping, and vent terminals.

NOTICE:

- Boiler may leak water or steam at the end of its useful life. Be sure to protect walls, carpets, and valuables from water or steam that could leak from boiler.
- This boiler contains controls which may cause the boiler to shut down and not restart without service. If damage due to frozen pipes is a possibility, heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on heating system to prevent damage if boiler is inoperative.

3 Specifications

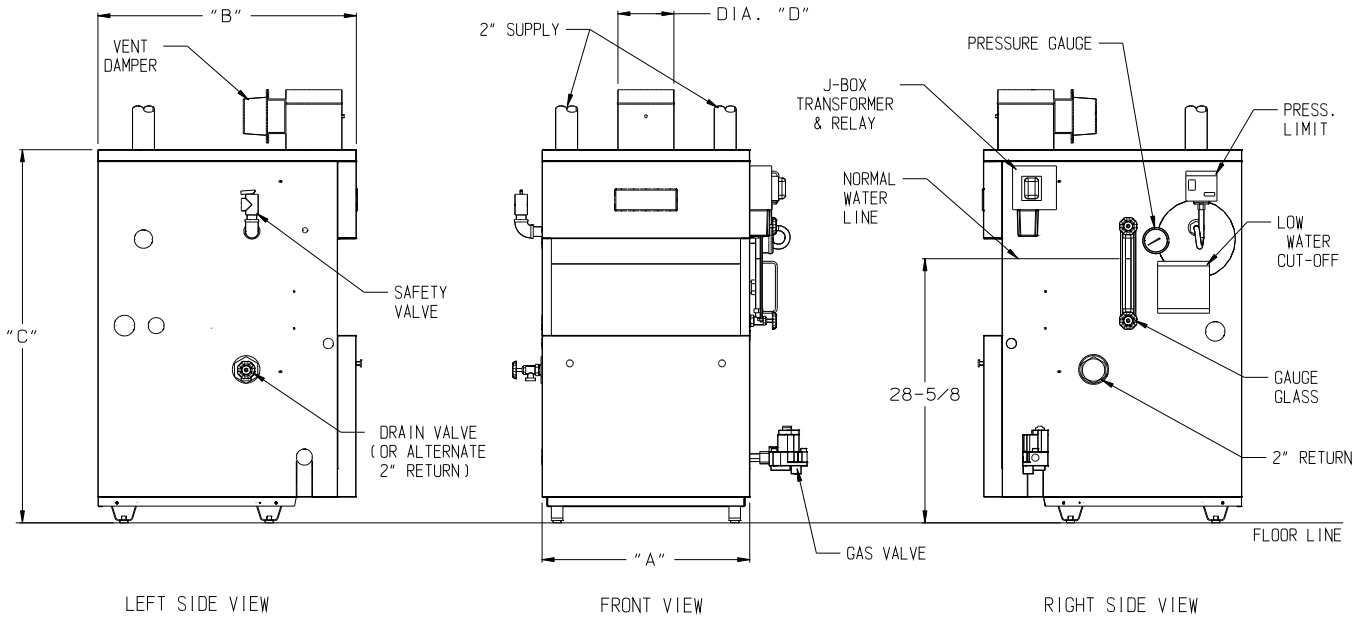


Figure 3-1: General Configuration

Table 3-2: Specifications

AGS Space Heating Ratings Natural Gas AHRI CERTIFIED® www.ahridirectory.org						NO. OF SEC.	Dimensions				Water Volume (Gal.)		Approx. Shipping Weight (lbs.)
Model Number	Input (MBH)	Heating Capacity (MBH)	AHRI NET Rating Steam (MBH)		AFUE (%)		"A" (in)	"B" (in)	"C" (in)	"D" (in)	Steam Boiler	(1)	
			SQ. ft.	MBH									
FORCESTM03	69	57	179	43	82.0	3	12-3/4	28	40-7/16	4	5.1	1.2	350
FORCESTM04	103	85	267	64	82.0	4	16	28	40-7/16	5	6.5	1.5	420
FORCESTM05	138	113	354	85	82.0	5	19-1/4	28	40-7/16	6	7.9	1.8	485
FORCESTM06	172	142	446	107	82.1	6	22-1/2	28	40-7/16	6	9.3	2.1	555
FORCESTM07	207	171	533	128	82.1	7	25-3/4	30	40-7/16	7	10.7	2.4	620
FORCESTM08	241	199	621	149	82.2	8	29	30	40-7/16	7	12.1	2.7	690

(1) Steam boiler's "steamable water volume": water volume from NWL (normal water level) to low water cutoff level.

3 Specifications *(continued)*

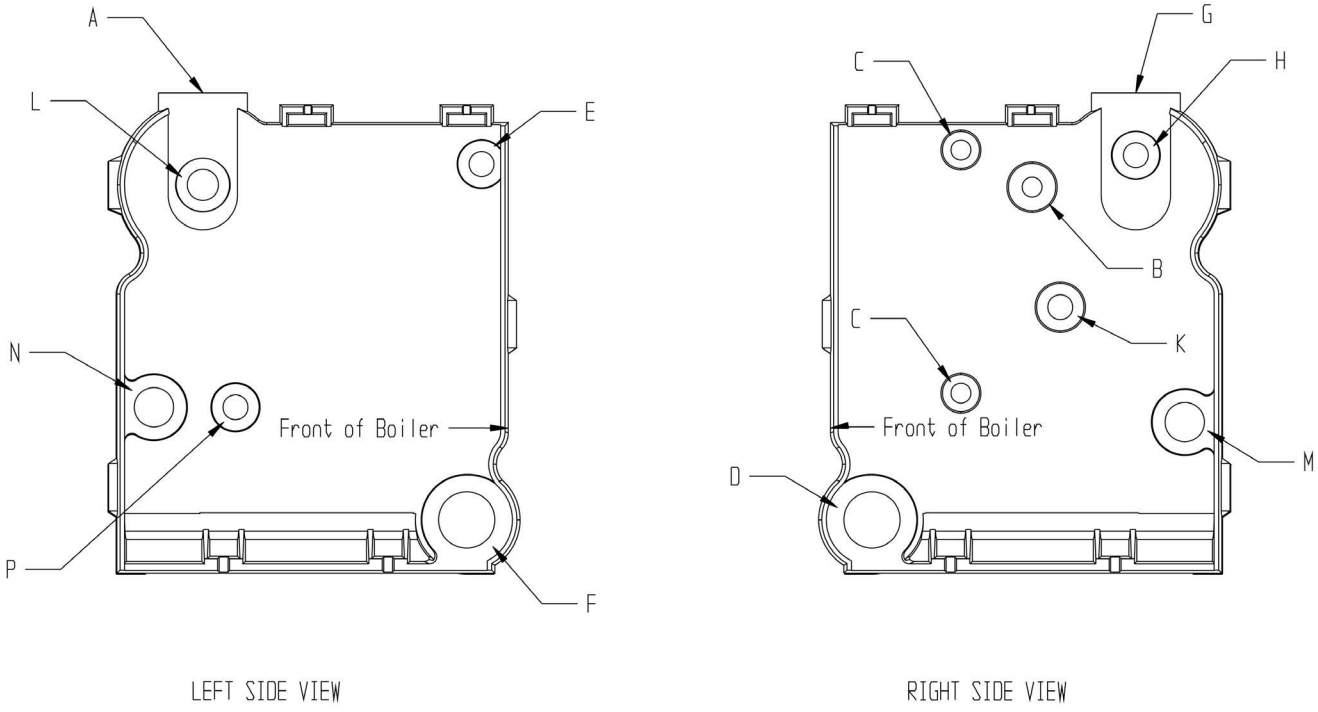


Figure 3-3: Tapping Locations

Table 3-4: Trim and Control Installation in Section Tappings

Tapping	Size (NPT)	Steam Boiler with Probe LWCO
A	2	Supply
B	½	Bush to ¼ Pressure Gauge
C	½	Gauge Glass
D	2	Return
E	¾	3 in. Nipple & Street Elbow **Safety Valve**
F	2	Contractor Installed Bush to ¾ Drain Valve and/or Optional Return
G	2	Optional Supply (AGS3-AGS6) Required Supply (AGS7-AGS8)
H	¾	Bush to ¼ & Syphon, Limit
J	¾	Not Applicable
K	¾	Low Water Cutoff
L	1 ¼	Skimming Connection **(6 in. Nipple and Cap)**
M	1¼	Factory Plugged Indirect Water Heater (IWH) Return
N	1¼	Factory Plugged Indirect Water Heater (IWH) Supply
P	¾	Factory Plugged Limit Control

4 Pre-Installation

⚠ WARNING

Carefully read all instructions before installing boiler. Failure to follow all instructions in proper order can cause personal injury or death.

1. Inspect shipment carefully for signs of damage. Any claim for damage or shortage in shipment must be filed immediately against carrier by consignee. No claims for variances or shortages will be allowed by Boiler Manufacturer, unless presented within sixty (60) days after receipt of equipment.
2. Safe, reliable operation of this boiler depends upon installation by a professional heating contractor in strict accordance with this manual and the requirements of the authority having jurisdiction.
   A. In the absence of an authority having jurisdiction, installation must be in accordance with this manual and the *National Fuel Gas Code*, ANSI Z223.1 latest edition. In Canada, follow CAN/CSA B149.1 (*Natural Gas and Propane Installation Code*).
   B. Where required by the authority having jurisdiction, this installation must conform to the *Standard for Controls and Safety Devices for Automatically Fired Boilers* (ANSI/ ASME CSD-1)-latest edition.
3. Make sure that a properly sized chimney is available which is in good condition. Consult the authority having jurisdiction, Part 6 of this manual, and the *National Fuel Gas Code* for additional information on venting requirements.
4. Make sure the boiler is properly sized. A steam boiler must be sized to match the amount of connected radiation. If the boiler is undersized for the connected radiations, radiators furthest from the boiler will remain cold, resulting in uneven heat. This will happen even if the output of the boiler matches the design heat loss of the structure. Conversely, a boiler that is too large for the connected radiation will short cycle on pressure, resulting in inefficient operation. Determine the boiler size required for the connected radiation using a reference such as the *I=B=R Residential Hydronic Heating Guide* (Pub. RHH) published by Air Conditioning Contractors of America (ACCA).
5. Make sure that the boiler received is configured for the correct gas (natural or LP).
6. This boiler is not configured for installation at altitudes above 2,000 ft.

⚠ DANGER

- Do not attempt to operate a natural gas boiler on LP, or an LP boiler on natural gas without first converting it using a kit provided by the factory.
- Failure to properly convert this boiler for the fuel being used will result in operation of the boiler at high Carbon Monoxide (CO) levels and/or other unsafe conditions, resulting in personal injury or loss of life. Improper conversion may also result in unreliable operation and severe property damage.

5 Locating Boiler

⚠ WARNING

Failure to observe the following location requirements could result in a fire, explosion or Carbon Monoxide (CO)hazard.

1. Clearances:
   A. Observe minimum clearances shown below to avoid potential fire hazard. Except as noted, these clearances apply to all combustible construction as well as noncombustible walls, ceilings and doors. Also see Figure 5-1.

Front - Alcove Left Side - 6 in. Right Side - 18 in.
Rear - 6 in. Top - 17 in.

   B. A 24 in. service clearance from the jacket is recommended on the left, right, and front of the boiler. These clearances may be Reduced to those shown in Figure 5-1, however servicing the boiler will become increasingly difficult as these service clearances are reduced.
   C. If the right side 24 in. service clearance is reduced, adequate clearance must be maintained to easily read and access the controls. Alternatively, access may be provided using a door.

2. The boiler must be installed on a hard level surface. This surface may be combustible.
3. Do not install this boiler in a location where gasoline or other flammable vapors or liquids, or sources of hydrocarbons (i.e. bleaches, cleaners, chemicals, sprays, paint removers, fabric softeners, etc.) are used or stored.
4. Do not install this boiler in an area where large amounts of airborne dust will be present, such as a workshop.
5. The boiler should be located as close to the chimney as possible.
6. Do not install this boiler over carpeting. This may cause a fire.
7. Do not install this boiler directly on a surface that may get wet. Raise the boiler on a pad.
8. Protect ignition system components from sources of water that may spray, drip or rain on them during installation or service.
9. For basement installation provide concrete base if floor is not level or if water may be encountered on floor around boiler.

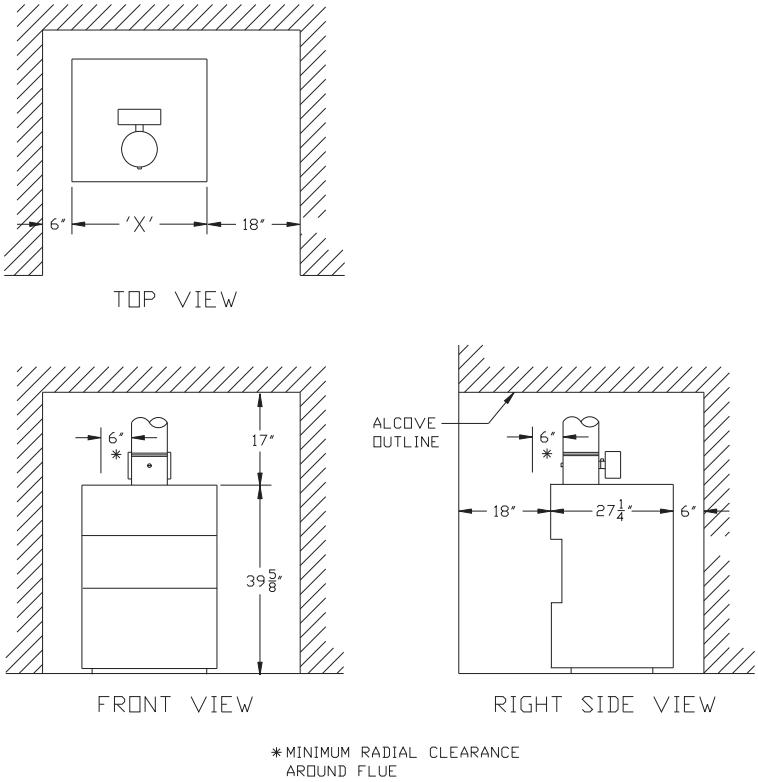


Figure 5-1: Clearances to Combustible Construction and Noncombustible Ceilings, Walls, and Doors

6 Air for Combustion and Ventilation

⚠ WARNING

- This boiler is not designed for use in a space that is depressurized relative to the outdoors. Operating this boiler in a depressurized space may cause severe personal injury or death.
- INSUFFICIENT COMBUSTION AIR SUPPLY may result in the production and release of deadly Carbon Monoxide (CO) into the home.
- PROVIDE ENOUGH AIR to ventilate the boiler room, and sustain combustion. Ignition failure, overheating, fire, carbon monoxide, and spillage of flue gases may result from poor air supply.
- Do not install this boiler in areas where it will draw combustion air from areas where chemicals, such as bleaches, fabric softeners, paints, cleaners, refrigerants, and cat boxes are used or stored. Do not draw combustion air containing large amounts of dust such as that generated by dry wall construction or woodworking. Failure to observe this warning could result in objectionable odors, severe boiler damage, personal injury or loss of life.

Sufficient fresh air must be supplied for combustion, ventilation, and flue gas dilution. Provisions for an adequate fresh air supply must be made in accordance with local codes, or in the absence of such codes, the *National Fuel Gas Code* (NFPA 54/ ANSI Z223.1). In Canada, refer to the *Natural Gas and Propane Installation Code* (CAN/CSA 149.1). The *National Fuel Gas Code* describes three basic ways to supply this boiler with adequate fresh air:

Indoor Combustion Air – Combustion air is drawn into the boiler room from other parts of the building and from the outdoors through natural infiltration (cracks under doors, etc). **This method can not be used in all cases – see discussion below.**

Outdoor Combustion Air – Combustion air is brought directly into the boiler room from outdoors through ducts or grills sized and installed specifically for this purpose.

Mechanical Combustion Air Supply – Combustion air is brought into the room from outdoors using a blower system that is engineered specifically for this purpose.

Each of the above methods is described in more detail in the following sections. The *National Fuel Gas Code* also describes some acceptable variations on these techniques that do not appear here.

Using the Indoor Combustion Air Method

1. Total the input of all appliances in the boiler room in thousands of BTU/hr.
2. Find the volume of the boiler room in cubic feet:

   Volume (ft^3) = Length (ft) x Width (ft) x Height (ft)

   If the boiler room adjoins another room and there is no door present between these two rooms, add the volumes of the rooms together. Repeat for any other connected rooms which do not have doors. **Do not add the volume of two rooms separated by a door even if that door is "always left open"**.
3. Divide the volume obtained in Step 2 by the input calculated in Step 1.
4. If the result is at least 50 ft^3 per 1,000BTU/hr, and neither of the conditions described in (6) below are met, normal infiltration should provide ad equate fresh air into the boiler room.
5. If the result is less than 50 ft^3 per 1,000BTU/hr, provide two openings into the boiler room, one near the floor and one near the ceiling. The top edge of the upper opening must be within 6 in. of the ceiling and the bottom edge of the lower opening must be within 6 in. of the floor (Figure 6-1):
   A. Each opening must have a free area of 1 square inch per 1,000 BTU/hr input of all gas burning appliances in the boiler room. The minimum opening dimension is 3 inches. Minimum opening free area is 100 square inches per opening.
   B. If the total volume of both the boiler room and the room to which the openings connect is less than 50 cubic feet per 1,000 BTU/hr of total appliance input, install a pair of identical openings into a third room. Connect additional rooms with openings until the total volume of all rooms is at least 50 cubic feet per 1,000 BTU/hr of input.
   C. The "free area" of an opening takes into ac count the blocking effect of mesh, grills, and louvers. Where screens are used, they must be no finer than ¼ in. (4 x 4) mesh.
   D. If providing openings into adjacent rooms is undesirable, use the Outdoor Combustion Air Method.
6. Do not use the Indoor Combustion Air Method described above if either of the following are true:
   A. The indoor space is so tightly constructed that the number of air changes per hour is known to be 0.4 or less.

