D249 Series
Cast Iron Commercial
Natural Gas Steam Boiler

INSTALLATION, OPERATION & MAINTENANCE MANUAL
### RATINGS AND CAPACITIES

#### Ratings and Capacities - Chart 1

<table>
<thead>
<tr>
<th>Input/Size (Mbh)</th>
<th>Output (1)</th>
<th>Net AHRI Ratings (2)</th>
<th>Flue Outlet No. &amp; Size</th>
<th>Flue Collector Size to Chimney</th>
<th>Horsepower Gross Output (4)</th>
<th>Therm. Eff.</th>
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<td></td>
<td>Gross Output Mbh</td>
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<td>3633</td>
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1) Ratings are at sea level to 2,000 feet. For altitudes above 2,000 feet, reduce all ratings 4% for each 1,000 feet above sea level.

2) Net steam ratings based on an allowance of 1.333 (300-1500). Contact Technical Support before selecting boiler for installations having unusual piping and pick-up factors, such as intermittent system operations, extensive piping systems, etc.

3) Ratings in square feet are computed at 240 Btuh/square foot for steam boilers.

4) Ratings based on 33,500 Btuh per horsepower.

5) Pressure drop based on given flow from single outlet and returning to single inlet at the opposite end of the boiler.

6) Chimney sizes shown are one option based on a typical venting system as shown in **Figure 6**, and sized according to the National Fuel Gas Code, assuming Type B double wall vent and vent connectors. Other venting system designs are acceptable as shown on **Flue Connection And Venting section of this manual**. For further chimney design and sizing information, consult the National Fuel Gas Code, ANSI Z223.1/NFPA 54-latest revision, or ASHRAE HVAC Systems and Equipment Handbook, Chimney, Gas Vent, and Fireplace Systems, or the Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances. NFPA 211. Follow standard engineering practice.
For further component information see Parts, Kits and Optional Accessories Manual provide with your boiler see pages listed.

* SEE PAGE 8 - COMPONENT CARTON PARTS LIST
** SEE PAGE 7 - STEAM CARTON PARTS LIST
*** SEE PAGE 3 - ACCESSORY CARTON PARTS LIST
**** SEE PAGE 8 - JACKET END PANEL CARTON PARTS LIST
***** SEE PAGE 4 - BASE END PANEL CARTON PARTS LIST
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</table>
SAFETY INFORMATION

Safety Information

IMPORTANT: Read the following instructions COMPLETELY before installing!!

**WARNING**

Fire, explosion, asphyxiation and electrical shock hazard. Improper installation could result in death or serious injury. Read this manual and understand all requirements before beginning installation.

**WARNING**

Keep boiler area clear and free from combustible materials, gasoline and other flammable vapors and liquids.
DO NOT obstruct air openings to the boiler room.
Modification, substitution or elimination of factory equipped, supplied or specified components may result in personal injury or loss of life.
TO THE OWNER - Installation and service of this boiler must be performed by a qualified installer.
TO THE INSTALLER - Leave all instructions with boiler for future reference.
When this product is installed in the Commonwealth of Massachusetts the installation must be performed by a Licensed Plumber or Licensed Gas Fitter.

1. Never test for leaks with an open flame. Use soap suds to check all connections. This will avoid any possibility of fire or explosion.
2. Boiler is configured for operation with natural gas. Over-firing will result in premature failure of boiler sections and cause dangerous operation. Verify there is adequate gas supply piping.
3. Never vent this boiler into enclosed space. Always connect boiler to chimney and vent to outside. Never vent to another room or inside a building.
4. Verify there is adequate air supply for complete combustion.
5. Follow regular service and maintenance schedule for efficient and safe operation.

**WARNING**

Fire hazard. Do not install boiler on combustible flooring such as carpeting or wood flooring. Failure to follow these instructions could result in death or serious injury.

6. DO NOT install boiler on combustible flooring such as carpeting or wood flooring.

When Your Boiler Arrives

When boiler arrives be sure to save and refer to instructions.

Inspect each item received for visible damage. If any parts are damaged, report this to freight company immediately and request them to call and make inspection before you make any installation. Have inspector prepare a signed report. Send copy of report to manufacturer.

We must have the signed inspection report of the freight company to prove their liability.

Read these instructions carefully before beginning the installation to be sure all packages have been received. It is recommended that you follow the step-by-step instructions for best assembly results. Before discarding any packing material carefully examine for loose parts. Also store all parts received where they will not be lost or damaged.

Codes Governing Installation

Installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to the National Fuel Gas Code, ANSI Z223.1/NFPA54.

Where required by the authority having jurisdiction, the installation must conform to the standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1. Additional controls and safety devices are required for CSD-1.

Installation

Boiler is designed to provide wide heating capacity range with multiple burner modules, each equipped with its own set of controls. For purposes of orientation, gas manifold location is considered the front. Instructions are written for assembly of boiler starting with left side and working to right side.
**Combustion Air**

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

**Chimney And Vent Pipe Connection**

This is a very important part of the heating system. It must be clean, the right size, properly constructed and in **Good Condition**. No boiler can function properly with a bad chimney. See Pages 8-12 for specific venting instructions. Flue pipe should be same size as draft hood outlet from boiler to flue collector. See **Chart 1** for Typical Chimney Size. Maintain a minimum upward slope of 1/4 inch per linear foot from boiler to the chimney. Fasten joints together with sheet metal screws to prevent sagging.

**Boiler Location**

Locate boiler on level, non-combustible foundation as near to chimney or flue as possible. Allow 24 inches at front and sides of boiler for servicing and cleaning. When installed in utility room, the door should be wide enough to allow the largest boiler parts to enter, or permit replacement of any other appliance in the same room. Installing contractor **must** provide ventilated foundation for boiler when installing:

- Over a room
- Over electrical wiring or cables of any kind
- If concrete floor is not cured or water is channeled under concrete floor

**Minimum Vent Pipe Clearance**

If the vent pipe must go through a crawl space, double wall vent pipe should be used. Where vent passes through a combustible wall or partition, use a ventilated metal thimble. The thimble should be 4 inches larger in diameter than vent pipe. If boiler is installed with single wall galvanized type vent pipe, it must have 6 inches clearance between its surface and any combustible material. If UL listed type B (insulated) vent pipe is used, clearance between it and combustible material to be as listed by pipe manufacturer.