6 Air for Combustion and Ventilation *(continued)*

B. The boiler room is depressurized relative to the outdoors. This depressurization is possible if the structure is tightly constructed and/or is equipped with exhaust fans.

Example:

A 103MBH input boiler and a water heater are to be installed in a room measuring 6 ft. - 3 in. x 7 ft. with an 8 ft. ceiling. The water heater has an input of 30,000 BTU/hr:

Total input in thousands of BTU/hr. = (103,000 BTU/hr. + 30,000 BTU/hr.) ÷ 1,000 = 133

Volume of room = 6.25 ft. x 7 ft. x 8 ft. = 350 ft.^{3}

350 ÷135 = 2.59. Since 2.59 is less than 50, there will be an inadequate fresh air supply in the boiler room unless openings are installed between the boiler room and at least one adjacent room. It turns out that the boiler room in this example is adjacent to a full basement which is 20 ft. x 45 ft. x 8 ft. high. If two openings are installed into this basement that each have a free area of 135 in.^{2}, the combined volume of the boiler room and basement will be:
350 ft.^{3} + 6,400 ft.^{3} = 6,750 ft.^{3} and:
6,750 ÷ 133 = 50.8 ft.^{3} per 1,000 BTU/hr. In the absence of one of the conditions described in (6) above, this arrangement should provide an adequate fresh air supply to all the appliances in the boiler room.

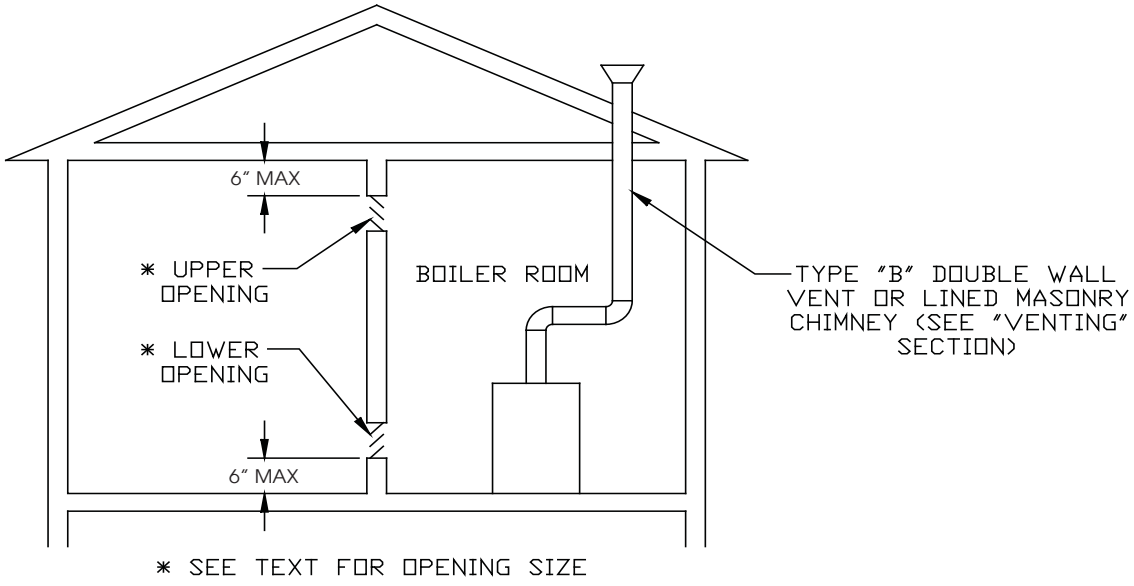


Figure 6-1: Indoor Combustion Air Method

6 Air for Combustion and Ventilation *(continued)*

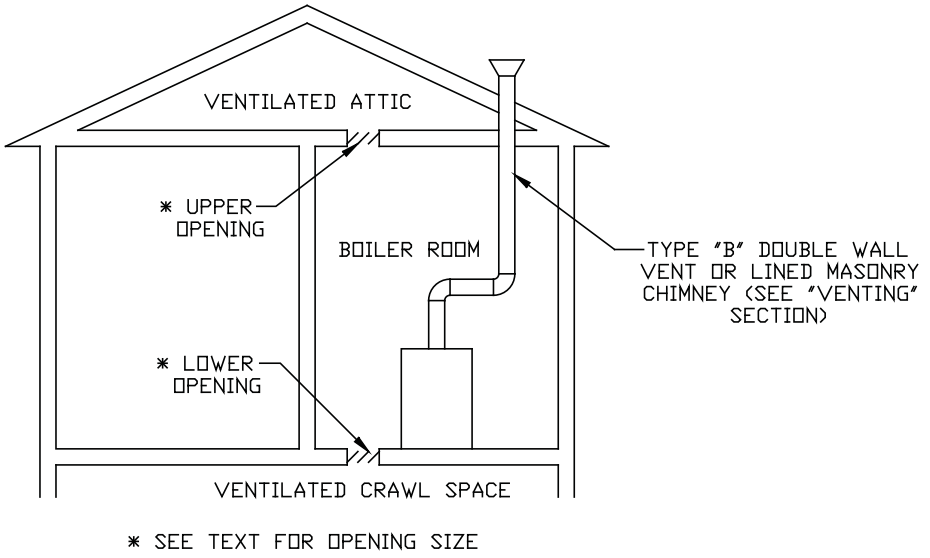


Figure 6-2: All Air From Outdoors, Ventilated Crawl Space and Attic

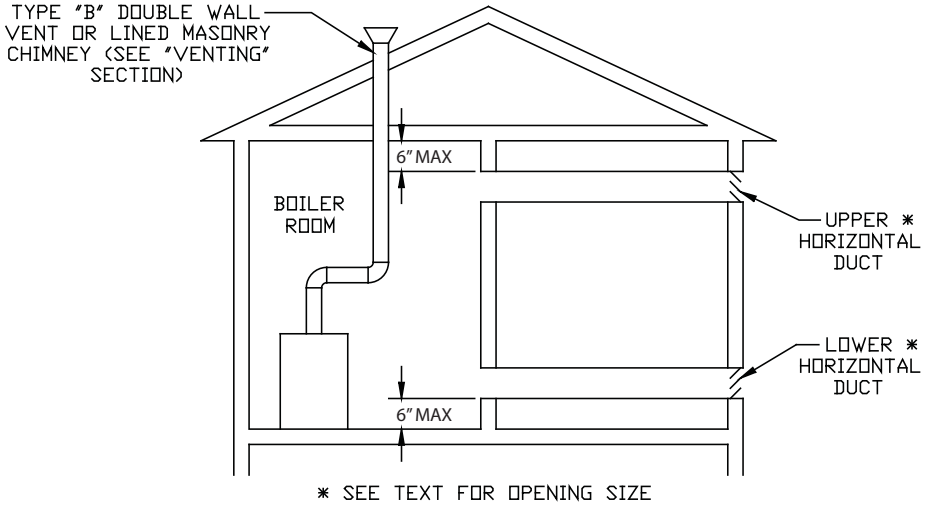


Figure 6-3: All Air From Outdoors, Via Ventilated Attic

Using the Outdoor Combustion Air Method

1. Openings must be installed between the boiler room and the outdoors or a ventilated space, such as an attic or crawl space, which communicates directly with the outdoors.
2. Two openings are required. The top edge of the upper opening must be within 6 inches of the ceiling. The bottom edge of the lower opening must be within 6 inches of the floor.
3. Size openings and ducts as follows:
   A. Vertical ducts or openings directly outdoors (Figure 6-2, Figure 6-3, and Figure 6-4) - Each opening must have a free cross sectional area of 1 square inch per 4,000 BTU/hr of the total input of all gas-fired appliances in the boiler room. Minimum opening size is 3 inches.
   B. Openings to outdoors via horizontal ducts (Figure 6-5) - Each opening must have a free cross sectional area of 1 square inch per 2,000 BTU/hr of the total input of all gas fired appliances in the boiler room. Minimum opening size is 3 inches.
   C. The “free area” of an opening takes into ac count the blocking effect of mesh, grills, and louvers. Where screens are used, they must be no finer than ¼ in. (4 x 4) mesh.
   D. If motorized louvers are installed in the openings to the outdoors, they must be inter locked to prevent operation of the fuel burning appliances in the boiler room unless the louvers are open.

6 Air for Combustion and Ventilation *(continued)*

Mechanical Combustion Air Supply

A mechanical system may be used to bring all combustion air to the boiler which meets all of the following requirements:

1. The system must be manufactured specifically for this purpose.
2. Size the system to deliver combustion air at the rate prescribed by the system manufacturer's instructions, but no less than 0.35 CFM for each 1,000 BTU/hr of the combined input of all fuel burning appliances in the boiler room. If exhaust fans are present within the building, additional capacity may be required to prevent the boiler room from being depressurized.
3. The system must be interlocked to prevent operation of the fuel burning appliances in the boiler room if the system is not operating.

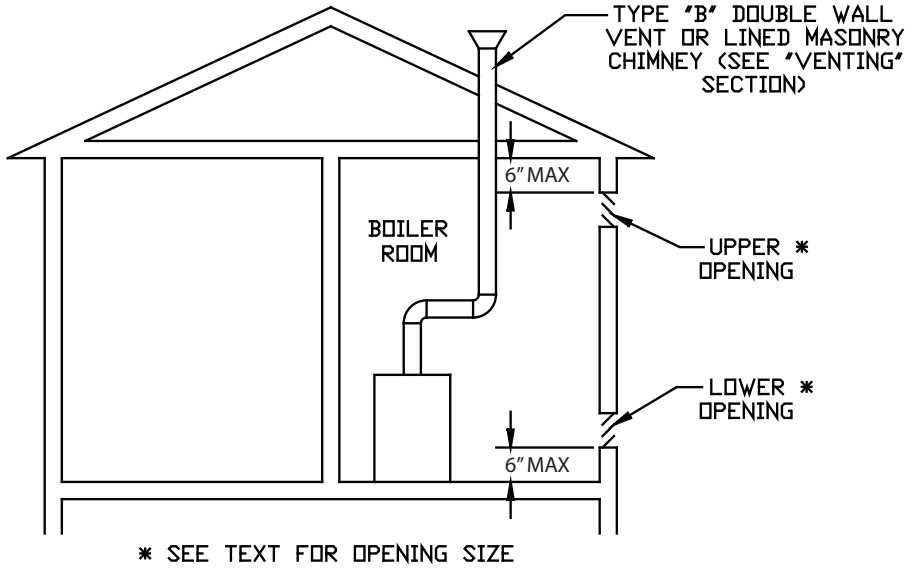


Figure 6-4: Outdoor Combustion Air Method: Using Openings into Boiler Room

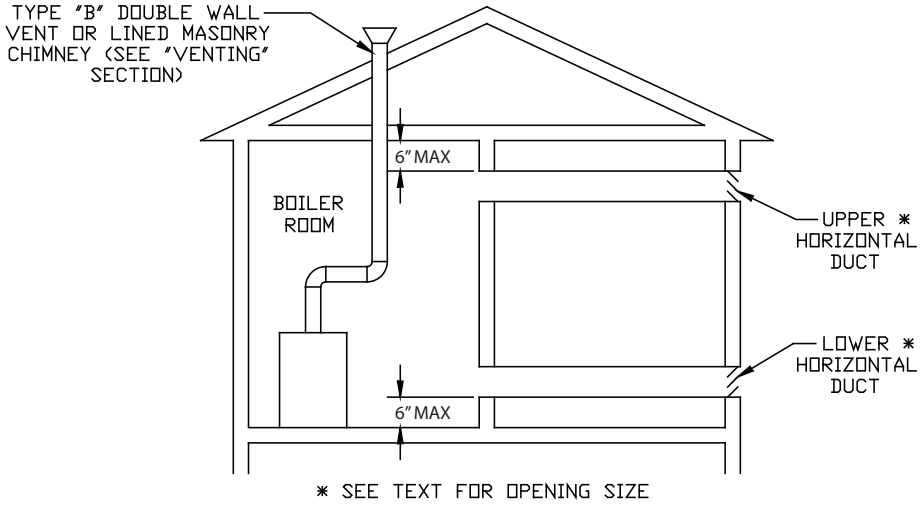


Figure 6-5: Outdoor Combustion Air Method: Using Horizontal Ducts into Boiler Room

7 Venting

⚠ WARNING

- Improper venting may result in property damage and/or the release of flue gases, which contain deadly Carbon Monoxide (CO), into the home, which can cause severe personal injury or death.
- Do not use plastic venting materials (such as CPVC, PVC and RADEL) to vent this boiler.
- Inspect existing chimney before installing boiler. Failure to clean or replace damaged pipe or tile lining will cause severe injury or death.

The vent system installation must be in accordance with local codes, or in the absence of such codes, the *National Fuel Gas Code* (NFPA 54/ANSI Z223.1).

A typical vent installation is illustrated by Figure 7-1. The components of vent installation are boiler draft diverter, vent damper, vent connector and chimney. This boiler is equipped with a draft hood which is built into the boiler; do not attempt to install an external draft hood.

1. Acceptable Chimneys - The following chimneys may be used to vent this boiler:
   A. Listed Type B or L gas vent - Install in accordance with the manufacturer's instructions, the terms of its listing, and applicable codes.
   B. Masonry Chimney - The masonry chimney must be constructed in accordance with local codes, or in the absence of any, the *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances* (NFPA 211). The chimney must be lined with a clay liner or other listed lining system. Do not vent this boiler into an unlined chimney.
2. Acceptable Vent Connectors - The following may be used for vent connectors:
   A. Listed type B or L Gas Vent
   B. Single Wall Galvanized Pipe - Use 0.018 in. (26 gauge or heavier). The size and location of the chimney may not permit the use of a single wall connector in some cases. (see the *National Fuel Gas Code*). Do not use single wall pipe for vent connectors in attics.
   C. Other Vent Connectors Permitted by the *National Fuel Gas Code*.
3. Chimney and Vent Connector Sizing - Size the chimney and vent connector in accordance with the *National Fuel Gas Code*.
4. Exterior Chimneys - An exterior chimney has one or more sides exposed to the outdoors below the roof line. The *National Fuel Gas Code* prescribes two conditions under which an exterior chimney may be used:

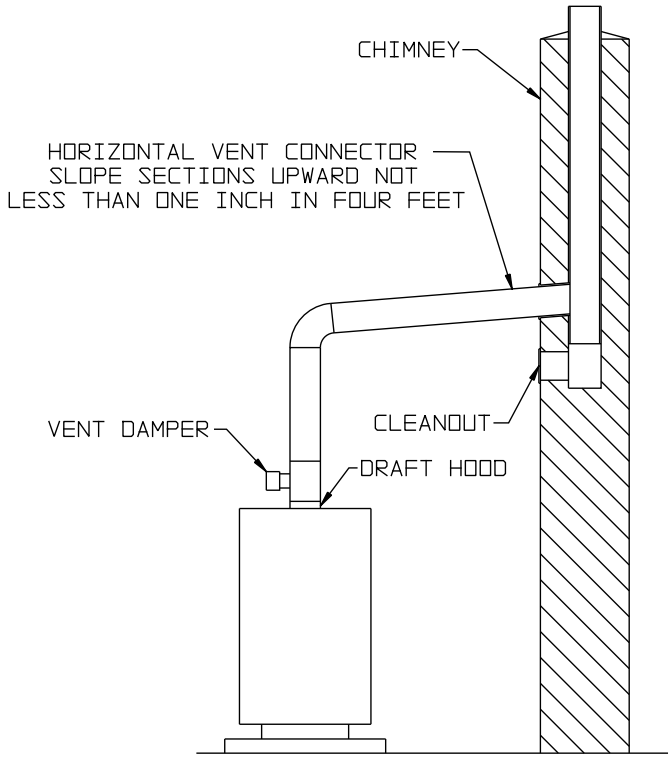


Figure 7-1: Typical Vent System Installation and Components

7 Venting *(continued)*

A. In some very restrictive cases, this boiler may be vented into an exterior ceramic lined masonry chimney. See the *National Fuel Gas Code* for information on when exterior chimneys may be used.

B. An exterior masonry chimney may be used if it is lined with B vent or a listed chimney lining system.

5. This boiler may be vented using a listed power venter. The power venter must be in sized and installed in accordance with the power venter manufacturer's instructions, the terms of the power venter listing, and applicable codes. The boiler must be electrically interlocked with the power venter to prevent boiler operation if the power venter fails to operate. Before deciding to use a power venter, make certain that the flue gas exiting the power venter will not damage adjacent construction or other structures. Also make certain that the power venter terminal will not be subjected to winds which could affect power venter operation.
6. Do not connect the vent of this appliance into any portion of a mechanical vent system operating under positive pressure.
7. Do not connect the boiler into a chimney flue serving an open fireplace or other solid fuel appliance.
8. Prior to boiler installation, inspect chimney for obstructions or other defects and correct as required. Clean chimney as necessary.
9. Vent pipe should slope upward from draft diverter not less than one inch in four feet. No portion of vent pipe should run downward or have sags. Vent pipe must be securely supported.
10. The vertical section of vent pipe coming off the boiler should be as tall as possible, while still maintaining the proper clearance from the horizontal vent connector to combustibles and the proper pitch called for in (9) above.
11. Vent pipe should be installed above the bottom of the chimney to prevent blockage.
12. Vent pipe must be inserted flush with inside face of the chimney liner and the space between vent pipe and chimney sealed tight.
13. Do not install the vent damper in any portion of the vent system which is used by appliances other than the boiler being installed.
14. Installation of the vent damper supplied with this boiler is mandatory. Install vent damper (see Figure 7-2) as follows:

    A. Open vent damper carton and remove installation instructions. Read the instructions thoroughly before proceeding. Verify that vent damper is same size as draft diverter outlet (Figure 3-1). Unpack vent damper carefully. Do not force closed damper blade. Forcing vent damper closed may result in damaged gear train and void warranty.

    B. Vent damper is factory shipped having approximately ¾ in. diameter hole in the vent damper blade, which must be plugged. Use the plug supplied with the damper.

    C. Mount the vent damper on the flue collar without modification to either and secure with sheet metal screws. Make sure screws do not interfere with damper blade operation. Vent damper blade position indicator must be visible to users.

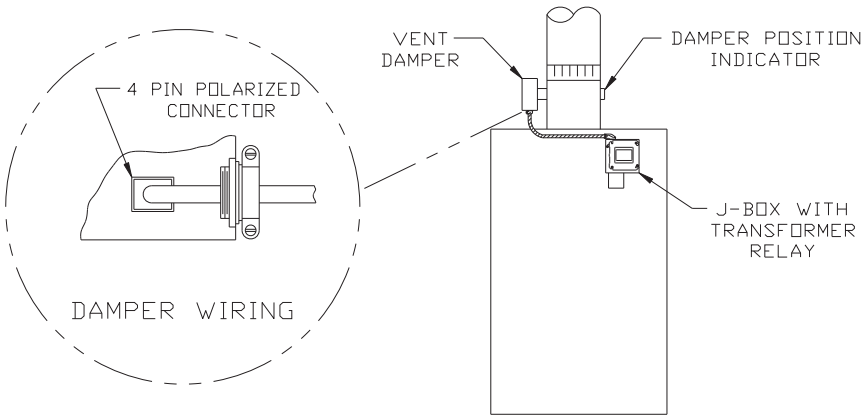


Figure 7-2: Vent Damper Installation Details

7 Venting *(continued)*

D. The damper wire harness is shipped pre-wired into the boiler. Plug the loose end of this harness into the damper and secure the flexible conduit to the damper using a connector nut provided. Provide adequate clearance to combustible construction and servicing.

E. Install vent connector pipe and vent fittings from vent damper outlet to chimney or gas vent. Secure with sheet metal screws and support as required.

Removing an Existing Boiler from a Common Chimney

In some cases, when an existing boiler is removed from a common chimney, the common venting system may be too large for the remaining appliances. At the time of removal of an existing boiler the following steps shall be followed with each appliance remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common venting system are not in operation.

1. Seal any unused opening in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion and other deficiencies which could cause an unsafe condition.
3. Insofar as practical, close all building doors and windows and all doors between the space in which all the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.
4. Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so the appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after five (5) minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar, or pipe.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliances to their previous condition of use.
7. Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Part 10 of the National Fuel Gas Code, ANSI Z223.1.

8 Steam Piping

⚠ WARNING

- Do not use softened water in steam boilers. Accelerated boiler corrosion will result. Tie in fresh water supply to boiler upstream of a water softener.
- Oxygen contamination of boiler water will cause corrosion of iron and steel boiler components, and can lead to boiler failure. Check for and correct system leaks.

NOTICE:

Before using copper for steam piping, consider the following characteristics of copper piping:

1. High coefficient of thermal expansion can induce mechanical stresses and cause expansion/contraction noises if not accounted for in piping system design and installation. This can especially be an issue in multiple riser installations.
2. Soldering or brazing pastes and fluxes that end up in the system can cause poor heat transfer, surging, an unsteady water line and wet steam if not thoroughly removed during the skimming procedure.
3. Galvanic corrosion of adjoining metal may occur due to dissimilar metals in certain water chemistry (such as pH less than 7.0 or greater than 11.0) if dielectric unions are not used.

General Piping Notes

Figures 8-2 through 8-4 shows recommended near boiler piping for most common types of gravity return steam systems. Additional information on steam system design may be found in the *I=B=R Residential Hydronic Heating Guide* (Pub. RHH) published by Air Conditioning Contractors of America (ACCA).

One of the primary purposes of this near boiler piping is to separate tiny water droplets from the steam exiting the boiler so that “dry” steam is sent to the system. If the near boiler piping is not correct, wet steam will enter the system and the following problems may occur:

1. Short cycling on low water
2. Boiler or system Flooding
3. Hammering
4. Failure to heat one or more radiators

Avoid the three common piping mistakes shown in Figure 8-5. This applies even if the existing boiler has one of the piping mistakes shown in Figure 8-5 and appears to be working. If two or more steam mains must be connected to the boiler, connect a separate take-off for each main into the header between the riser(s) and equalizer. Also note the following points:

1. A size reduction must be made to connect the header to the equalizer. This reduction must be made in the equalizer line. Do not make this size reduction in the horizontal header.
2. One pipe steam systems require air vents on each radiator, as well as at the end of each main. For the system to work properly, these vents must be properly installed, sized, and be in good condition. Inspect and replace any defective vents. If there are no vents at the ends of the mains, install them.
3. The use of gravity returns on a multiple steam boiler installation is not recommended due to potential problems maintaining a uniform water line in all boilers (even a one ounce per square inch difference in the pressure of adjacent boilers will cause a 1 ¾ inch difference in their water lines).
4. For installations with condensate or boiler feed pumps, follow the pump manufacturer’s selection and installation instructions. Such systems generally do not require Hartford loops.
5. Do not use a check valve in place of, or in addition to, a Hartford loop on a gravity return system.
6. Pipe the fill connection from a clean source of cold water. When the water supply is from a well, make sure that a strainer is installed in the well system.
7. The single most important factor in determining expected life cycle of a steam boiler is the amount of fresh water added to boiler during operation. Fresh water brings minerals and oxygen into the boiler. These contaminants greatly accelerate corrosion of cast iron boiler sections. Assure all system radiators, piping and vents are absolutely leak tight.
   A. If system contains hidden piping (hidden behind walls, buried in concrete, etc.) pressure test this piping and repair any leaks found.

8 Steam Piping *(continued)*

B. Providing a means of monitoring the amount of fresh water added to the system will allow an increase in water loss to be identified, and the cause corrected, before significant damage to the boiler occurs. This can be accomplished using water meter installed in the water feed line. Alternatively, some automatic water feeders, such as the Hydrolevel VXT Series, have the ability to monitor the total amount of water they have added to the system.

Near-Boiler Piping Installation

1. Install safety valve (spindle must be in vertical position) into tapping on boiler left side using the 3/4 in. NPT nipples and elbow supplied (Figure 8-1).
2. Pipe the discharge of the safety relief valve to a location where water or steam will not create a hazard or cause property damage if the valve opens. The end of the discharge pipe must terminate in an unthreaded pipe. If the safety valve discharge is not piped to a drain it must terminate at least 6 inches above the floor. The termination of the safety valve discharge piping must be in an area where it is not likely to become plugged by debris or subjected to freezing.

⚠ DANGER

- Do not install any valves between boiler and relief valve.
- Do not install any valves between relief valve and discharge.
- Do not move relief valve from factory specified location.
- Do not plug relief valve discharge.
- Do not install a relief valve with a setting greater than 15 psi.

⚠ WARNING

- Pipe discharge of relief valve to a location where water or steam will not create a hazard or cause property damage if the relief valve opens.
- End of discharge pipe must terminate in an unthreaded pipe.
- Termination of the relief valve discharge piping must be in an area where it is not likely to become plugged by debris or subjected to freezing.

3. Install drain valve into tapping on boiler left side using the 2 x 3/4 bushing provided (see Figure 8-1).
4. Install the nipple and cap provided in the 1-1/4 skimmer tapping as shown in Figure 8-1.
5. The FORCESTM03 - FORCESTM06 may be piped with either one or two Supply risers as shown in Figures 8-2 and 8-3 respectively. If only one supply riser is used, use the 2 in. nipple and cap provided to plug the unused supply tapping (Figure 8-1).
6. The optional “drop header” piping shown in Figure 8-4 is useful when there is limited overhead clearance between the boiler and the mains. The riser closest to the equalizer can be omitted on the FORCESTM03 - FORCESTM06.
7. The piping shown in Figures 8-2 through 8-4 are shown with the equalizer and return connections on the right side. This piping can be “flipped” so that the equalizer/return are on the left side and the boiler drain located on the right. If only one riser is used on the FORCESTM03 - FORCESTM06 it must be located on the side opposite the equalizer/return.
8. A second system supply tee may be installed adjacent to the first supply tee. Both supply tees are to be located after the riser(s) but before the equalizer line. See Figure 8-5 for common near-boiler piping mistakes.

8 Steam Piping *(continued)*

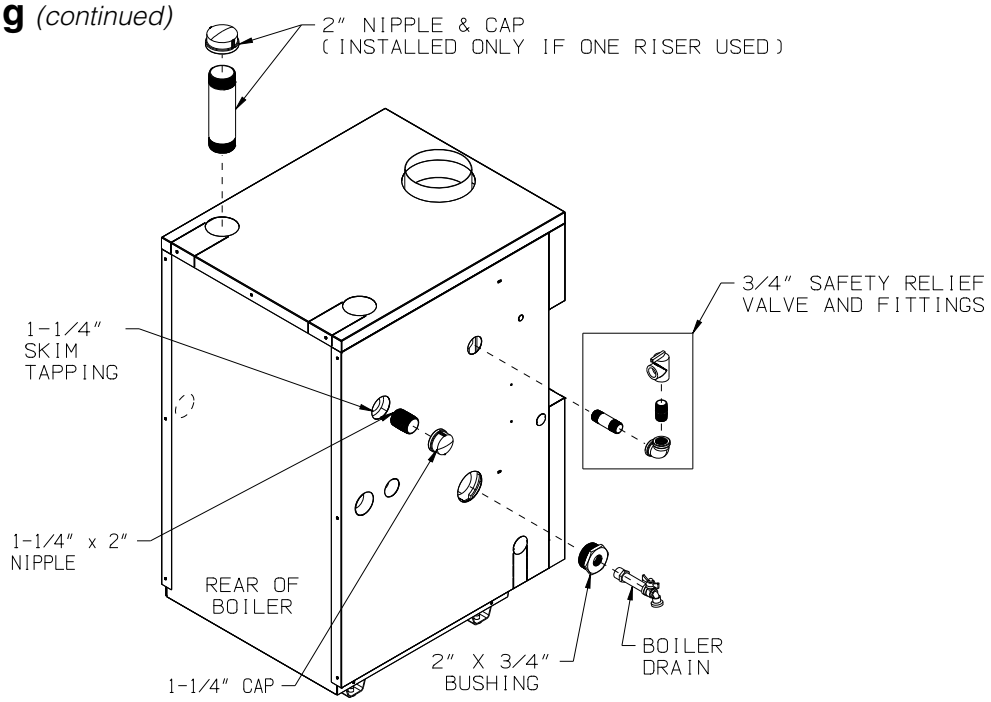
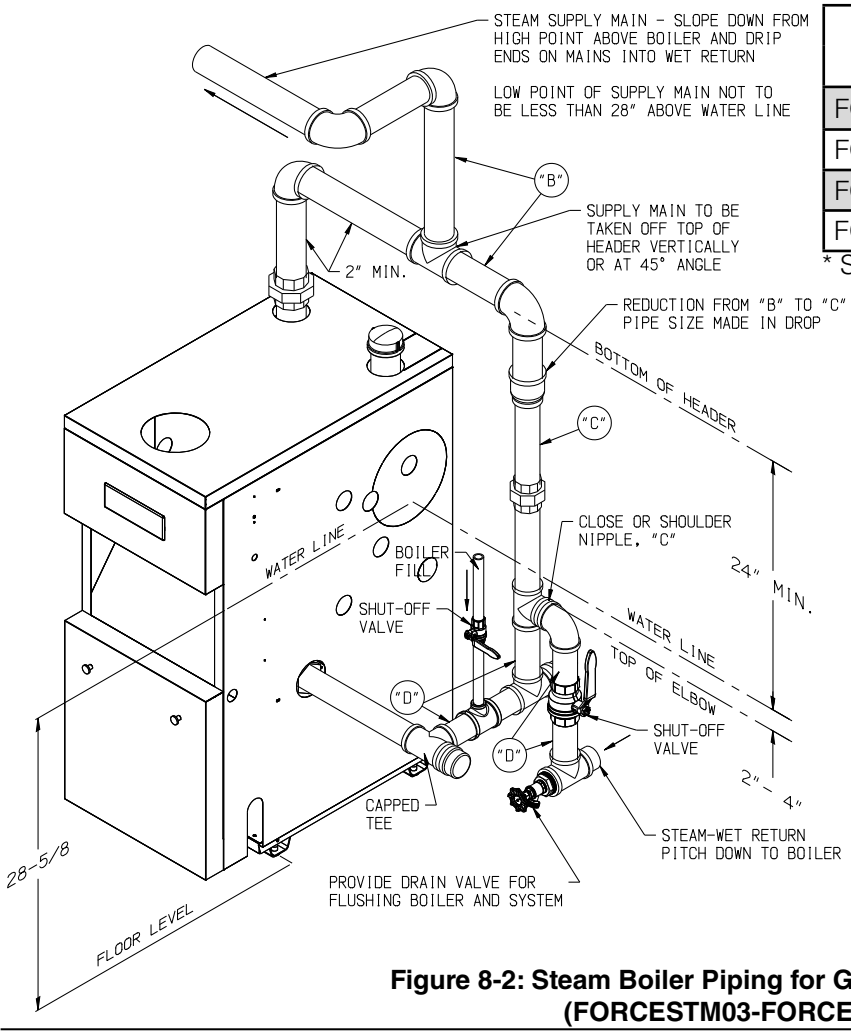


Figure 8-1: Installation of Factory Supplied Fittings



Boiler Model	Minimum Pipe Dia. (IN NPT)			
	"A"	"B"	"C"	"D"
FORCESTM03	*	2	1 1/2	1 1/4
FORCESTM04	*	2	1 1/2	1 1/4
FORCESTM05	*	2	1 1/2	1 1/4
FORCESTM06	*	2	1 1/2	1 1/4

* Second 2 in. supply riser optional

Figure 8-2: Steam Boiler Piping for Gravity Return, Single Riser (FORCESTM03-FORCESTM06 only)

8 Steam Piping *(continued)*

Boiler Model	Minimum Pipe Dia. (IN NPT)			
	"A"	"B"	"C"	"D"
FORCESTM03	2*	2	1 1/2	1 1/4
FORCESTM04	2*	2	1 1/2	1 1/4
FORCESTM05	2*	2	1 1/2	1 1/4
FORCESTM06	2*	2	1 1/2	1 1/4
FORCESTM07	2	3	1 1/2	1 1/4
FORCESTM08	2	3	2	1 1/2

*Second 2 in. supply riser optional.