**WARNING**

Fire hazard. Do not install boiler on combustible flooring such as carpeting or wood flooring. Failure to follow these instructions could result in death or serious injury.

**CHART 2**

**FOR INSTALLATION ON NON-COMBUSTIBLE FLOORS ONLY, MINIMUM CLEARANCES TO COMBUSTIBLE CONSTRUCTION**

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<th>Inputs of 400 MBH or less</th>
<th>Inputs over 400 MBH</th>
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<td>Top</td>
<td>52”</td>
<td>52”</td>
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<td>Front</td>
<td>18”</td>
<td>18”</td>
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<tr>
<td>Flue Collector</td>
<td>6”</td>
<td>6”</td>
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<td>Rear</td>
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<td>Sides</td>
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<td>Steam/Water Piping</td>
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Greater clearances (24”) for access should supersede fire protection clearances.
### COMBUSTION AIR REQUIREMENTS – Chart #3

(MINIMUM SQUARE INCHES OPENING)

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<tr>
<th>MODEL NUMBER</th>
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<th>**CONFINED AREA</th>
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<td>OUTSIDE COMBUSTION AIR 1 SQ. IN./4000 Btu/hr (SEE FIG. 2)</td>
<td>INSIDE COMBUSTION AIR 1 SQ. IN. /1000 Btu/hr (SEE FIG. 1)</td>
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<td>1500</td>
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<td>375</td>
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* Unconfined area: A space whose volume is not less than 50 cubic feet per 1000 Btu per hour of all appliances installed in that space (cubic feet of space = height x width x length).

** Confined area: A space whose volume is less than 50 cubic feet per 1000 Btu per hour of all appliances installed in that space (cubic feet of space = height x width x length).
1. Provide combustion and ventilation air in accordance with the section “Air for Combustion and Ventilation”, of the National Fuel Gas Code, ANSI Z223.1/NFPA 54, or applicable provisions of the local building codes.

2. Boiler is located in unconfined space in building or conventional construction frame, masonry or metal building, infiltration normally is adequate to provide air for combustion and ventilation. However, if equipment is located in building of tight construction (See National Fuel Gas Code, ANSI Z223.1), boiler area should be considered as confined space. If there is any doubt, install air supply provisions in accordance with latest revision of National Fuel Gas Code.

3. Boiler is installed in unconfined space, in building of tight construction, air for combustion and ventilation must be obtained from outdoors or from spaces freely communicating with outdoors. Permanent opening or openings having total free area of not less than 1 square inch per 5,000 Btu per hour of total input rating of all appliances shall be provided. Ducts may be used to convey makeup air from outdoors and shall have same cross-sectional area of openings to which they are connected.

4. When air for combustion and ventilation is from inside buildings, confined space shall be provided with two permanent openings, one starting 12 inches from top and one 12 inches from bottom of enclosed space. Each opening shall have minimum free area of 1 square inch per one thousand (1000) Btu per hour of total input rating of all appliances in enclosed space, but must not be less than one hundred (100) square inches. Openings must freely communicate directly with other spaces of sufficient volume so combined volume of all spaces meets criteria for unconfined space. Figure 1.

5. When boiler is installed in confined space and all air is provided from outdoors confined space shall be provided with one or two permanent openings according to methods A or B (see page 10). When ducts are used, they shall be of same cross sectional area as free area of area of openings to which they connect. Minimum dimension of rectangular air ducts shall be not less than 3 x 3 inches or 9 square inches.
VENTILATION AND COMBUSTION AIR

A. When installing two openings, one must commence within 12 inches from top and other within 12 inches from bottom of enclosure. Openings shall communicate directly, or by ducts, with outdoors or spaces (crawl or attic) that freely communicate with outdoors. One of following methods must be used to provide adequate air for ventilation and combustion.

1) When directly communicating with outdoors, each opening shall have minimum free area of 1 square inch per 4,000 Btu per hour of total input rating of all equipment in enclosure. Refer to Figure 2 on previous page.

2) When communicating with outdoors by means of vertical ducts, each opening shall have minimum free area 1 square inch per 4,000 Btu per hour of total input rating of all appliances in the enclosed space.

3) If horizontal ducts are used, each opening and duct shall have minimum free area 1 square inch per 2,000 Btu per hour of total input rating of all appliances in the enclosed space.

B. One permanent opening, commencing within 12 inches of top of enclosure, shall be permitted where equipment has clearances of at least 1 inch from sides, 1 inch from back, and 6 inches from front of boiler. Opening shall directly communicate with outdoors or shall communicate through vertical or horizontal duct to outdoors or spaces (crawl or attic) that freely communicate with outdoors. Openings must have minimum free area of 1 square inch per 3000 Btu per hour of total input rating of all equipment located in enclosure. Free area must be no less than sum of areas of all vent connectors in confined space.

6. In calculating free area using louvers, grilles or screens for above, consideration shall be given to their blocking effect. Screens used shall not be smaller than 1/4 inch mesh. If free area through design of louver or grill is known, it should be used in calculating size opening required to provide free area specified. If design and free area is not known, it may be assumed that wood louvers will have 20-25% free area and metal louvers and grilles will have 60-75% free area. Louvers and grilles should be fixed in open position or interlocked with boiler so they are opened automatically during boiler operation.

VENT INSTALLATION

A WARNING
Vent connectors serving appliances vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.

1. The vent pipe must slope upward from the boiler not less than 1/4” for every 1’ to the vent terminal. Figures 1 & 2.

2. Horizontal portions of the venting system shall be supported rigidly every 5 feet and at the elbows. No portion of the vent pipe should have dips or sags.