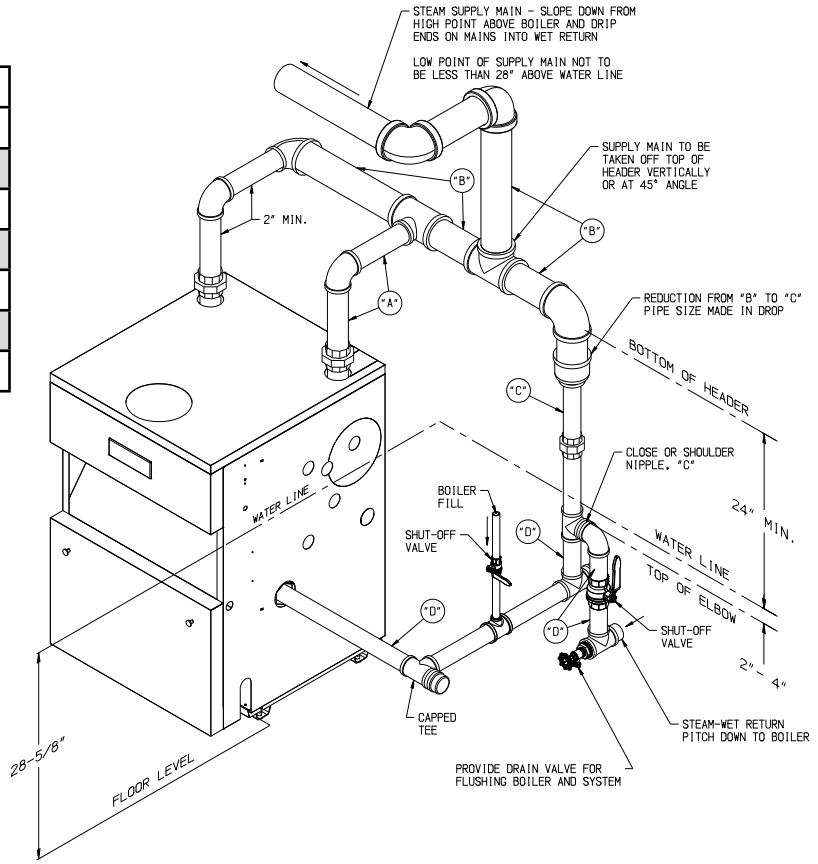


Figure 8-3: Steam Boiler Piping for Gravity Return, Dual Riser (Required on FORCESTM07-FORCESTM08)

Boiler Model	Minimum Pipe Dia. (IN NPT)			
	"A"	"B"	"C"	"D"
FORCESTM03	2*	2	1 1/2	1 1/4
FORCESTM04	2*	2	1 1/2	1 1/4
FORCESTM05	2*	2	1 1/2	1 1/4
FORCESTM06	2*	2	1 1/2	1 1/2
FORCESTM07	2	3	1 1/2	1 1/4
FORCESTM08	2	3	2	1 1/2

* Second 2 in. supply riser optional

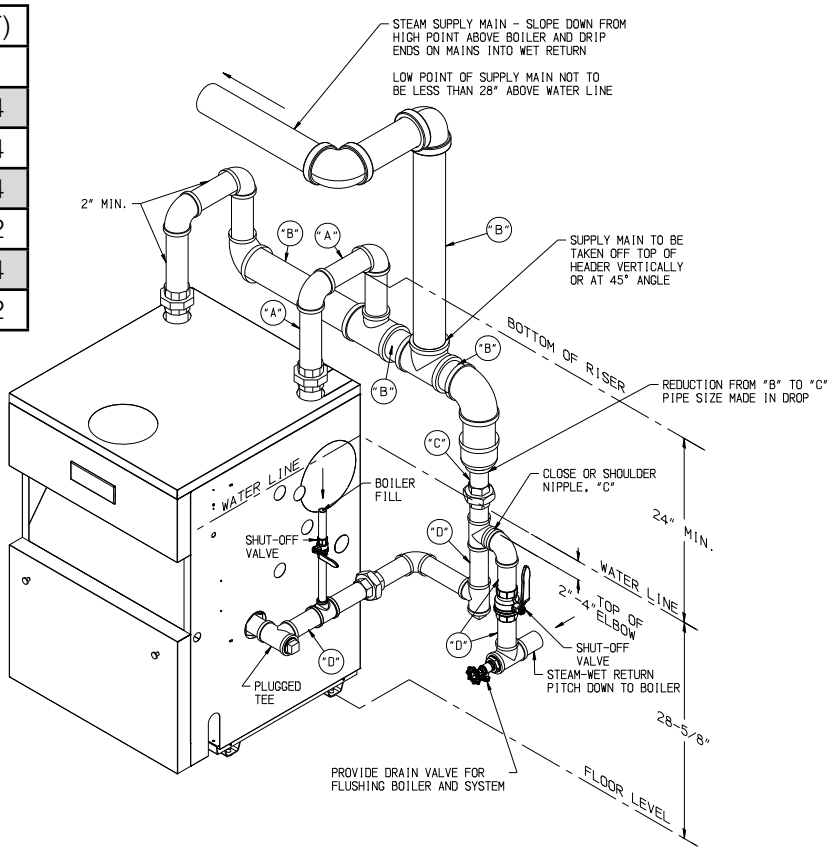


Figure 8-4: Steam Boiler Piping for Gravity Return, Drop Header Piping

8 Steam Piping *(continued)*

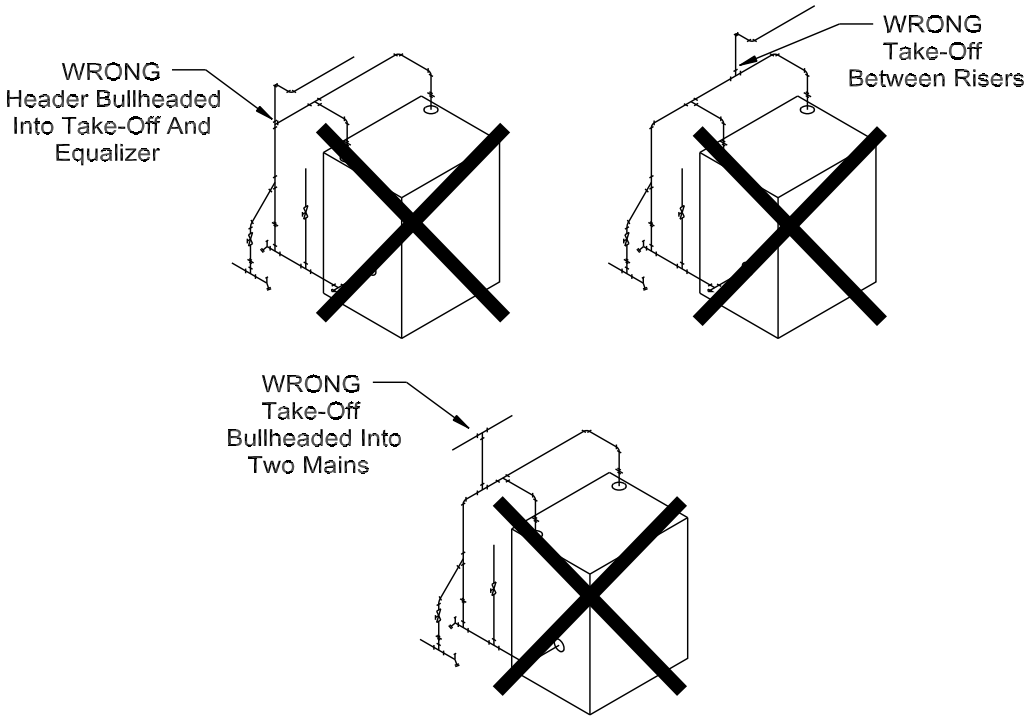


Figure 8-5: Common Near-Boiler Piping Mistakes

9 Indirect Water Heater Piping

NOTICE:

- Some indirect water heaters may not be suitable for use with a steam boiler. Consult the water heater manufacturer's guidelines before installing it in this type of system.
- Boiler water temperatures and flow rates in this type of system may be considerably lower than those upon which the water heater manufacturer's ratings are based. This may result in substantially longer water heater recovery times.

All boilers are equipped with tappings to permit the connection of an indirect water heater. In this type of system, hot boiler water is drawn from below the water line and passed through the heat exchanger in the indirect water heater. This section describes boiler-side piping only. Refer to the indirect water heater instruction manual for domestic water piping. The components in this system and their functions are as follows:

1. Circulator - Mount the circulator as shown in Figure 9-1. The circulator should be located as low and as close to the boiler as practical. Do not install valves, or other devices having a significant pressure drop, between the boiler and the circulator inlet. All piping between the boiler and the circulator inlet should be 1 in., regardless of the size of the piping required in the rest of the system. See Figure 11-3 in Part 11 for wiring information
2. "Y" Strainer - Install a "Y" strainer to prevent sediment from accumulating inside the indirect water heater.
3. Check Valve - Prevents gravity circulation through the indirect water heater when the boiler is responding to a call for heat.
4. Boiler Limit Control - Use a SPST break-on-rise temperature limit control such as the Honeywell L4006A. Do not set the limit above 180°F as doing so may cause the boiler to steam when there is no call for heat. See Figure 11-3 for wiring information.
5. Valves and Unions - Install shut-off valves, drain valves, and unions in locations that will facilitate maintenance of the system. Do not install any valves between the boiler and circulator inlet.

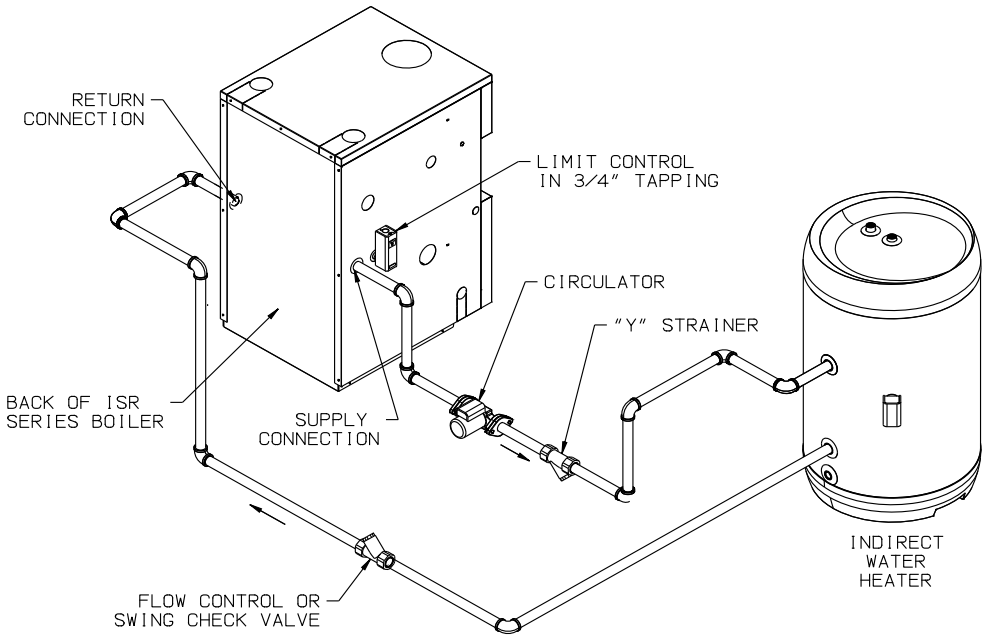


Figure 9-1: Indirect Water Heater Boiler-Side Piping

10 Gas Piping

⚠ WARNING

- Shut off gas supply before servicing the boiler.
- All gas piping must be gas tight. Use thread compound that is listed for gas service on all threaded joints to avoid leaks, which may result in fire or explosion.
- Size gas piping, regulators, valves and meters so as to provide an adequate gas flow and pressure to the boiler during operation. Failure to do so may cause poor combustion, noise, injury or death.

1. Size gas piping - Design system to provide adequate gas supply to boiler. Consider these factors:
   A. Allowable pressure drop from point of delivery to boiler. Maximum allowable system pressure is ½ psig. Actual point of delivery pressure may be less; contact gas supplier for additional information. Minimum gas valve inlet pressure is listed on rating label.
   B. Maximum gas demand. Consider existing and expected future gas utilization equipment (i.e. water heater, cooking equipment).
2. Connect boiler gas valve to gas supply system -
   A. Use methods and materials in accordance with local plumbing codes and requirements of gas supplier. In absence of such requirements, follow *National Fuel Gas Code, ANSI Z223.1/NFPA 54*.
   B. Use thread compounds (pipe dope) resistant to action of liquefied petroleum gas.
   C. Install sediment trap, ground-joint union and manual shut-off valve upstream of boiler gas control valve. See Figure 10-1.
   D. All above ground gas piping upstream from manual shut-off valve must be electrically continuous and bonded to a grounding electrode. Do not use gas piping as grounding electrode. Refer to *National Electrical Code, ANSI/NFPA 70*.
3. Pressure test - Boiler and its gas connection must be leak tested before placing boiler in operation.
   A. Protect boiler gas control valve. For all testing over ½ psig, boiler and its individual shutoff valve must be disconnected from gas supply piping. For testing at ½ psig or less, isolate boiler from gas supply piping by closing boiler's individual manual shutoff valve.
   B. Locate and address leaks using listed combustible gas detector, a non corrosive leak detection fluid or other listed leak detection method. Do not use matches, candles, open flames, or other ignition source.

⚠ DANGER

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

⚠ WARNING

- If gas pressure in the building is above ½ psig (3.5 kPa), an additional gas pressure regulator is required. Using one additional regulator for multiple gas appliances may result in unsafe boiler operation. The additional regulator must be able to properly regulate gas pressure at the input of the smallest appliance. If the regulator can not do this, two or more additional regulators are required. Consult regulator manufacturer and/or local gas supplier for instructions and equipment ratings.
- If an additional regulator is used to reduce boiler inlet pressure below 1/2 psig (3.5 kPa) it must be at least 6 to 10 ft. upstream of the boiler.
- It is very important that the gas line is properly purged by the gas supplier or utility company.

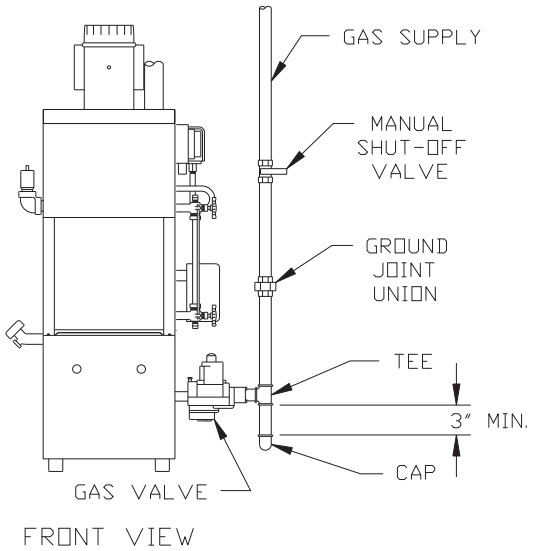


Figure 10-1: Gas Connection to Boiler

11 Wiring

⚠ WARNING

- All wiring and grounding must be done in accordance with the authority having jurisdiction or, in the absence of such requirements, with the *National Electrical Code (ANSI/NFPA 70)*.
- Electrical power may be supplied from more than one circuit. Disconnect electrical power to the boiler and heating system before servicing. Positively assure that no voltage is present. Lock electrical boxes to prevent someone from inadvertently restoring power before the heating system is safe to operate.
- Never defeat or jump out safety devices.
- Protect each boiler circuit with a properly sized over-current protection device.
- Make electrical connections carefully according to the boiler's wiring diagram and instructions. Failure to properly wire electrical connections to the boiler may result in serious physical harm or property damage.
- Wire additional field supplied safety limits, such as low water cut-offs and pressure limit devices, so as to break the 120V power supply to the boiler. Do not alter the boilers factory wiring when adding a field supplied limit device.

1. 120 Volt Wiring - The boiler should be provided with its own 15A branch circuit with fused disconnect. All 120 volt connections are made inside the junction box on the right side of the boiler. Remove the transformer to gain access to this box (also see Figure 11-1):
   A. Hot ("black") - Wire nut to black transformer lead
   B. Neutral ("white") - Wire nut to white transformer lead
   C. Ground ("green" or bare) - Ground screw inside junction box
2. Thermostat Wiring - Follow thermostat manufacturer instructions. To insure proper thermostat operation, avoid installation in areas of poor air circulation, hot spots (near any heat source or in direct sunlight), cold spots (outside walls, walls adjacent to unheated areas, locations subject to drafts). Provide Class II circuit between thermostat and boiler. Connect thermostat wire leads to the blue transformer lead and brown relay lead inside the junction box.
   Set thermostat appliance type or cycle rate per thermostat instructions. On thermostats that include a heat anticipator , set anticipator to 0.2A. If system tends to short cycle without reaching desired room temperature, increase heat anticipator setting by 0.1 or 0.2 amps.
3. Feeder Wiring – Follow wiring instructions provided with feeder. Use only electronic feeders such as Hydrolevel VXT-24 or McDonnell Miller WF2-U-24. Do not use McDonnell Miller #101A which does not include a delay timer. Do not alter any of the factory wiring on the boiler.

⚠ CAUTION

- When making low voltage connections, make sure that no external power source is present in the thermostat circuits. If such a power source is present, it could destroy the boiler's control. One example of an external power source that could be inadvertently connected to the low voltage connections is a transformer in old thermostat wiring.
- Do not attempt to connect a McDonnell & Miller model #101A feeder, or other feeder without a delay, to a boiler equipped with a Hydrolevel CG400 low water cutoff. Doing so could destroy the boiler transformer and/or flood the system.
- Do not use the transformer provided on the boiler to power external devices other than the feeders specified in (3). Doing so may cause damage to the transformer.

11 Wiring *(continued)*

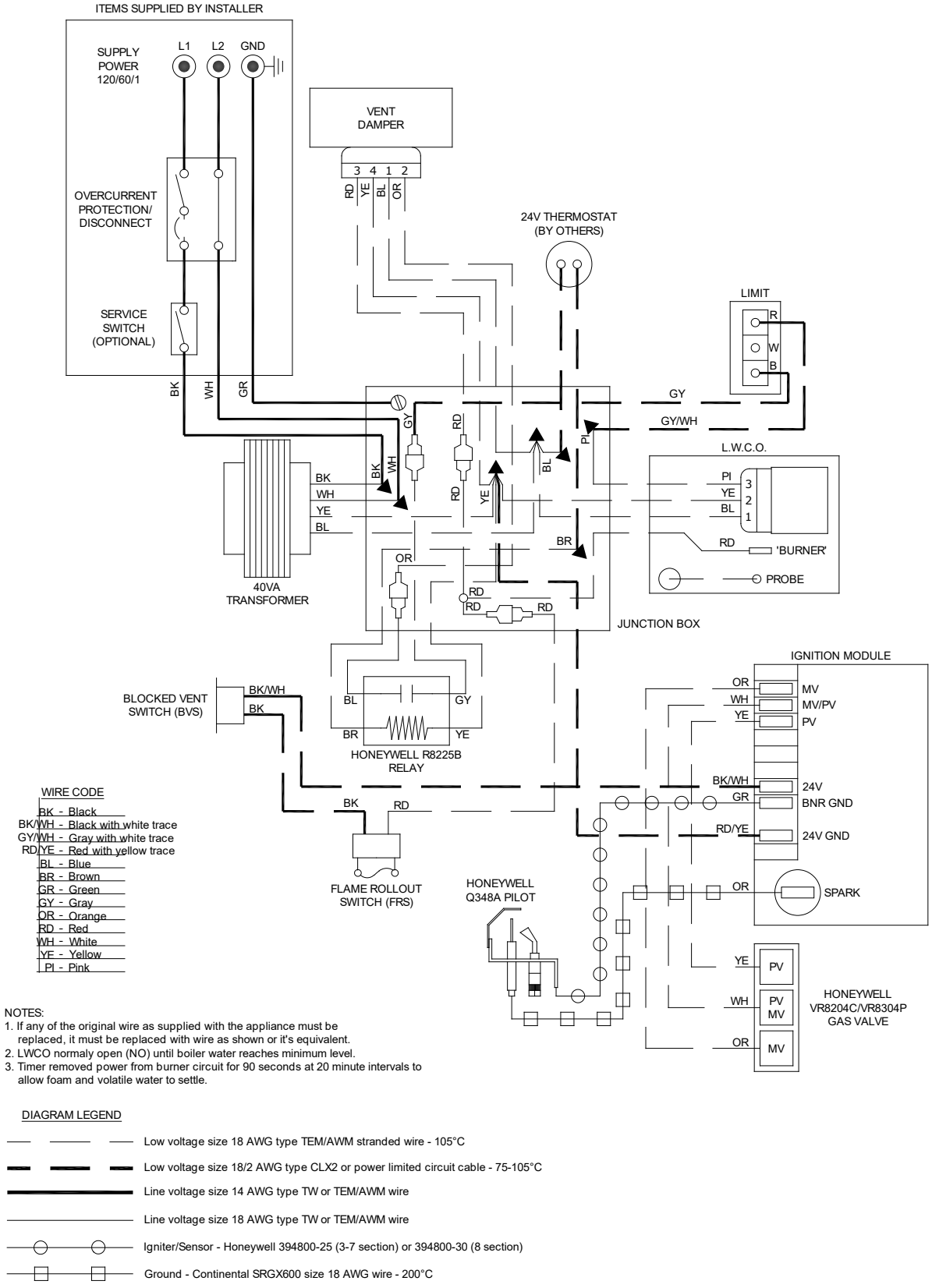


Figure 11-1: Gas Steam Boiler Connections Diagram, Hydrolevel CG-400A LWCO

11 Wiring *(continued)*

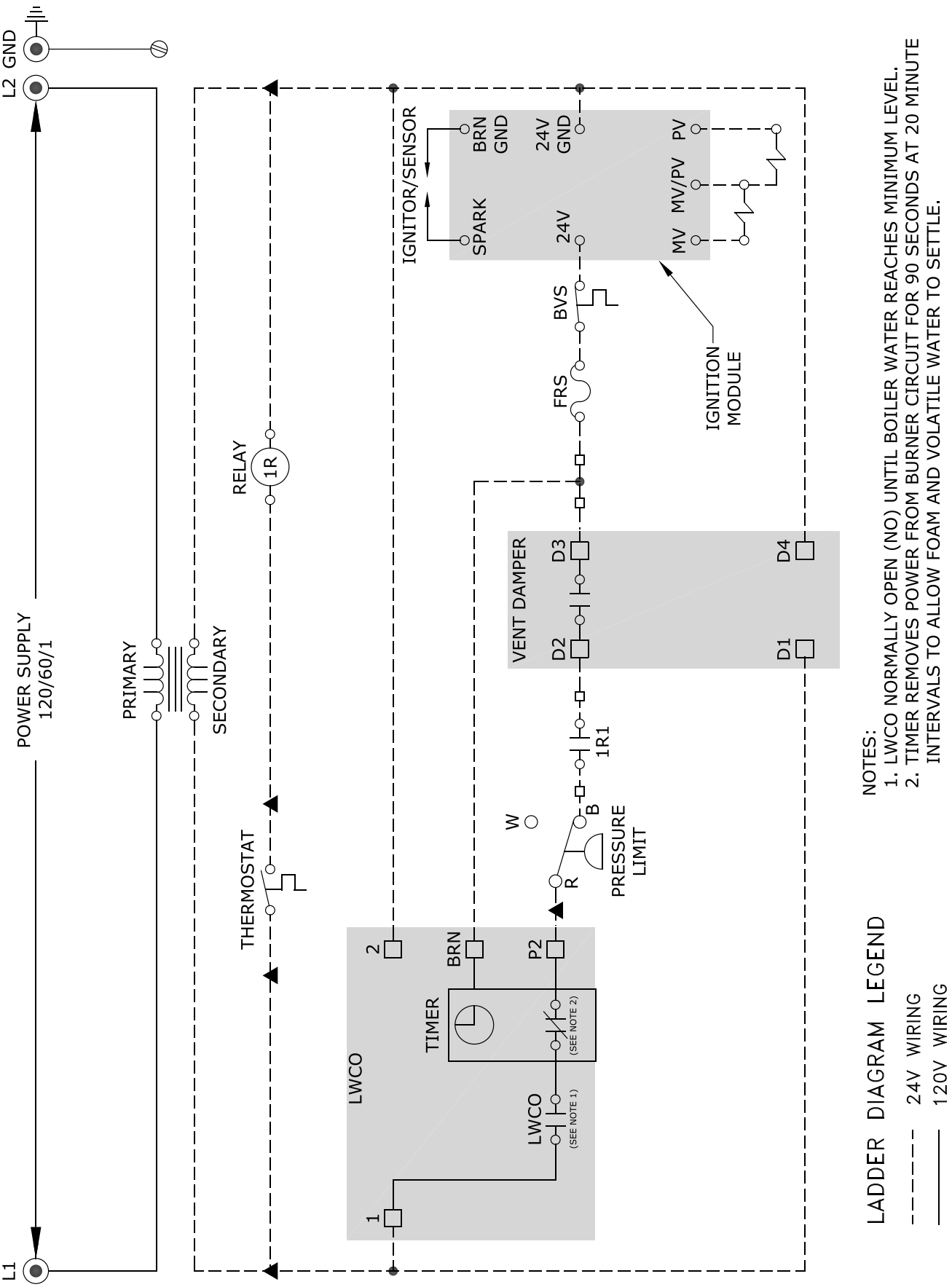


Figure 11-2: Gas Steam Boiler Ladder Diagram, Hydrolevel CG-400A LWCO

11 Wiring *(continued)*

Indirect Water Heater Wiring

Figure 11-3 shows field wiring for an indirect water heater. A Honeywell R845A or equivalent DPST relay and transformer is required. The high limit described in Part 9 must also be supplied by the installer. A call for heat from the indirect water heater thermostat will energize the relay making both sets of contacts. One set of these contacts then energizes the circulator. The other set of contacts will make the “T” and “T” contacts on the burner primary control, firing the burner. If the boiler water temperature exceeds the high limit setting of 180ºF, the high limit will open the “T” - “T” circuit and the burner will shut down.
If there is a call for space heat, the heating thermostat will make the “T”-”T” circuit and the boiler will fire without regard to the status of the indirect water heater. The low water cut-off and pressure limit control will interrupt 120 volt power to the burner in the event of a low water or excessive pressure condition.

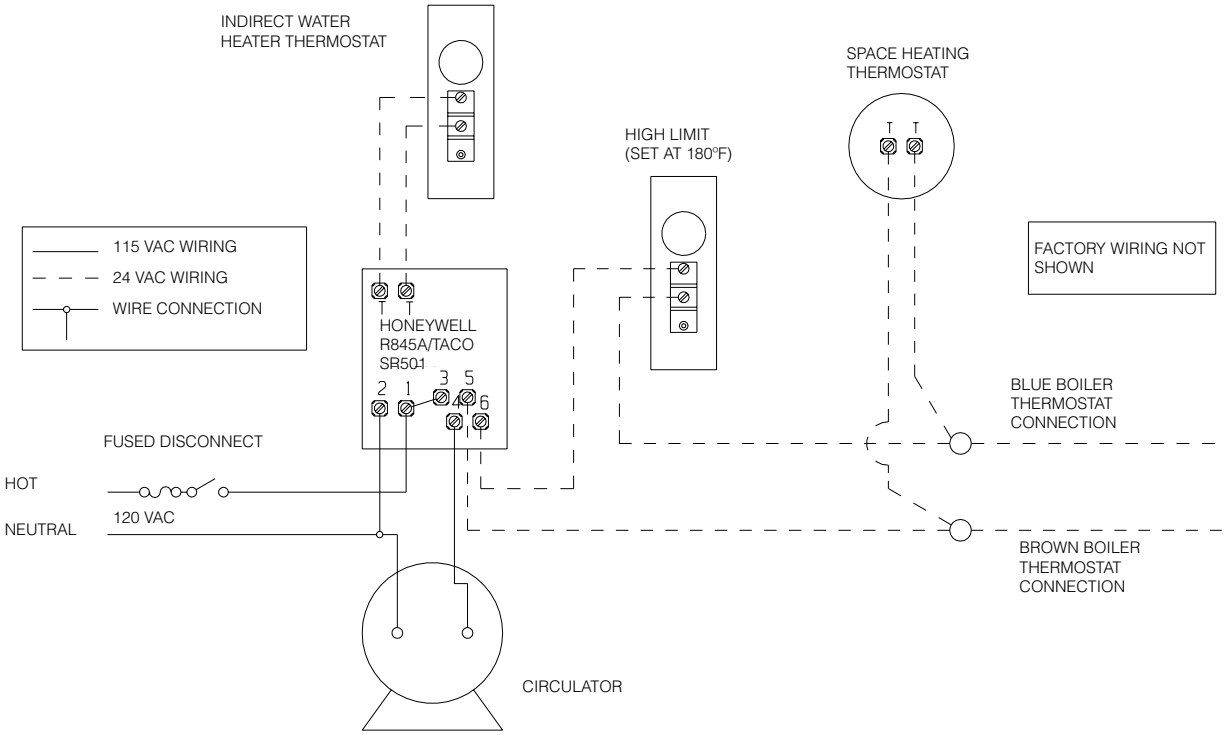


Figure 11-3: Wiring Indirect Water Heater to Boiler

12 Start-up and Checkout

⚠ WARNING

Do not leave the boiler in service if it fails any of the following start-up checks. Doing so may result in fire, explosion, or Carbon Monoxide (CO) poisoning.

⚠ WARNING

- Gas leaks may result in fire or explosion.
- Never use a flame to check for gas leaks.
- Make sure that the area around the boiler is clear and free from combustible materials, gasoline and other flammable vapors and liquids.
- Water leaks may cause extensive property damage.

1. Start with the boiler dry and the gas supply to the boiler shut off.
2. Main Burner Check - Check main burners to see that they were not dislodged during shipment. Rear of burners should be in the vertical slots in the rear of burner tray and the front of the burners should be seated completely on the orifices.
3. LWCO Probe Check - Turn on power to the boiler. Both the green power light and the yellow low water light should come on (Figure 12-1).

⚠ WARNING

If the yellow light on the LWCO is not illuminated when the boiler is powered and there is no water in the boiler, shut down power to the boiler and contact the factory for assistance before proceeding further.

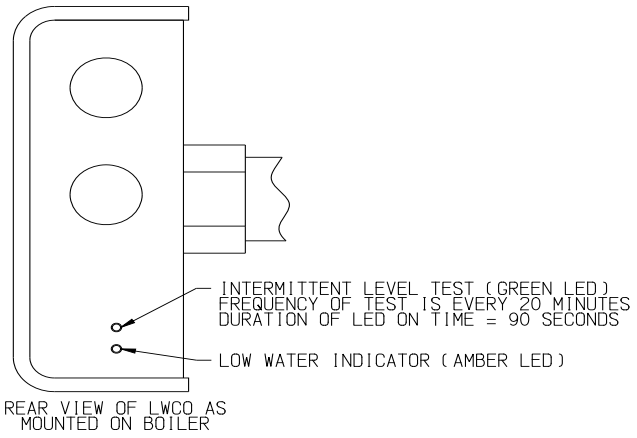


Figure 12-1: CG-400 Low Water Cut-Off

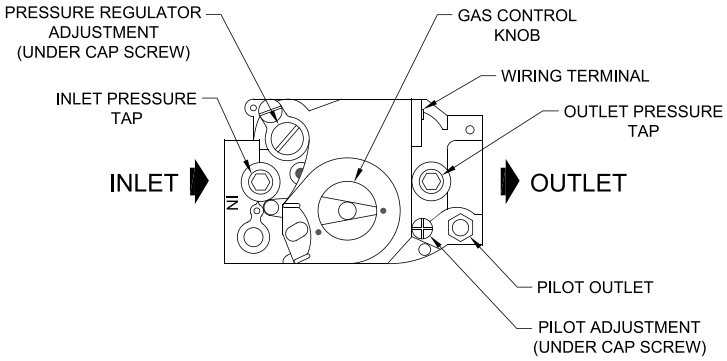


Figure 12-2: Top View of Gas Valve

4. Fill the boiler to the normal water line (28-3/4 in. above the floor or pad on which the boiler sits.
5. Turn on the gas supply to the boiler. Check the gas line for leaks and purge piping sections that are full of air. Refer to the *National Fuel Gas Code*, the *Natural Gas and Propane Installation Code*, the gas supplier, or the authority having jurisdiction for additional information on testing and purging gas lines.
6. LWCO Probe Check - Turn on power to the boiler. Both the green power light and the yellow low water light should come on (Figure 12-1).
7. Inspect all wiring for loose or uninsulated connections.
8. Adjust thermostat to the highest setting.
9. Start the boiler using the lighting instructions shown in Figure 12-3. Upon initial start-up, the gas train will be filled with air. Even if the gas line has been completely purged of air, it may take several tries for ignition before a flame is established. Once a flame has been established for the first time, subsequent calls for burner operation should result in a flame on the first try.
10. Make sure vent damper is in open position when main burners are firing.
11. Check entire gas train for leaks using non corrosive leak detection fluid or other approved leak detection method while boiler is firing. Fix any leaks found immediately.

12 Start-up and Checkout *(continued)*

FOR YOUR SAFETY READ BEFORE OPERATING

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

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

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

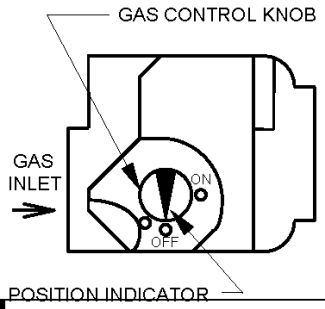
WHAT TO DO IF YOU SMELL GAS
- **Do not try to light any appliance.**
- **Do not touch any electric switch; do not use any phone in your building.**
- **Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.**
- **If you cannot reach your gas supplier, call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

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

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

OPERATING INSTRUCTIONS

1. **STOP! Read the safety information above on this label.**
2. **Set the thermostat to lowest setting.**
3. **Turn off all electric power to the appliance.**
4. **This appliance is equipped with an ignition device which automatically lights the pilot. Do not try to light the pilot by hand.**
5. **Remove front door.**
6. **Locate the gas control valve at the end of the gas supply pipe going into the boiler. The gas control knob is the brown or blue plastic knob located on top of the gas control valve.**



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

TO TURN OFF GAS TO APPLIANCE

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

Figure 12-3: Operating Instructions

12 Start-up and Checkout *(continued)*

12. Check the manifold pressure and adjust if necessary. To do this, use the following procedure:

    A. Connect a manometer to the inlet pressure tap on the gas valve (see Figure 12-2).

    B. Check the inlet line pressure with all gas appliances on and off. The inlet pressure at the boiler must be within the following limits regardless of what combination of appliances is firing:

Inlet Press (inches w.c.)	Natural Gas	LP Gas
Minimum	5.0	11.0
Maximum	14.0	14.0

    C. If the inlet pressure falls outside of these limits, find and correct the cause of the problem before proceeding further.

    D. Connect a manometer to the manifold (outlet) pressure tap on the gas valve (Figure 12-2).

    E. Read the manifold pressure. It should be set at:

	Natural Gas	LP Gas
Manifold Press. (inches w.c.)	3.5	10.0

⚠ CAUTION

Avoid operating this boiler in an environment where saw dust, loose insulation fibers, dry wall dust, etc. are present.

    F. If a manifold pressure adjustment is needed, make the adjustment by turning the regulator screw (see Figure 12-2) clockwise to raise the pressure and counter-clockwise to reduce the pressure. If a manifold pressure adjustment is made, recheck the inlet pressure after making the adjustment to be certain that it is still within acceptable limits. Replace the cover screw on the regulator.

13. Check Main Burner Flame - See Figure 12-4. Flame should have a clearly defined inner cone with no yellow tipping. Orange-yellow streaks caused by dust should not be confused with true yellow tipping.

14. Check Pilot Burner Flame - The pilot burner produces three (3) flames. The center flame should be steady, medium hard blue enveloping 3/8 to 1/2 inch of sensing probe. See Figure 12-5.

15. Gas valve safety shutdown test - With main burners firing, disconnect ignition cable from ignition module. Both pilot burner and main burners should stop firing.

16. Check pressure limit control operation. When steam pressure is registered on pressure gauge, lower pressure limit setting below gauge reading. Both pilot burner and main burners should stop firing. Raise pressure limit setting above gauge reading. The pilot burner and main burners should relight.