Flue Connection And Venting
Vent installations shall be in accordance with “Venting of Equipment”; of the National Fuel Gas Code, ANSI Z223.1/ NFPA 54, or applicable provisions of the local building codes.

1. Consult dimensional drawing for number and size of flue pipes required for each size boiler.

2. Maintain minimum upward slope of 1/4 inch per linear foot from the boiler to chimney.

3. Run flue pipe directly as possible. Keep turns to a minimum. Insert flue pipe into, but not beyond, inside wall of chimney. Do not connect into a chimney serving an open fireplace.

4. Insulate flue pipe where it passes near combustible material.

5. Rigidly support pipe with hangers and straps.

6. Extend chimneys at least 2 feet above any object within radius of 15 feet, including roof.

7. Install hood on all flue pipes which extend through roof. In most locations, venting of boiler relies on natural draft. In as much as energy available from natural draft is quite low, serious thought should be given to vent system design, i.e., adequate size, use of gradual transitions, tees, elbows, etc., close proximity of boiler and chimney. On all boilers, vertical risers must be at least as large as vent openings on draft-hood. Boiler manufacturer makes no specific recommendations regarding application of draft inducers that may be used with this boiler. If draft inducer is used, it is up to installing contractor and draft inducer manufacturer to determine proper application.
**Flue Connection And Venting - Continued**

Simple vent system consists of 6-foot minimum vertical rise immediately off draft-hood, as shown in Figure 3. Terminate this vertical flue above building roof with suitable rain cap at least 2 feet above surrounding obstructions, i.e., parapets, adjacent buildings, penthouses, etc. This type of vent system applies to single draft-hood boilers ONLY, and has limited practical use, because it is restricted to single-story boiler rooms and because of problems encountered in roof flashing.

Vertical venting system shown in Figure 3 cannot be used on multiple-base boilers because of physical interference of multiple rain caps.

For multiple-base boilers, pant leg venting system shown in Figure 4 can be applied, if desired.

Vent system shown in Figure 5 is commonly used. With vent diameters sized to match flue outlets, minimum vertical rise of 4 feet above draft-hood must be maintained for proper operation. Refer to Chart 1 for typical chimney sizes. Requirements for this type of system are: an adequately sized chimney, adequate combustion air, and outlet end of horizontal run must be no more than 6 feet from chimney with no more than one 90° elbow in this run as shown.

For installations where required minimum 4-foot vertical rise cannot be maintained, diameter of horizontal run must be increased one inch for each foot of riser reduction. This procedure will reduce resistance of system, and if chimney is adequate boiler will vent properly.

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**Figure 3**

**Figure 5**

**Figure 4**
Removing Existing Boiler From Common Venting System

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

1. Seal any unused openings in the common venting system.

2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion and other deficiencies which could cause an unsafe condition.

3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

4. Place in operation the appliance being inspected. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.

5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.

6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliance to their previous conditions of use.

7. Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1/NFPA 54. 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 Chapter 13 of the National Fuel Gas Code, ANSI Z223.1/NFPA 54.

Flue Connection And Venting - Continued

In certain cases where these short rises of less than 4 feet have been used, spillage of combustion products has occurred at the draft-hoods farthest from the chimney. Assuming the chimney is adequately sized, one acceptable method to correct this spillage problem is to permanently baffle the riser(s) closest to the chimney to reduce the excess of room air entering those draft-hoods. DO NOT BAFFLE ENOUGH TO CAUSE SPILLAGE. The use of fixed baffles in the short risers above the boiler draft-hood are acceptable as spelled out in American National Standard NFPA 54/ANSI Z223.1 National Fuel Gas Code, latest revision.

Fabricate these fixed baffles, using 20-gauge steel. See Figure #6. Permanently attach the baffle to the inside of the riser(s). Trial and error will dictate the degree to which each should be positioned to avoid draft-hood spillage at the far end of the boiler. Be careful to avoid bending the fixed baffle so it will obstruct the flue gas flow in the horizontal collector.

IMPORTANT: Extend chimneys at least 2 feet above any object within radius of 15 feet, including roof.

### Baffle Size (Inches)

<table>
<thead>
<tr>
<th>Riser</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Shown is suggested size of fixed baffle for different size risers.

IMPORTANT: Extend chimneys at least 2 feet above any object within radius of 15 feet, including roof.
**BOILER DIMENSIONS**

**Front View**

**Left Side View**

**Top View**

ALL SUPPLY AND RETURN CONNECTIONS ARE 4 INCH

---

**Chart 4**

<table>
<thead>
<tr>
<th>Boiler Model No.</th>
<th>Water Content in Gallons</th>
<th>Shipping Weight Lbs.</th>
<th>A Jacket Width L to R</th>
<th>AA Base &amp; Battery Length</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>*Boiler Modules</th>
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<tr>
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<td>20</td>
<td>922</td>
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<td>10 3/8</td>
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<td>21</td>
<td>12 1/2</td>
<td>-</td>
<td>-</td>
<td>12 1/2</td>
<td>400 x x</td>
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<tr>
<td>500</td>
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<td>-</td>
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<td>-</td>
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<td>1977</td>
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<tr>
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<td>14 5/8</td>
<td>500 500 500</td>
</tr>
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* **Note** - See page 14 Base Assembly
Base Assembly

300, 400 and 500 boilers are the basic models.

- 300 model has (6) burners
- 400 model has (8) burners
- 500 model has (10) burners

Combinations of basic models are used to assemble 600 through 1500 models.
Refer to Chart 3 for proper order of assembly. When two or more bases are used to assemble boiler, verify tops of bases are even.

1. Fasten bases together with 5/16 cap bolts and nuts.

2. Insert two bolts in front posts and two in rear posts as shown in Figure 7A.

3. After bases are fastened, install base end panels. Install end panels before assembling sections. See Figure 7B.

**NOTICE**

Verify bases are level after assembly.