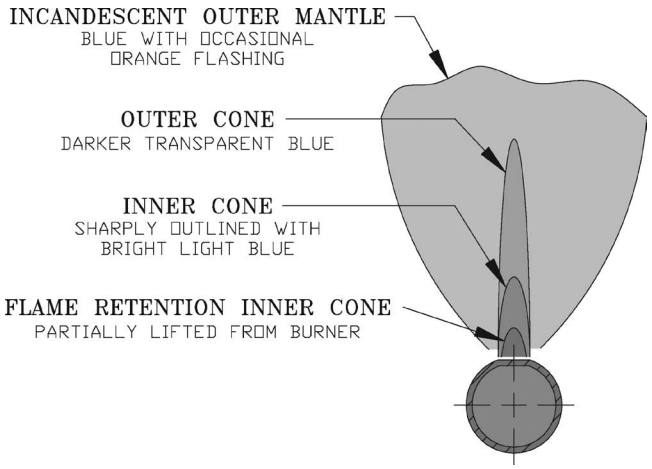


Figure 12-4: Main Burner Flame

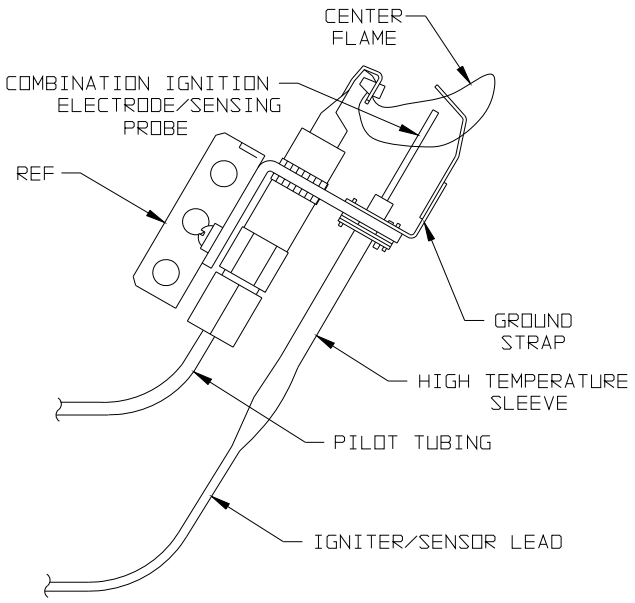


Figure 12-5: Pilot Burner Flame

12 Start-up and Checkout *(continued)*

17. Check LWCO Operation – Verify low water cutoff operation while the boiler is running. Slowly open drain valve and drain boiler until the water level drops below low water cutoff line. Water still should be visible in the gauge glass when the low water cutoff shuts down the main burners. Both pilot burner and main burners should stop firing. Make sure pressure limit, thermostat or other controls have not shut off the boiler and the amber LED on LWCO is illuminated. Upon test completion refill the boiler to the normal water level.
18. Check Thermostat Operation - Raise and lower temperature setting to start and stop boiler operation. Adjust thermostat to normal setting.
19. Check of External Safety Devices - Verify proper operation of any field installed safety devices, such as an external LWCO.
20. Combustion Chamber Burn-off
    A. The mineral wool combustion chamber panels may contain a cornstarch based binder that must be burned out at installation to prevent odors during subsequent boiler operation.
    B. Ventilate the boiler room, set the high limit to its maximum setting, set the thermostat to call for heat. Allow the boiler to fire for at least an hour or until the odor from the cornstarch has dissipated.
21. System Leak Check - After the boiler has operated for at least 30 minutes, check the boiler and heating system piping for leaks. Repair any leaks found at once.

⚠ CAUTION

System leaks can cause severe boiler damage.

22. Inspect the vent system for flue gas leaks - Repair any leaks found before leaving the boiler in operation.
23. Steam Boiler Skimming

⚠ WARNING

Burn Hazard. The following procedure involves the handling of and/or close proximity to very hot water and steam.

- Keep away from the discharge side of valves when opening them.
- When buckets are used, fill them only to the point where they can be safely carried.
- Wear gloves and other protective equipment to minimize risk of exposure to hot water and steam.

ALL STEAM BOILERS REQUIRE PROPER SKIMMING. THIS NOTICE WILL HELP CONTRACTORS COMPLETE STEAM BOILER INSTALLATIONS AND AVOID CUSTOMER CALLBACKS

Skimming removes oil from the boiler water volume. If not removed properly oil can reduce steam generation and make the boiler surge. A boiler is surging when the water level in the gauge glass is bouncing or not visible while boiler is producing steam. Oil can originate from the inside of black pipe, or from petroleum based thread sealant or from the lubricant used in the cast iron hole threading process. Less than perfect near boiler piping may also make skimming more important.

This process combines best practices learned from a number of skilled, experienced technicians, and it can be completed in about an hour. No chemical additives should be needed. For best practice, skim boiler at time of its commissioning before the system is filled with steam for the first time. This prevents any contaminants that may be present in the boiler from entering the system. Once the system has run for a number of days, subsequent skimming(s) may be required. Use the following procedure to skim the boiler.

Recommended Skimming Procedure:

A. Prepare at least two empty buckets. Find a close place to dump water.
B. Turn on the boiler. Run it until it is hot and starts to make steam.
C. Turn off the boiler. **IMPORTANT - DO NOT TURN BOILER ON DURING SKIMMING PROCESS.**
D. With Caution, lift valve and verify that there is no steam pressure in the boiler.

12 Start-up and Checkout *(continued)*

E. Install a full-port ball valve on the skim tapping pipe nipple provided and installed in Section 8. See Figure 8-1. This valve is a "just in case" valve. You will not close this valve after the skimming process starts. The large diameter of this pipe is necessary for effective skimming. Do not install an elbow on this pipe. We are trying to skim the water surface; therefore, the water must come off a horizontal pipe. There should not be water at this level yet.

F. Open the ball valve just installed. Hang a bucket on the pipe.

G. Find the manual fill valve. **If there is no manual fill valve, add the water to the boiler through the bottom drain valve on the boiler**.

H. Open the manual fill valve until the water starts to flow slowly out of the pipe nipple and valve installed earlier. When water flows out the pipe nipple, close the fill valve and wait until the flow stops.

I. Reopen the manual fill valve slightly so the stream of water coming from the pipe nipple is no larger than a wooden pencil. Slower flow is best.

J. Continue to skim until the bucket is almost full. Remove the full bucket and use the second bucket while you dump the first. Do not shut off the valve while doing this. You cannot stop the water once you have started the flow. Remember - Do not re-fire the boiler.

K. Keep skimming until the water temperature is comfortable to the human hand.

L. When done skimming stop adding water. Drain the water to the proper fill level.

M. Remove the pipe nipple and valve. Re-install the pipe cap.

N. Turn the boiler back on and let it create steam. Decide if the surging stopped or improved or if debris is in gauge glass. If so, repeat the process.

O. If there is no improvement after 3 or 4 tries then the problem is not oil related. Consider checking near boiler piping, flame impingement, or water pH. Low water pH or water treatment chemicals can also cause foaming and/or surging.

P. The skimming process may also need to be repeated days or weeks after commissioning. If there is no improvement, check the items listed in step O.

24. Test System Water Quality.

After boiler and system have been cleaned and refilled as previously described, test water quality. Add recommended chemicals to bring chlorides, hardness and pH within limits outlined in Table 14-1.

NOTICE: When substantial amount of make-up water is used due to lost condensate, or when make-up water is hard or corrosive, water treatment is required. contact qualified water treatment company for recommended water treatment compounds and procedures.

25. Review User's Information Manual and system operation with owner or operator.

13 Operation

Sequence of Operation (Refer to Figures 11-1 & 11-2 for connection and ladder diagrams)

1. When the boiler is energized, 24 volts is immediately applied to terminals “1” (blue) and “4” (yellow) on the vent damper. Assuming that there is no call for heat, and that the damper switch is in the “automatic” position, the damper will close. On boilers equipped with Hydrolevel CG400A probe type low water cut-offs, voltage is also always applied to terminals “1” (blue) and “2” (yellow) on the low water cut-off to power the water level sensing circuit.
2. Assuming that water is above the cut-off level, power will appear at terminal “3” on the CG400 LWCO.
3. Assuming that steam pressure is below the pressure limit setting, power will appear on one side of relay contact 1R1 (Gray lead). Relay 1R is the R8225 mounted under the junction box.
4. A call for heat from the thermostat energizes relay coil 1R causing contacts 1R1 to make. Current then flows through contacts 1R1 to pin terminal “2” (orange) at the vent damper and the damper opens.
5. Once the vent damper is fully open, an end switch inside the damper will make, energizing pin “3” (red) at the damper.
6. Current passes from terminal “3” on the vent damper though the flame rollout and blocked vent (“spill”) switches. Under normal conditions, both of these switches are made and voltage will therefore immediately appear across terminals “24V” and “24V (GND)” on the ignition module.
7. Upon application of voltage across the “24V” and “24V (GND)” terminals, the ignition module will start an ignition spark at the pilot and apply 24 volts across the pilot valve (terminals “PV” and “MV/PV”).
8. Once the pilot is established, the pilot flame will act as a diode, converting the AC current at the electrode to a half wave DC current at the pilot’s ground strap. This DC current flows through the boiler to the “GND (BURNER)” connection on the ignition module. For the ignition module to recognize that a pilot flame is present, the DC current flowing into this terminal must be in excess of approximately 1.0 uA.
9. Once the ignition module detects the presence of a pilot flame, voltage is applied across the main valve (terminals “MV” and “MV/PV”), opening the valve and establishing main flame.
10. The way in which the ignition module handles failure to establish pilot or the loss of an already established pilot depends upon the exact ignition module supplied with the boiler.

Safety Control Operation

Hydrolevel CG400A Low Water Cut-off - Interrupts burner operation if the water in the boiler drops below a safe level. As the water drops past the cut-off point, the amber lamp on the CG400 will glow. The CG400 will interrupt power to the burners 15 seconds after the water level drops past the cut-off point. This feature prevents short cycling of the burners due to a bouncing water line. The burners will then remain off until 30 seconds after the water level has been raised above the cut-off point.

The CG400 is also equipped with a feature which will shut down the burners after they have been firing for 20 minutes, regardless of the water level status. The CG400 then keeps the burners off for 90 seconds, allowing the water level and any foam which is present to settle. During this 90 second interval, the green LED on the CG400 will glow. If the water level is still above the cut-off line at the end of this 90 second interval, the CG400 will restart the burners.

The vent damper will close when the low water cut-off interrupts burner operation.

Pressure Limit Control - Interrupts burner operation when the pressure in the boiler exceeds the “Main” setting. Burner operation is restored when the pressure in the boiler drops to the “Main” pressure less the differential pressure .The vent damper will close when the pressure limit control interrupts burner operation.

Blocked Vent (“Spill”) Switch - Interrupts burner operation in the event that flue gas spills from the draft diverter opening. This switch is equipped with a reset button which must be pressed to restore normal burner operation. An open blocked vent switch is indicative of a problem with the vent system or the combustion air supply. If the blocked vent switch opens, the cause of the venting problem must be found and corrected by a qualified gas service technician before the blocked vent switch is reset.

Flame Roll-out Switch - Interrupts burner operation when flames or excessive heat are present in vestibule. The flame roll-out switch is a single use device which must be replaced by an identical switch in order to restore normal operation. An open flame roll-out switch is usually indicative of a plugged heat exchanger. The cause of the flame roll-out must be found and corrected by a qualified gas service technician, and the switch replaced with an identical one, before the boiler is returned to operation.

14 Service and Maintenance

Important Product Safety Information: Refractory Ceramic Fiber Product

⚠ WARNING

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

Precautionary Measures:

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

First Aid Procedures:

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

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14 Service and Maintenance *(continued)*

⚠ WARNING

- Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.
  ATTENTION. Au moment de l'entretien des commandes, étiquetez tous les fils avant de les débrancher. Les erreurs de câblage peuvent nuire au bon fonctionnement et être dangereuses. S'assurer que l'appareil fonctionne adéquatement une fois l'entretien terminé.
- Failure to maintain the boiler in proper working condition may lead to fire, explosion, personal injury or death and extensive property damage.
- Turn off all gas and electric power supplies to the boiler before servicing. Contact with or release of dangerous flammable gas, electrical voltage, moving parts and very hot water under pressure may cause serious personal injury, property damage or death.
- Lock electrical boxes and gas valves closed to prevent someone from inadvertently restoring power or gas before the heating system is safe to operate.
- Water leaks can cause severe corrosion damage to the boiler or other system components. Repair any leaks found immediately.

On a continuous basis:

1. Keep the area around the boiler free and clear from combustible materials, gasoline, and other flammable vapors and liquids.
2. Keep the area around the boiler and boiler room ventilation openings clear of objects which might obstruct the flow of combustion and ventilation air.

Every three months:

Boiler water must be monitored throughout the heating season. Boiler water must be tested every three (3) months for the constituents shown in Table 14-1. If chloride, total hardness, or pH levels in the boiler water are outside of the levels shown in Table 14-1, excessive make-up water is being added. Find and repair all system leaks, drain, and refill the boiler with fresh make-up water that meets the criteria in Table 14-1. Then bring the boiler to pressure for 15 minutes to drive off excess oxygen.

Table 14-1: Steam Boiler Water Quality Criteria (Concentration Limits for Make-up Water & Boiler Water)

Constituent	Make-up Water	Boiler Water
Chlorides	≤ 30 mg/L (ppm)	≤ 100 mg/L (ppm)
Hardness (as CaCo3)	≤ 100 mg/L (ppm)	≤ 200 mg/L (ppm)
pH	≥ 9.0 and ≤ 12.0	

Any time the chloride, total hardness, or pH levels in the boiler water exceed the levels listed in Table 14-1, drain, refill with fresh make-up water that meets the criteria in Table 14-1, and bring the boiler to pressure for 15 minutes to drive off excess oxygen.

At the end of each heating season, drain and refill the boiler with fresh make-up water that meets the criteria in Table 14-1 to a level 4-6 inches above the normal water line. Then bring the boiler to pressure for 15 minutes to drive off excess oxygen

On an annual basis:

1. Turn off electrical power and gas supply to the boiler.
2. Inspect the flue passages for signs of blockage. If there is any carbon in the combustion chamber or the flue passages, clean the heat exchanger before proceeding further. See the cleaning procedure below.
3. Remove all burners, noting the location of the pilot main burner. If burners show signs of deterioration, they should be replaced (some discoloration around the burner ports is normal). Clean the burners by first brushing the ports with a soft bristle brush and then vacuuming out any debris through the venturi opening.
4. Remove any debris found in the combustion chamber, being careful not to disturb combustion chamber insulation.
5. Inspect the pilot assembly. Clean any deposits found on the electrode and grounding strap. The ideal gap between the electrode and the ground strap is 1/8 in. Inspect the porcelain for cracks or other deterioration. Replace pilot assembly if deterioration is found.
6. Inspect the base insulation for deterioration. Replace if necessary.
7. Inspect the ignition cable insulation for cracks or other deterioration. If deterioration is found, replace cable.
8. Reinstall burners, being careful to put the pilot main burner in its original location.

14 Service and Maintenance *(continued)*

9. Inspect all boiler wiring for loose connections or deterioration.
10. Inspect the vent system:
    A. Make sure that the vent system is free of obstructions.
    B. Make sure that all vent system supports are intact.
    C. Inspect joints for signs of condensate or flue gas leakage.
    D. Inspect venting components for corrosion or other deterioration. Replace any defective vent components.
11. Inspect the boiler and system for leaks.

⚠ CAUTION

IF, DURING NORMAL OPERATION, IT IS NECESSARY TO ADD MORE WATER THAN INDICATED BELOW, CONSULT A QUALIFIED SERVICE TECHNICIAN TO CHECK YOUR SYSTEM FOR LEAKS.

Model No.	Gallons Per Month	Gallons Per Year
FORCESTM03	0.1	1
FORCESTM04	0.1	1
FORCESTM05	0.2	2
FORCESTM06	0.2	2
FORCESTM07	0.2	3
FORCESTM08	0.2	3

A leaky system will increase the volume of make-up water supplied to the boiler, which can significantly shorten the life of the boiler. Entrained in make-up water are dissolved minerals, salts, and oxygen. When the fresh, cool make-up water is heated in the boiler, the minerals fall out as sediment, the salts coat the inside of the boiler, and the oxygen escapes as a gas. The accumulation of sediment eventually isolates the water from contacting the cast iron. When this happens the cast iron in that area gets extremely hot and eventually cracks. The presence of free oxygen or chloride slats in the boiler corrodes the cast iron from the inside. More make-up water and higher concentrations of contaminants damage the boiler sooner. **Our warranty does not cover corrosion and sediment-related damage.** Clearly it is in everyone's best interest to prevent this type of failure. You can do your part by ensuring that your system is leak-free, keeping leakage to less than 2 percent of the total water volume each month.

12. Inspect the low water cut-off:
    A. For Hydrolevel CG400A low water cut-offs - Remove and inspect the probe for scale and sediment buildup. Clean any sediment or scale from the probe with a scouring pad or steel wool. Consult the Hydrolevel CG400 manual for any additional maintenance information. Test the low water cut-off before placing the boiler back into service
13. Allow the boiler to cool to room temperature. Remove the drain valve and 2 x 3/4 bushing on the left side of the boiler. Use a flashlight to inspect the bottom row of pushnipples for accumulated scale or mud. If a significant amount is present, use the following procedure to clean the inside of the heat exchanger:
    A. Temporarily install a 1 1/4 inch or larger full port ball valve in place of the boiler drain. Temporarily pipe the outlet of this valve to a location where hot water and steam can be safely discharged.
    B. Make sure that this valve is closed and that the water level is at the normal water line.
    C. If a king valve is present in the steam main takeoff, close it. Alternatively, temporarily replace enough of the vents on the mains and/or radiators with plugs so that 2-5 psi can be developed when the boiler is fired.
    D. Fire the boiler and allow it to steam until 2-5 psi is registered on the gauge.
    E. Turn off the burners and immediately fully open the 1-1/4 valve.
    F. Allow the boiler to blow down until either the water runs clear or the water level reaches the bottom of the gauge glass.
    G. Allow all parts of the boiler to cool to room temperature. Drain the boiler completely and remove the 1-1/4 valve.
    H. If significant mud or scale is still present in the bottom of the boiler, repeat steps (b) through (g) until all mud or scale is removed.
    I. Once all mud or scale is removed, replace the 1-1/4 valve and temporary blow-down piping with the standard drain valve. After all parts of the boiler are at room temperature, refill the boiler to the normal water line.
14. Place the boiler back in operation using the procedure outlined in "Start-up". Check the pilot line and any other gas piping disturbed during the inspection process for leaks.

14 Service and Maintenance *(continued)*

⚠ CAUTION

If, during normal operation, it is necessary to add water to this boiler more frequently than once a month, check the system for leaks. A leaky system will increase the volume of make-up water supplied to the boiler which can significantly shorten the life of the boiler. Entrained in make-up water are dissolved minerals and oxygen. When fresh, cool make-up water is heated in the boiler, minerals fall out as sediment and the oxygen escapes as a gas. Both can result in reduced boiler life. The accumulation of sediment can eventually isolate the water from contacting the cast iron. When this happens the cast iron in that area gets extremely hot and may eventually crack. The presence of free oxygen in the boiler creates a corrosive atmosphere which, if the concentration becomes high enough, can corrode the cast iron through from the inside. Since neither of these failures types are a result of a casting defect, the warranty does not apply.

Heat Exchanger Cleaning Procedure

1. Turn off electrical power and gas supply to the boiler.
2. Disconnect the damper and vent connector from the boiler.
3. Remove the top jacket panel. If possible, remove the rear and left side jacket panels.
4. Remove the burners.
5. Disconnect the wiring at the blocked vent switch.
6. Remove the four 1/4 in. bolts holding the flue collector onto the block.
7. Remove the flue collector from the heat exchanger.
8. Carefully remove the flue collector gasket strips and set them aside.
9. Clean the flue passageways using a stiff bristle brush. Be certain that all foreign material is removed from the gaps between the pins.
10. Clean the bottom surfaces of the heat exchanger.
11. Put a light in the combustion chamber and look through the flue passages from the top to verify that they have been thoroughly cleaned.
12. Replace the flue collector gasket strips. If desired, RTV-732 silicone sealant with a 500°F intermittent duty temperature rating may be substituted for this rope gasket. The flue collector must be thoroughly sealed to the heat exchanger.
13. Reassemble the rest of the boiler in reverse order of above.

⚠ WARNING

Soot deposits in the flue passages are a sign that the boiler may be operating at high carbon monoxide (CO) levels. After cleaning the boiler of soot deposits, check the CO level in the flue gas to insure that the boiler is operating properly. If it is necessary to check CO, use a combustion analyzer, or other instrument which is designed to measure CO in flue gas. A CO “sniffer” designed for testing CO levels in ambient air cannot be used to check boiler combustion. Take a flue gas sample by inserting a sample probe through the draft diverter opening and into the flue collector so that the sample is taken in the area directly over the heat exchanger. Do not take a sample until the boiler has been firing for at least five minutes. A normal CO reading for this series boiler is less than 50ppm (0.005%). A reading of more than 100ppm (0.01%) is indicative of a combustion problem.

Some causes of excessive CO include:

- Incorrectly sized or drilled burner orifice
- Partially plugged flue passages
- Improper manifold pressure
- Foreign material in burner venturis or burner ports
- Leak in seal between canopy and heat exchanger
- Damaged base
- Inadequate supply of combustion air

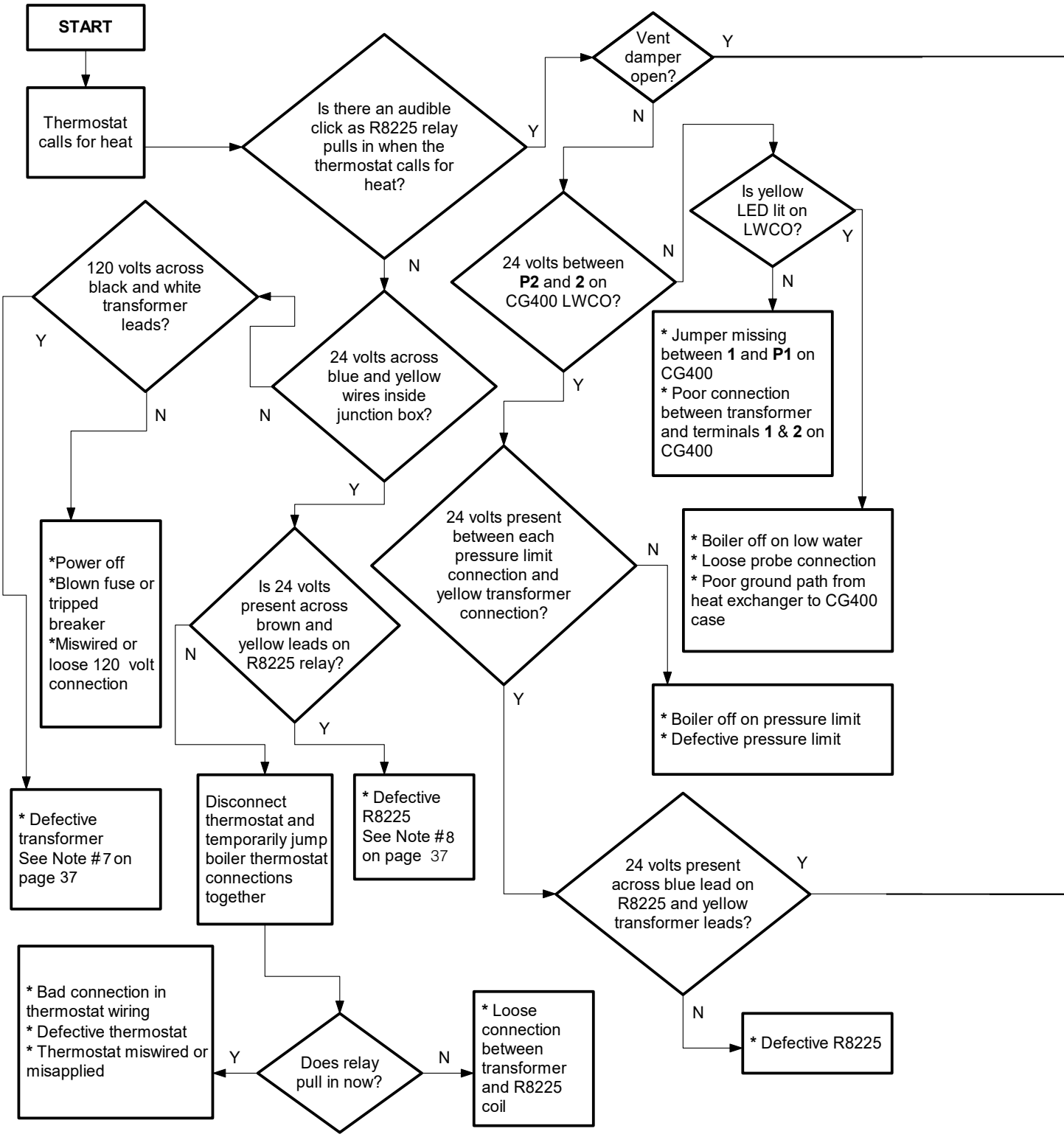
15 Troubleshooting

The following pages contain trouble shooting tables for use in diagnosing control problems. When using these tables the following should be kept in mind:

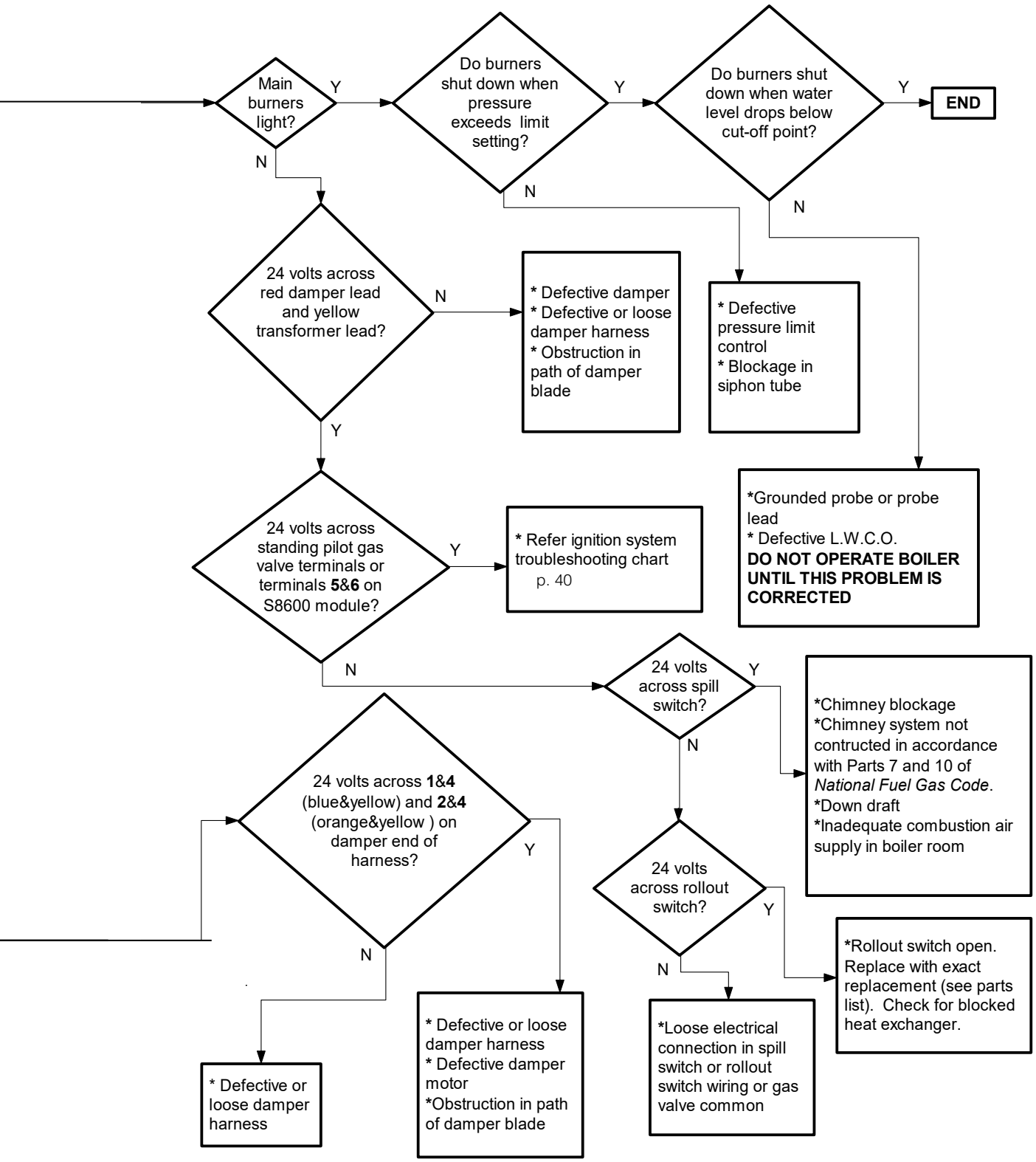
1. This information is only meant to be used by a professional heating technician as an aid in diagnosing boiler problems.
2. Where applicable, follow all precautions outlined in the Section 12 (Start-up and Checkout).
3. In general, these tables assume that there are no loose or miswired electrical connections. Before using these tables inspect all electrical connections on the boiler to make sure that they are tight. Also, check the wiring on the boiler against the wiring diagram in Figures 11-1 and 11-2.
4. When checking voltage across at wiring connectors (such as at the vent damper harness plug) be careful not to insert the meter probes into the metal sockets. Doing so may damage the socket, resulting in a loose connection when the harness is reconnected.
5. The possible causes at the end of each branch in these charts are not listed in order of likelihood. All controls on the boiler are tested at least once in the manufacturing process and a defective control or component is generally the least likely cause. Before replacing a component, try to rule out all other possible causes.
6. These troubleshooting charts assume that the vent damper is closed at the beginning of the troubleshooting process. With 120 volts applied to the boiler and no call for heat, the damper should go to the closed position. If it does not, do the following:
   A. Confirm that 120 volts is applied to the boiler and that there is no call for heat.
   B. Make sure that the switch on the damper is in the “automatic” position.
   C. Unplug the harness from the damper and check for 24 volts across pin #1 (blue) and pin #4 (yellow).
   D. If voltage is present, the damper is defective or there is an obstruction in the path of the damper blade.
   E. If no voltage is present, there is either a loose connection in the damper harness or the transformer is defective.
7. If the charts indicate that the transformer is defective, it is possible that this transformer has been destroyed by a short circuit in the boiler wiring. Before replacing the transformer, carefully inspect all low voltage wiring on the boiler for places where it is touching the frame of the boiler or wiring on the other side of the transformer.
8. If the charts indicate that the R8225 relay is defective, there is a good chance that a second transformer is present in the thermostat circuit, resulting in the application of 48 volts across the relay coil. In older buildings, this transformer may be hidden in a location far from the boiler. If this second transformer exists, it must be found and removed before the R8225 is replaced.

15 Troubleshooting *(continued)*

Troubleshooting Chart for Boilers Equipped with Hydrolevel CG400A Low Water Cut-offs and Vent Dampers
Caution: Read page 37 before attempting to use this chart