Section Assembly

1. Start sections from left or right end of base.

2. Place end section on base with center-line of section directly over joint of base end closure.

3. With boilers having two or more bases, as you progress be sure parting line (center-line of section) of intermediate sections fall on junction of two bases. See Figure 8.

**Note:** First Section Alignment is critical. Use side of base to align first section. Do not allow side to overhang base.
1. When starting section assembly, clean nipples and nipple ports.

2. Coat nipples and nipple ports with Hercules Gripp or other good sealant. See Figure 9.

3. Place nipples in ports. Take care to seat them squarely to prevent cocking. Figure 10.

4. When pulling sections together with tie rods, insert tie rods in holes nearest to nipple ports. Move tie rods to proper location, if necessary, only after sections are fully pulled together. See insert Figure 11.

5. Oil or lubricate threads, insert rods in lugs with washers under nuts and tighten uniformly and evenly so that sections are pulled parallel as they go together. Tighten bolts by hand to 30-40 Ft-lbs each. Do not overtighten. Do not use an impact wrench. When all sections are pulled up, locate tie rods in alternating pairs of upper and lower holes between adjacent sections. See Figure 11.

6. Be sure both ends of completed section assembly are resting evenly on both ends of base.

7. Apply furnace cement at joints of sections front, top and back. Apply furnace cement where sections join the base. See Figure 12.

8. Place necessary plugs and control wells in correct locations. See Figure 31 page 24.
   A. Plug all other tappings, leaving air vent in top of one of end sections, and connect water.
   B. Fill boiler with water until it runs out air vent. See Figure 31 port D page 24.
   C. Hydrostatically test boiler in accordance with applicable codes.
   D. Check for leaks before continuing with assembly.
   E. Drain and remove unnecessary plugs.

Apply non-asbestos furnace cement to joints on all sides of boiler.
Attaching Draft Hoods

1. Attach draft hoods to boiler sections after applying boiler Hercules Grip to top of boiler sections where hoods and sections meet.

2. Use J-bolts to attach front of draft hoods to slots in section flanges. See Figure 13.
Installing Boiler Jacket Panels

**NOTICE**

Start jacket assembly at left side.

1. Attach lower jacket end panel (left) to two Z-bars on base end closures through two slotted holes on bottom of jacket end panel. Use (2) #10 x ½” screws. See Figure 14.

2. Attach middle jacket end panel (left) to lower jacket end panel with middle laying over lower. Line up holes. Use (5) #10 x ½” screws. See Figure 15.

3. Attach upper jacket end panel (left) to middle jacket end panel with upper behind middle. Line up holes. Use (6) #10 x ½” screws. Ensure bare metal plate is inserted between casting ridge and draft hood. This holds panel in place. See Figure 16.
4. Position top/front intermediate panel so back edge of top hangs on adjustable clips on front of draft hood(s);
   A. Left edge hangs on bracket on left upper jacket end panel,
   B. Right edge with integral bracket hangs on tie rod(s).
   See Figure 17.

5. Attach top/front intermediate panel to lower base brackets through four slotted holes in panel. Use (4) #10 x ½” screws. See Figure 18.

6. On multiple base boilers, each additional top/front intermediate panel attaches in same way (working your way from left to right). Figure 18.
7. Attach upper jacket end panel (right) so left edge hangs on bracket on top/front intermediate panel. Insert bare metal plate in same manner as left panel. See Figure 19.

A. Attach side panel to base bracket through to slotted holes. See Figure 20

B. For added support attach side panel to draft hood.
11. Position top of rear jacket panel(s) to draft hood baffle flange. Secure with (2) #10 x ½” screws. Secure bottom of rear jacket panel(s) to bracket(s) on boiler base using (2) #10 x ½” screws. See Figure 23.

8. Attach middle jacket end panel (right) to upper jacket end panel with middle laying over upper. Line up holes. Use (6) #10 x ½” screws. See Figure 22A.

9. Attach lower jacket end panel (right) to middle jacket end panel with lower behind middle. Line up holes. Use (5) #10 x ½” screws.

10. Attach lower jacket end panel to two Z-bars on base end closures through two slotted holes on bottom of jacket end panel. Use (2) #10 x ½” screws. See Figure 22B.
12. Attach burner door knobs with #8-32 x ¼” screws and #8-32 hex nuts.

13. Slide bottom of lower access door(s) in slots on top of manifold brackets. See Figure 24.

14. Position control access jacket panel(s) so tabs slide into slots on top/front intermediate jacket panel(s).

15. Attach control access jacket panel to front jacket. Use (2) #10 x ½” screws. See Figure 25.

16. Each boiler base includes:
   • Factory installed lighting Instruction Labels.
   • Factory installed Data plate indicating required gas type, firing rate, and gas pressure for that base. These plates are located on Jacket Top/Front Panels.
   • Field installed rating plate showing total Input and Output Ratings. Rating plate is shipped in AC Carton and is to be mounted on side Jacket End Panel by installing contractor.

17. Attach any Local Code Label, not provided by manufacturer, to boiler.

NOTE: Attachment of control access jacket panel can wait until controls have been mounted to front jacket panel.
Control Mounting And Installation

Electrical controls, J-box, etc. can be mounted on either left or right jacket end panel.

Boiler safeties (LWCO, etc.) and respective piping must be mounted on opposite end of boiler electrical controls.

1. Attach J-box assembly to jacket end panel. Align with holes in end panel. Use (4) #10 x ½” screws. See Figure 27.

2. Attach control panel to front jacket panel align with predrilled holes. Use (4) #10 x ½” screws. Secure harness to control panel with zip-ties. Attach wire clips to side and front panels (3). Route wires through clips. See Figure 28A.

3. Orient harness of control panel assembly so correct (female) plug is toward J-box and will connect to J-box harness. See Figure 28A.