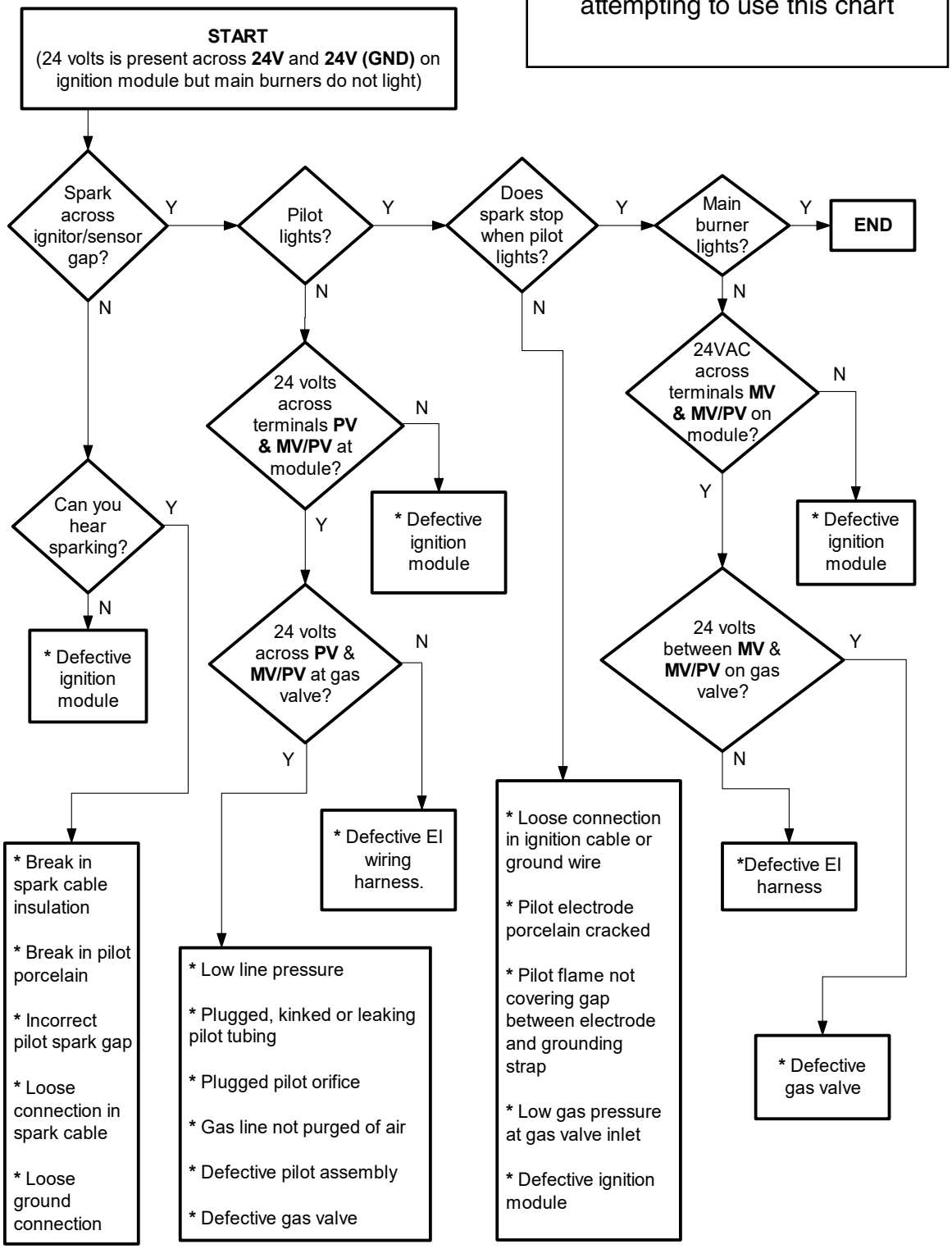
15 Troubleshooting *(continued)*



15 Troubleshooting *(continued)*

Ignition System Troubleshooting Chart

Caution: Read page 37 before attempting to use this chart

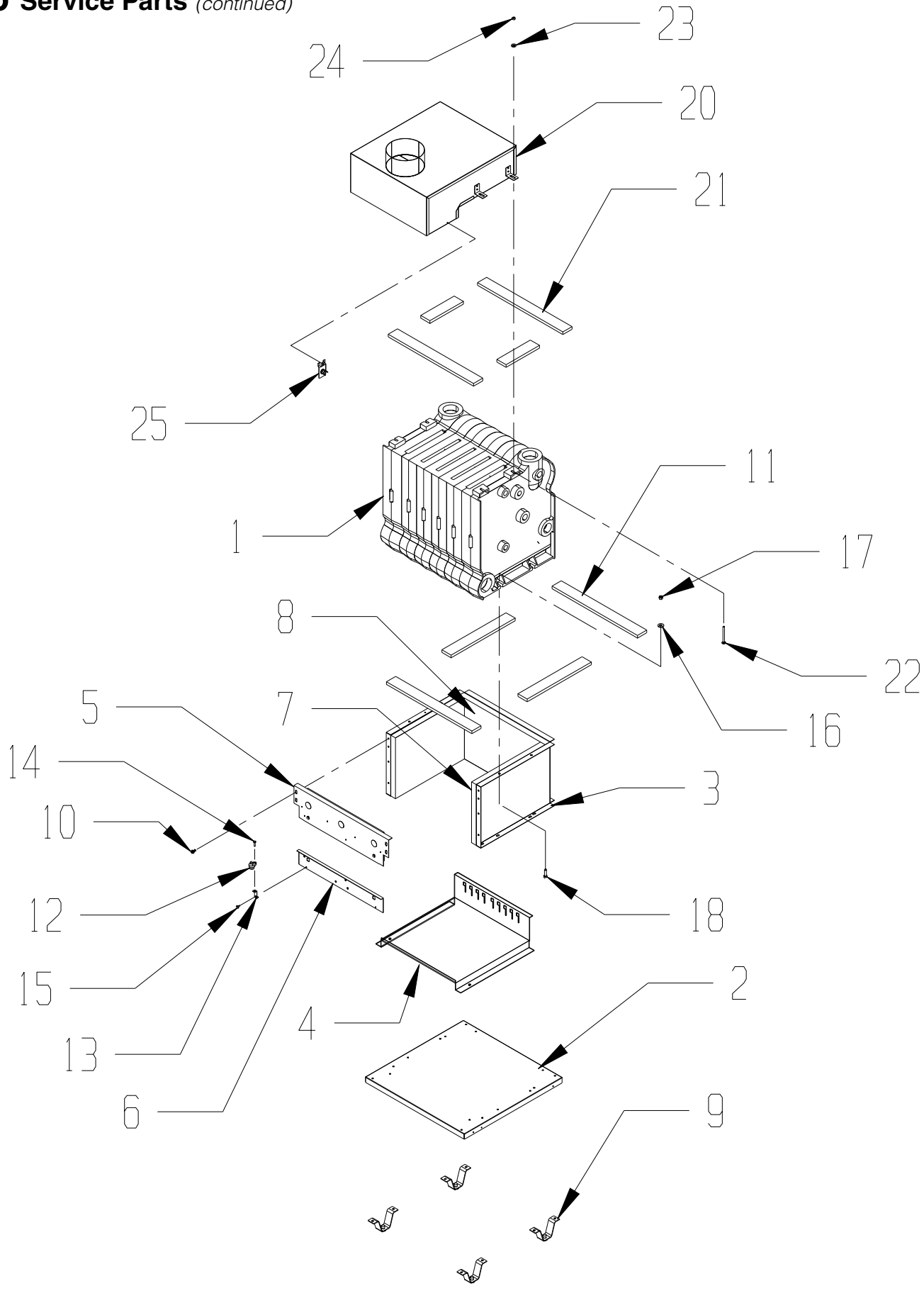


16 Service Parts

All Service Parts may be obtained by contacting your local Ferguson branch.

Key No.	Description	Part Number [Quantity]					
		FORCESTM03	FORCESTM04	FORCESTM05	FORCESTM06	FORCESTM07	FORCESTM08
1	Heat Exchanger Assembly (Complete)	109454-01 [1]	109455-01 [1]	109456-01 [1]	109457-01 [1]	109458-01 [1]	109459-09 [1]
2	Base Tray	112592-03 [1]	112592-04 [1]	112952-05 [1]	112952-06 [1]	112952-07 [1]	112952-08 [1]
3	Base Wrapper						
4	Burner Tray						
5	Base Front Panel Assembly (includes insulation)						
6	Burner Access Panel						
7	Base End Insulation						
8	Base Rear Insulation						
9	Base Leg Assembly						
10	Screw, Self Tapping, Phillips Pan Head, 1/4-20 x 1/2 in.						
11	1/2 in. x 2 in. Sealing Strip						
12	Flame Rollout Switch						
13	Flame Rollout Switch Bracket Assembly						
14	#8 x 3/4 in. Self Tapping Screw						
15	#10 x 1/2 in. Sheet Metal Screw						
16	Washer, 5/16, USS						
17	Hex Lock Nut, 5/16-18						
18	Screw, Self Tapping, Type F, Hex Head, 5/16-18 x 1-1/4 in., Plated						
11	1/2 in. x 2 in. Sealing Strip	6206002 [1]					
12	Flame Rollout Switch	109616-01 [1]					
13	Flame Rollout Switch Bracket Assembly	112593-01 [1]					

16 Service Parts *(continued)*



16 Service Parts *(continued)*

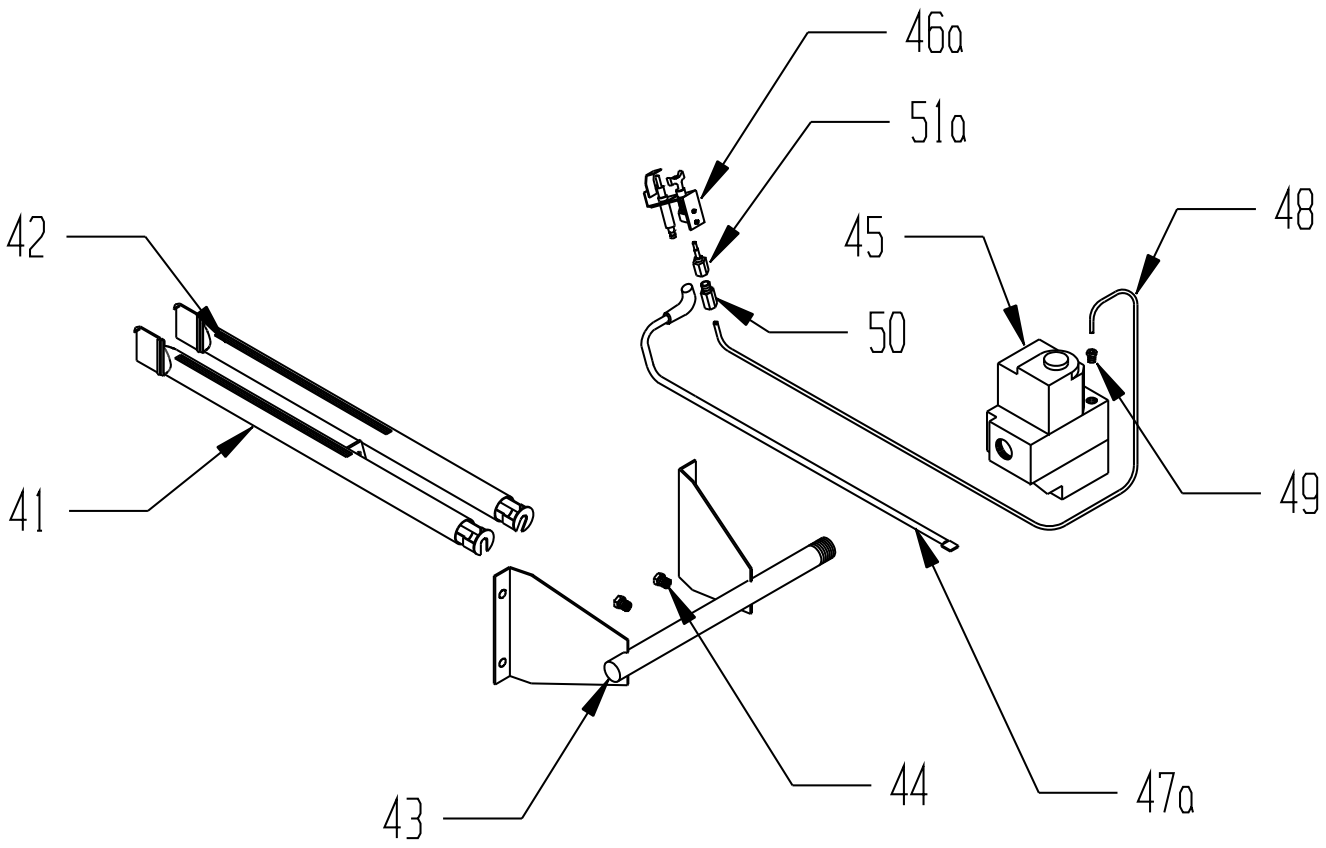
Key No.	Description	Part Number [Quantity]					
		FORCESTM03	FORCESTM04	FORCESTM05	FORCESTM0601	FORCESTM07	FORCESTM08
20	Draft Diverter	112596-03 [1]	112596-04 [1]	112596-05 [1]	112596-06 [1]	112596-07 [1]	112596-08 [1]
21	1/2 in. x 1 in. Sealing Strip	6206001 [1]					
22	1/4-20 x 1-1/4 in. Carriage Bolt	Obtain Locally [4]					
23	1/4 in. USS Flat Washer	Obtain Locally [4]					
24	1/4-20 Hex Nut	Obtain Locally [4]					
25	Blocked Vent Switch	112595-01 [1]	112595-02 [1]				

16 Service Parts *(continued)*

Key No.	Description	Part Number [Quantity]					
		FORCESTM03	FORCESTM04	FORCESTM05	FORCESTM06	FORCESTM07	FORCESTM08
41	Main Burner with Pilot Bracket	112599-01 [1]					
42	Main Burner Less Pilot Bracket	112600-01 [3 burners per kit]					
43	Manifold	112601-03 [1]	112601-04 [1]	112601-05 [1]	112601-06 [1]	112601-07 [1]	112601-08 [1]
44	Nat. Gas Main Burner Orifice	#44, Orange 112602-01 [1]	#45 112603-01 [1] (7 orifices)		#46 112604-01 [1]	#48 112605-01 [1] (14 orifices)	
	LP Gas Main Burner Orifice	#54 112606-01 [1]	#55, Green 112607-01 [1] (7 orifices)		1.25 mm, Purple 112608-01 [1] (14 orifices)		
45	Gas Valve (Nat.), Honeywell	VR204C3007 109620-01 [1]				VR8304P4306 112009-01 [1]	
	Gas Valve (LP), Honeywell	VR8204C3015 109615-01 [1]				VR8304P4314 109621-01 [1]	
46a	Pilot Assembly (Nat.), Honeywell, Q348A1275	112609-01 [1]					112610-01 [1]
	Pilot Assembly (LP), Honeywell, Q348A1259	112611-01 [1]					112612-01 [1]
47a	Ignitor/Sensor Cable, 25 in., Honeywell 394800-25	Included with Pilot Assembly					
	Ignitor/Sensor Cable, 30 in., Honeywell 394800-30						
48	1/4 in. Pilot Tubing	30 in. 109611-01 [1]					40 in. 109611-02 [1]
49	1/4 Short Ferrule	Included with Gas Valve					
50	1/4 Long Ferrule (included with Pilot Assembly) Honeywell 386449-4	109638-01 [1]					
51a	KF24 Pilot Orifice (Q348 Pilot Nat.)	Included with Pilot Assembly					
	K16 Pilot Orifice (Q348 Pilot LP)	Included with Pilot Assembly					
*	Pilot Ground Wire	109623-01 [1]					

* Not Pictured

16 Service Parts *(continued)*

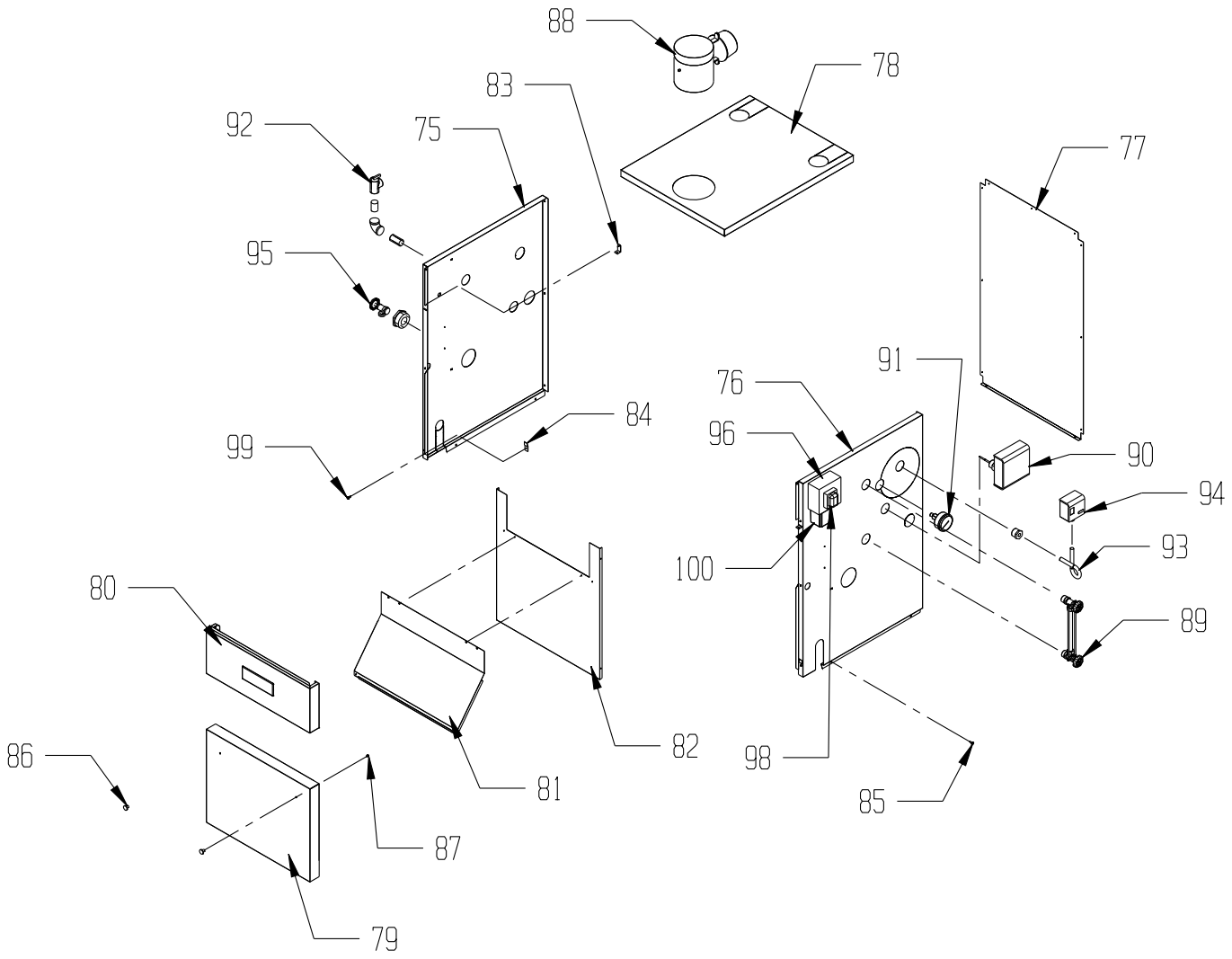


16 Service Parts *(continued)*

Key No.	Description	Part Number [Quantity]					
		FORCESTM03	FORCESTM04	FORCESTM05	FORCESTM06	FORCESTM07	FORCESTM08
75-87	Complete Jacket Set	106442-03 [1]	106442-04 [1]	106442-05 [1]	106442-06 [1]	106442-07 [1]	106442-08 [1]
*	Ignition Module, UTEC 1003-664A	112616-01 [1]					
*	Ignition Module Support Bracket	Included with Ignition Module					
*	Damper Wire Harness	112617-01 [1]					
*	Blocked Vent Switch Harness	112618-01 [1]					
*	J-Box FRS Harness	112619-01 [1]					
*	CG400 L.W.C.O. - J-Box Harness	112620-01 [1]					
*	Pressure Limit - J-Box Harness	112621-01 [1]					
*	Intermittent Ignition Harness	109641-01 [1]					
88	Vent Damper	4 in. 109634-01 [1]	5 in. 109634-02 [1]	6 in. 109634-03 [1]		7 in. 109634-04 [1]	
89	Gauge Glass, Extended Shank (with Probe LWCO only)	112622-01 [1]					
90	Low Water Cutoff, Hydrolevel CG400-2090 (includes Probe)	111272-01 [1]					
*	Probe for CG400	110353-01 [1]					
91	Pressure Gauge	109707-01 [1]					
92	Safety Valve, 3/4 NPT, 15 psi, (Conbraco 13-511-08 or equivalent)	Obtain Locally [1]					
93	90˚ Syphon	112623-01 [1]					
94	Pressure Limit, Honeywell L404F1367	111280-01 [1]					
95	3/4 in. Boiler Drain	Obtain Locally [1]					
96	Junction Box, 4-11/16 in. x 4-11/16 in. x 2-1/8 in.	Obtain Locally [1]					
98	24V Transformer (AT140D1012)	112624-01 [1]					
*	Transformer/J-Box Adapter Plate	Included with 24V Transformer					
99	8-32 x 1/2 in. Self Tapping Screw	Obtain Locally [2]					
100	SPST Relay (R8225B1049)	112625-01 [1]					

* Not pictured

16 Service Parts *(continued)*



16 Service Parts *(continued)*

Gas Conversion Kits:

Key No.	Description	Part Number [Quantity]					
		FORCESTM03	FORCESTM04	FORCESTM05	FORCESTM06	FORCESTM07	FORCESTM08
Not Shown	Natural Gas to LP	106567-01	106567-02		106567-03	106567-04	
Not Shown	LP to Natural Gas	106568-01	106568-02		106568-03	106568-04	

SERVICE RECORD

DATE	SERVICE PERFORMED

SERVICE RECORD

DATE	SERVICE PERFORMED

SERVICE RECORD

DATE	SERVICE PERFORMED

SERVICE RECORD

DATE	SERVICE PERFORMED