4. Connect plugs on harnesses. See Figure 28B.
5. Connect plugs on harnesses. See Figure 29.

6. On multiple base boilers, mount remaining control panels to intermediate jacket panels following steps 4 & 5.

7. On each base, connect gas valve harness. Refer to Wiring Diagram page 30.

8. Connect pilot spark wire after control panel installation. See Figure 30.
Figure 31 shows end section and provided tappings. Tappings are same in both right and left end sections.

<table>
<thead>
<tr>
<th>OPENING</th>
<th>SIZE</th>
<th>STEAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4&quot;</td>
<td>Supply and Return</td>
</tr>
<tr>
<td>B</td>
<td>½&quot;</td>
<td>Primary LWCO and Gauge Glass Set</td>
</tr>
<tr>
<td>C</td>
<td>¾&quot;</td>
<td>Drain, Left End</td>
</tr>
<tr>
<td>C</td>
<td>¾&quot;</td>
<td>Drain, Right End</td>
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<tr>
<td>D</td>
<td>½&quot;</td>
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<tr>
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<td>1&quot;</td>
<td>Accessories</td>
</tr>
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<td>F</td>
<td>1&quot;</td>
<td>Safety Valve</td>
</tr>
<tr>
<td>G</td>
<td>¾&quot;</td>
<td>Plugged or Electronic (Probe Type) LWCO</td>
</tr>
</tbody>
</table>

*If using opening F for other than Safety Valve or Safety Relief Valve, or Safety/Relief valve is larger than 1". Install Safety/Relief Valve in Header Piping as near boiler as possible.

**BOILER TRIM**
Following controls are supplied as standard equipment. Details of their function and operation will be found in section on Checking and Adjustments page 33.

**STEAM TRIM**
1. Low Water Cut-Off (mounted externally) with blow-off valve
2. High Pressure Limit Control
3. Pressure Gauge
4. Water Gauge Glass Set
5. Siphon Loop

**STEAM TRIM ASSEMBLY**
Field assemble Steam Trim, Low Water Cut-Off, High Pressure Limit Control, Pressure Gauge, Water Gauge Glass Set and Siphon Loop, as shown in Figure 32. See Figure 31 and Chart above for location of controls.

**NOTICE**
Do not place any shutoff between pressure relief valve and boiler, or on discharge pipes between such safety valves and atmosphere. Installation of pressure relief valve shall conform to requirements of ANSI/ASME Boiler and Pressure Vessel Code, Section IV.
STEAM BOILERS - SERIES S

BOILER TAPPINGS ARE AVAILABLE FOR ALL CONNECTIONS SHOWN

NOTE: Mount electrical supply on opposite side.

<table>
<thead>
<tr>
<th>BOILER SIZE</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 THRU 1500</td>
<td>No. 47-2* Control Mounts in Gauge Glass Tappings</td>
</tr>
</tbody>
</table>

NOTE: For multiple boiler installation with gravity return, use feeder Cutoff Combination or separate feeder and separate cutoff on each boiler.

FOR CLOSED HEATING SYSTEMS
DIMENSION A = 2 × 2 1/2

*These items available through your distributor.

FOR CLOSED HEATING SYSTEMS
DIMENSION A = 2 = 2 1/2 inches

FOR PROCESS OR PARTIAL PROCESS SYSTEMS
DIMENSION A = 1 = 1 1/2 inches
Install Safety Valve As Close To Boiler As Possible

STEAM BOILER PIPING  See Figure 34

- Full size steam header is recommended by manufacture on all steam systems as shown above.
- Risers should be full 4” and at least 20” in height. Use skimmer tee as shown.
- Area of Main Steam Cross Header Pipe should be equal to or larger than total area of Steam Supply Mains leading from Header and should never be smaller than Supply tappings on Boiler. Return Header should be piped to both ends of Boiler. Area of Return Header should be equal to total area of Return Mains or larger.
- Pipe steam cross headers with swing joints, or equipped with slip joint connector, to prevent expansion and contraction of steam header from damaging boiler.
- Each installation has preferred piping arrangement according to system requirements. Installer’s heating engineer or using standard engineering practice choice of arrangements and sizes of headers should be decided.

Steam Piping Size

<table>
<thead>
<tr>
<th>Model</th>
<th>Header</th>
<th>Riser</th>
<th>Equalizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 to 900</td>
<td>4”</td>
<td>4”</td>
<td>2”</td>
</tr>
<tr>
<td>1000 to 1200</td>
<td>4”</td>
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<td>2 ½”</td>
</tr>
<tr>
<td>1300 to 1500</td>
<td>4”</td>
<td>4”</td>
<td>3”</td>
</tr>
</tbody>
</table>

Excessive Make-Up Water

A leaky system will increase the volume of make-up water supplied to the boiler, which can significantly shorten the life of the boiler.

Make-up water contains dissolved minerals, salts, and oxygen. When fresh, cool make-up water is heated in the boiler, minerals fall out as sediment. Salts coat the inside of the boiler, and oxygen escapes as a gas.

The accumulation of sediment eventually isolates 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 salts in the boiler corrodes the cast iron from the inside. More make-up water and higher concentrations of contaminants damage the boiler and shorten the boiler’s service life.

WATER QUALITY

- Do not use softened water in steam boilers. Accelerated boiler corrosion will result.
- Consult local water treatment companies for unusually hard water area (above 7 grains hardness) or low pH water conditions. Boiler water pH of 7 to 8.5 is manufacturer recommended.

WARNING

Do not install shut-off or steam valve between safety valve and boiler.
MULTIPLE STEAM BOILER PIPING - GRAVITY RETURN

STEAM MAIN

WATER LINE

OPTIONAL STOP VALVE

TO SYSTEM

F+T TRAP

TO RETURN SYSTEM

RETURN

OPTIONAL BLOW DOWN VALVE
**CAUTION**

**WHAT TO DO IF YOU SMELL GAS**

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

**DANGER**

Fire Hazard. Do not use matches, candles, open flames, or other methods providing ignition source. Failure to comply will result in death or serious injury.

---

**Gas Supply Connection, Natural Gas Only**

1. Use piping materials and joining methods acceptable to authority having jurisdiction. In absence of such requirements USA - National Fuel Gas Code, ANSI Z223.1/NFPA 54
2. On multiple base boilers, connect gas service with branch lines from common main.
3. Install ground joint union in each branch line for easy servicing of gas controls.
4. Provide sediment trap up stream of gas valve. **Figure 36.**
5. Size and install gas piping system to provide sufficient gas supply to meet maximum input at not less than minimum supply pressure. See **Chart 6** for pipe sizes for gas mains.
6. Pressure test boiler and gas connection before placing boiler in operation.
   - Pressure test over 1/2 psig (3.5 kPa). Disconnect boiler and its individual gas shutoff valve from gas supply system.
   - Pressure test at 1/2 psig (3.5 kPa) or less. Isolate boiler from gas supply system by closing manual gas shutoff valve.
   - Locate leakage using gas detector, noncorrosive detection fluid, or other leak detection method acceptable to authority having jurisdiction. Do not use matches, candles, open flames, or other methods that can provide ignition source.
   - Correct leaks immediately and retest.

---

**Chart 5**

<table>
<thead>
<tr>
<th>Models</th>
<th>Minimum Operating Gas Supply Pressure</th>
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<tbody>
<tr>
<td></td>
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**Chart 6**

**TABLE OF PIPE SIZES IN INCHES FOR GAS MAINS (NATURAL GAS)**

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<thead>
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<th>20'</th>
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<td>1 1/4</td>
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**Figure 36**

INSTALL MANUAL VALVE WITHIN 6 ft. (183cm) OF THE BOILER AND 5 ft (152cm) ABOVE THE FLOOR WHERE REQUIRED BY LOCAL CODES

3" (8 cm) Minimum DRIP LEG

TO GAS CONTROL INLET
### ELECTRICAL WIRING

**WARNING**

Electrical shock hazard. Turn OFF electrical power supply at service panel before making any line voltage connections. Failure to do so could result in death or serious injury.

**CAUTION**

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

#### Electrical Wiring

1. Electrically bond boiler to ground in accordance with requirements of authority having jurisdiction. Refer to National Electrical Code, ANSI/NFPA 70.
2. Install fused disconnect switch between boiler and electrical panel in convenient location.
3. Secure wiring from high temperature limit control to boiler jacket or gas piping to prevent accidental disconnect from controls.
4. Tape all wiring to gas valves securely to gas supply lines or run in appropriate conduit.

#### Thermostat Installation

1. Follow instructions included with your thermostat.
2. Locate thermostat about 5 feet above floor on inside wall.
3. Keep thermostat(s) at desired room temperature. If windows are opened or heat is not needed, set thermostat(s) to lower setting.

#### Adjust Thermostat Heat Anticipator

1. Set heat anticipator setting per thermostat manufacture instructions.
2. Follow thermostat manufacture instructions for final adjustment.
3. When set above temperature indicated on thermometer, boiler burners should ignite. Verify thermostat(s) turns boiler off when room temperature reaches selected setting and starts boiler when room temperature falls few degrees.
4. Set thermostat for desired temperature.

#### PLACES TO AVOID LOCATING THERMOSTAT

<table>
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<tr>
<th>Dead Spots</th>
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<td>Unheated Rooms on other side of Wall</td>
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</table>
WIRING DIAGRAMS

Commercial Boiler, 1, 2 & 3 Base

COMMERCIAL BOILER, 1, 2 & 3 BASE

WIRING SCHEMATIC

HIGH VOLT POWER SUPPLY

FIELD INSTALLER

RELAY

IGNITER/SENSOR

LOW VOLTAGE WIRING

TO ADDITIONAL BASES

LEGEND

LWCD = LOW WATER CUT OFF
FL = FIELD SUPPLIES
HL = HIGH LIMIT
MV = MAIN VALVE
PV = PILOT VALVE
PSS = PILOT SAFETY SHUTOFF
WTS = WATER TEMPERATURE SENSOR
EWF = ELECTRIC WATER FEEDER
P/P = PLUG/PLN
C/S = CAP/ SOCKET

------- HIGH VOLT FIELD INSTALLER
------- LOW VOLT FIELD INSTALLER
System Troubleshooting
1. Set thermostat or controller above room temperature and observe system response.
2. Establish of system malfunction or deviation from normal operation by using Pilot System Troubleshooting Table, in following section.
3. After any maintenance or repair, troubleshooting sequence should be repeated until procedure ends with normal system operation.

Component Verification

Verify Spark Ignition Circuit
Control electronic module and step-up transformer provides spark ignition at 15,000 V (open circuit). Check circuit at control module as follows:
1. Turn off manual gas valve to prevent flow of gas.

WARNING
Electrical shock hazard. Do not touch either end of jumper or stud terminal, high voltage circuit. Failure to follow these instructions could result in death or serious injury.
2. Disconnect ignition cable at control stud terminal to isolate circuit from pilot burner/igniter-sensor.
3. Prepare short jumper lead using heavily insulated wire, such as ignition wire.
4. Energize control.
5. Touch one end of jumper firmly to control ground terminal (GND).
6. Do not disconnect existing ground lead.
7. Move free end slowly toward stud terminal to establish spark.
8. Pull lead wire slowly away from stud. Note length of gap at which arcing discontinues.
9. Arc length of 1/8 inch (3.2 mm) or more indicates satisfactory voltage output.
10. If no arc can be established or maximum gap is less than 1/8 inch (3.2 mm), replace control.

Trial For Pilot Ignition
1. On every call for heat (system start), control performs internal safe-start check. If flame simulating condition is present, system will not start.
2. During normal start, control opens first (pilot) valve operator of gas control, which allows gas to flow to pilot burner. At same time, electronic spark generator in control produces 15,000 Volt spark pulse output (open circuit). Voltage produces spark at igniter sensor rod which ignites pilot burner.
3. If pilot flame does not light or presence of pilot flame is not detected back through flame-rod, control will not open second (Main) valve operator of gas control.
4. Control will continue to try to ignite pilot burner until either flame is detected or thermostat (controller) is set below call for heat.

Main Burner Operation
1. When pilot flame is established, flame rectification circuit is completed to burner ground.
2. Control flame sensing circuit detects flame current, shuts off spark generator and opens second (Main) valve operator to allow gas to flow to main burners.
3. Pilot flame ignites main burner conventionally.

Electronic control module cannot be repaired. If troubleshooting procedure indicates malfunction in control, control must be replaced. Intermittent Pilot systems must be serviced by trained service technicians.

Preliminary Check
Make following visual checks before troubleshooting and after maintenance.
1. Check power switch.
2. Open manual shutoff valves in gas line to boiler.
3. Verify all wiring connections are clean and tight.
4. Review control’s normal sequence of operation.
\textbf{Ignition Cable Verification}  
1. Cable must not run in continuous contact with a metal surface or spark voltage will be greatly reduced.  
2. Connections to stud terminal on control and on igniter-sensor must be clean and tight.  
3. Loose connections may not conduct flame current even though ignition spark is satisfactory.  
4. Check the cable electrical continuity.

\textbf{Grounding Verification}  
Ground is required for pilot burner/igniter-sensor mounting bracket, and control GND terminal. If ground is poor or erratic, safety shutdown may occur even though operation is normal at checkout. If nuisance shutdowns occur, check grounding.

\textbf{Startup And Checkout}  
If any failure of system component system will not operate. If system does not perform as outlined in Start System, below, refer to Pilot System Troubleshooting Table.

\textbf{Start System}  
1. Turn power to control(s) on. Turn off gas supply.  
2. Check control(s) operation as follows:  
   A. Set Thermostat or controller above room temperature to call for heat.  
   B. Watch for spark at pilot burner(s).  
   C. Turn on gas supply.  
   D. Appliance is equipped with automatic ignition device which automatically lights the pilot. Do not try to light appliance by hand.  
   E. Before operating, smell all around appliance area for gas. Be sure to smell next to floor because some gas is heavier than air and will settle on floor. Read "What To Do If You Smell Gas" on front page of this manual above.  
   F. Use only your hand to push in or turn gas control knob. Never use tools. If knob will not push in or turn by hand, don’t try to repair it, call qualified service technician. Force or attempted repair may result in a fire or explosion.
   G. 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 control system and any gas control which has been under water.

3. System start:  
   A. Spark will turn on and pilot gas valve will open at once. Pilot burner(s) should ignite after gas reaches pilot burner(s).  
   B. Spark ignition should cut off when pilot flame is established.  
   C. Main gas valve should open and main burners should ignite after gas reaches burner ports.

Light-off may not be satisfactory until gas input and combustion air have been adjusted.

\textbf{DANGER}  
Fire Hazard. Do not use matches, candles, open flames, or other methods providing ignition source. Failure to comply will result in death or serious injury.

\textbf{Pilot Flame Adjustment}  
1. Pilot flame should envelop 3/8 to 1/2 inch of tip of insulated rod on igniter-sensor. See Figure 38.  
2. If adjustment is required, remove pilot adjustment cover screw and turn inner adjustment screw clockwise to decrease or counterclockwise to increase pilot flame.  
3. Replace cover screw after adjustment to prevent possible gas leakage.

Test Ignition system safety shutoff device after placing boiler in operation. Disconnect sensor wire from ignition module. Burner operation should stop.

\textbf{Figure 38 - Proper Flame Adjustment}
Verify Burner Input
Check boiler for proper Btu input rate. Do not exceed Input rate stamped on nameplate of boiler located on end jacket panel. Verify primary air supply to main burners is properly adjusted for complete combustion.
If boiler is shut down for service, gas and electric must be off for 5 minutes before relighting.

Verify boiler for proper Btu Input proceed as follows:
1. With main burners operating, measure gas Input to boiler by reading the gas meter.
2. Verify all other appliances connected to same meter are shut off.
3. Rate of gas flow (cu. ft. per hour) multiplied by Btu value of gas should match Btu input shown on boiler nameplate.
4. If it is not within +/- 2%, adjust Pressure Regulator to obtain desired flow. Adjustment stem can be found cap regulator top. Adjustment screw is plastic and may require slightly greater turning force than metal threads.
5. Turn clockwise to increase input and counterclockwise to decrease input rate.
6. Replace Regulator Cap.

High Limit Control
While boiler is operating, set high limit control below boiler water temperature and main burners should shut off. Return control to normal setting. Main burners should restart.

WARNING
Burn and scald hazard. Discharge of water, vapor and steam may scald. Failure to follow these instructions could result in death or serious injury.

Pressure Relief Valve
1. Pressure relief valve on boiler is required.
2. Run a pipe from pressure relief valve outlet to appropriate open drain.
3. Pipe must be of same size as outlet on valve and open end must not be threaded.
4. Run drain in area not subject to freezing. Failure to do so may cause water damage or injury should valve release.
5. If valve discharge occurs, or valve fails to open as described above, contact service technician to replace relief valve and inspect heating system to determine cause, as this may indicate equipment malfunction.
6. Follow valve manufacture instructions for testing and maintenance.

Burner And Pilot Flame
1. Manufacture recommends visual check of burners and pilot flame monthly during heating season by owner and once year by service technician. See Figure 39.
2. Look for deterioration from corrosion of burners, pilot burners and boiler base frame.
3. Clean boiler base interior and exterior.

Burner And Pilot Flame
Manufacture recommends flue passages, burner adjustments and operation of boiler controls be checked once a year by a service technician.

To clean flue passages:
A. Remove burners and pilot(s) from boiler.
B. Remove clean-cut cover panel on draft hood to expose flue passages. See Figure 13 page 16.
C. Clean flue passageways between sections with flexible handle wire brush. Remove all dirt from bottom of boiler and reassemble all parts.
D. Verify pilot connection(s), adjustment of pilot(s) and burner flames after reassembly.

Venting System
1. Check chimney for correct size, proper construction, clean and in good condition to ensure proper combustion.
2. You must provide enough fresh air for combustion.
3. If your building is of tight construction, it may be necessary to add fresh air duct to provide oxygen. See Chart 3, page 8.
4. Monthly during heating season check that sections of vent pipe are secure at all joints and fittings. There should be at least two (2) sheet metal screws per joint.
5. Check that vent pipe slopes at least 1/4” per foot up from boiler to chimney.
6. Vent pipe should be securely fastened to prevent sagging.
7. Check vent Pipe for any deterioration from corrosion or any other sources.
8. Refer to Venting and Combustion Air instructions in this manual.

WARNING
Asphyxiation hazard. Improper installation could result in death or serious injury. Failure to follow these instructions could result in death or serious injury.
Cleaning The Steam Boiler
Steam boilers must be cleaned prior to use in order to ensure efficient operation.

Grease, oil, sand and dirt cause scum to form on the surface of water in new boilers. Heavier particles carried in grease may settle to bottom of boiler and form sludge. If permitted to remain in boiler it will prevent generation of steam, produces foaming and causes an unsteady water line. Remove accumulation of oil and grease by blowing off boiler as follows:

1. Install surface skim connection of at least 1 1/4” nominal pipe size in boiler using skim tee. See Figure 35 page 27. Skim line should extend to within 18” of floor or appropriate drain.
   A. Insert valve in line close to boiler.

2. Bring water line to center of outlet.
   A. Raise temperature to just below steaming.
   B. While burners are on, open the valve in skim line and slowly feed clean water into boiler adjusting inlet water so boiler water remains hot.
   C. Continue skimming until water is clean.

3. Close valves in boiler feed line and skim line.

4. Bring boiler pressure to about 10 lbs.
   A. Turn burners off.
   B. Open bottom drain valve permitting all water to drain from boiler.

5. After boiler has cooled, fill and flush out several times.

6. Fill to proper water level and ready for normal service.

Do not use soda or any alkali, vinegar or acid for cleaning heating boilers, it is difficult to completely remove them. Injury may occur after cleaning process if these agents are used.

Boiler Water Treatment
In steam systems where system is tight, free from leaks, and all steam is returned to boiler as condensate, amount of make up water is small. Water treatment is not required. On steam systems with less than 90% of steam being returned as condensate, or with very hard or corrosive make up water, treatment may be desirable. Follow recommendations of ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VI, latest version.

Between Heating Seasons
Boilers should not be drained between heating seasons. Steam boilers should be entirely filled with water during the summer months to exclude air.

Low Water Cutoff(s)
Inspect low water cutoff(s) annually or as recommended by low water cutoff manufacture. Flush float types per manufacturer’s instructions.

General Housekeeping
- Keep boiler area clear and free from combustible materials, gasoline and other flammable vapors and liquids.
- Keep boiler area clear of obstructions to flow of combustion and ventilation air.
### PILOT SYSTEM TROUBLESHOOTING TABLE

**NOTE:** Before troubleshooting, familiarize yourself with startup and check procedure.

- Check line voltage power, low voltage transformer, limit controller, thermostat (controller) and wiring. Also, check air proving switch on combustion air blower system (if used) and that vent damper (if used) is open and end switch is made.

- Pull ignition lead and check spark at module.
  - Spark okay?
    - On models with vent damper plug, make sure vent damper has not been installed, then removed. Replace vent damper if necessary.
    - On other models, replace module.

- **Turn gas supply OFF. Turn thermostat (controller) to call for heat.**
  - Power to module (24V module)
    - **NO**
  - Spark Across Igniter/Sensor Gap.
    - **NO**
    - **YES**

- **Turn gas supply ON.**
  - Pilot Burner Lights?
    - **NO**
    - **YES**

- Spark Stops When Pilot Lit?
  - **NO**
  - **YES**

- **Main Burner Lights?**
  - **NO**
  - **YES**

- System Runs Until Call For Heat Ends.
  - **NO**
  - **YES**

- Call For Heat Ends
  - System Shuts OFF?
    - **NO**
    - **YES**

- Troubleshooting Ends.
  - **NO**

**NOTE:** If the control, goes into lockout, reset system.

- Check continuity of ignition cable and ground wire.
- Clean flame rod.
- Check electrical connections between flame rod and module.
- Check for cracked ceramic flame rod insulator.
- Check that pilot flame covers flame rod and is steady and blue.
- Adjust pilot flame.
- If problem persists, replace module.

- Check for 24 Vac across PV-MV/PV terminals on module. If voltage is okay, replace gas control: if not, replace module.

**NOTE:** If ground is poor or erratic, shutdowns may occur occasionally even though operation is normal at the time of checkout.

- Check that all manual gas valves are open, supply tubing and pressures are good, and pilot burner orifice is not blocked.
- Check electrical connection between module and pilot operator on gas control.
- Check for 24 Vac across PV-MV/PV terminals on module. If no voltage, replace module.
- Check electrical connections between module and gas control. If okay, replace gas control or gas control operator.

- Check for proper thermostat (controller) operation.
- Remove MV lead at module: if valve closes, recheck temperature controller and wiring: if not, replace gas control.

Repeat procedure until trouble free operation is obtained.
IMPORTANT

In accordance with Section 325 (f) (3) of the Energy Policy and Conservation Act, this boiler is equipped with a feature that saves energy by reducing the boiler water temperature as the heating load decreases. This feature is equipped with an override which is provided primarily to permit the use of an external energy management system that serves the same function.

THIS OVERRIDE MUST NOT BE USED UNLESS AT LEAST ONE OF THE FOLLOWING CONDITIONS IS TRUE:

• An external energy management system is installed that reduces the boiler water temperature as the heating load decreases.
• This boiler is not used for any space heating
• This boiler is part of a modular or multiple boiler system having a total input of 300,000 BTU/hr or greater.
• This boiler is equipped with a tankless coil.