Instruction Manual for Lattner Scotch Marine Boilers

2006 to 2007

Lattner Boiler Company
1411 9th St. SW
Cedar Rapids, IA 52404
T: (800) 345-1527
F: (319) 366-0770
E: info@lattnerboiler.com
W: www.lattnerboiler.com
# Index

## Section I: General Description

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Boiler Design</td>
<td>3</td>
</tr>
<tr>
<td>2. Boiler Connections</td>
<td>4</td>
</tr>
<tr>
<td>3. Boiler Trim</td>
<td>4</td>
</tr>
<tr>
<td>4. Fuel Burning System</td>
<td>5</td>
</tr>
<tr>
<td>5. Fuel/Air Control</td>
<td>5</td>
</tr>
<tr>
<td>6. Gas/Fuel Train</td>
<td>6</td>
</tr>
<tr>
<td>7. Control Panel</td>
<td>6</td>
</tr>
<tr>
<td>8. Factory Tests</td>
<td>7</td>
</tr>
<tr>
<td>9. Nameplates &amp; Stamping</td>
<td>7</td>
</tr>
<tr>
<td>10. Guarantees</td>
<td>7</td>
</tr>
</tbody>
</table>

## Section II: Installation

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unloading</td>
<td>8</td>
</tr>
<tr>
<td>2. Rigging</td>
<td>8</td>
</tr>
<tr>
<td>3. Placement of Boiler</td>
<td>8</td>
</tr>
<tr>
<td>4. Combustion Air</td>
<td>8</td>
</tr>
<tr>
<td>5. Stack</td>
<td>9</td>
</tr>
<tr>
<td>6. Steam Outlet</td>
<td>9</td>
</tr>
<tr>
<td>7. Blowdown Piping</td>
<td>10</td>
</tr>
<tr>
<td>8. Safety Valve</td>
<td>11</td>
</tr>
<tr>
<td>9. Gas/Fuel Train Piping</td>
<td>11</td>
</tr>
<tr>
<td>10. Boiler Feed Systems</td>
<td>12</td>
</tr>
<tr>
<td>11. Electrical Connections</td>
<td>13</td>
</tr>
<tr>
<td>12. Before Firing the Boiler</td>
<td>13</td>
</tr>
<tr>
<td>13. Pressuretrols: Controller &amp; Limit</td>
<td>14</td>
</tr>
<tr>
<td>14. Firing the Boiler</td>
<td>15</td>
</tr>
<tr>
<td>15. Boil Out Recommendations for New Boilers</td>
<td>16</td>
</tr>
<tr>
<td>16. Standard Maintenance Items</td>
<td>16</td>
</tr>
<tr>
<td>17. Water Quality Limits for Lattner Boilers</td>
<td>17</td>
</tr>
</tbody>
</table>

## Section III: Boiler Care & Maintenance

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Daily Procedures</td>
<td>18</td>
</tr>
<tr>
<td>2. Weekly Procedures</td>
<td>18</td>
</tr>
<tr>
<td>3. Monthly Procedures</td>
<td>18</td>
</tr>
<tr>
<td>4. Annual Procedures</td>
<td>19</td>
</tr>
<tr>
<td>5. Care of Idle Boilers</td>
<td>19</td>
</tr>
<tr>
<td>6. Care &amp; Service of Boiler Tubes</td>
<td>19</td>
</tr>
<tr>
<td>7. Boiler Tube Replacement</td>
<td>20</td>
</tr>
<tr>
<td>8. Handhole Plate Removal &amp; Replacement</td>
<td>21</td>
</tr>
<tr>
<td>9. Sight Glass Removal &amp; Installation</td>
<td>22</td>
</tr>
<tr>
<td>10. McDonnell Miller Servicing</td>
<td>23</td>
</tr>
<tr>
<td>11. Warrick Relay Replacement</td>
<td>24</td>
</tr>
<tr>
<td>12. Auxiliary Low Water Cut-Off Probe Cleaning</td>
<td>24</td>
</tr>
</tbody>
</table>

## Section IV: Troubleshooting

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal Operation</td>
<td>25</td>
</tr>
<tr>
<td>2. Basic Service Tools</td>
<td>25</td>
</tr>
<tr>
<td>3. Before You Begin</td>
<td>25</td>
</tr>
<tr>
<td>4. Troubleshooting</td>
<td>26</td>
</tr>
</tbody>
</table>
Section I: General Description

WARNING: All installation procedures must be followed completely by a competent installer familiar with boilers and boiler accessories.

CAUTION: Read and follow all instructions before installing any boiler equipment. All cover plates, enclosures and guards must be maintained and in place at all times, except during maintenance and servicing.

1. Boiler Design

   Lattner horizontal firetube boilers are designed as three pass scotch marine dry back boilers with integral furnaces and convective heat transfer firetubes. The furnace and heat transfer tubes are completely submerged beneath the normal operating water level. The total heating surface is based on 5 square feet per boiler horsepower (output). All Lattner firetube boilers are built in accordance to the appropriate ASME Code for low pressure steam, high pressure steam, low pressure hot water, or high pressure hot water.

   1.1. Gas Flow
   The tube design of Lattner firetube boilers provides three pass longitudinal heated gas flow direction, ensuring maximum linear heated gas travel and heat transfer. Low maintenance, durable refractory lined steel baffles are incorporated for heated gas flow direction between the second and third passes. Symmetrical tube design and layout provides equalized flow of heat into each tube from the furnace and successive gas passes, ensuring high efficiency.

   1.2. Water Circulation
   All feedwater and water return connections enter the side of the vessel below the water line. By directing the make-up water below the water line of the boiler, the possibility of collapsing steam bubbles is eliminated allowing the boiler water to circulate naturally.

   1.3. Tubes
   Boiler tubes are a minimum of 2-1/2" OD, with a wall thickness of 0.105". Each tube is attached to the front and rear tube sheets through a rolling and beading process. High pressure boiler tubes are additionally seal welded at the entrance to the second pass.

   1.4. Furnace
   The furnace or combustion chamber is centrally located within the pressure vessel. It consists of a single cylindrical tube strength welded to the front and rear tube sheets. It is symmetrical in layout, assuring a balance flow-circulating pattern under all load conditions.

   1.5. Outer Casing (Jacket)
   The removable outer casing or jacket is fabricated of 22 gauge galvanealed steel panels supported by 2" thick fiberglass blanket insulation. This arrangement provides a skin temperature near ambient conditions.

   1.6. Fireside Inspection
   Front and read doors (davited or hinged on 60 horsepower and larger) are furnished for tube inspection and cleaning of the second and third passes. An inner rear furnace access door is available for furnace inspection, eliminating the need to remove the burner.

   1.7. Water Side Inspection
   For visual inspection of the water side internals and tube surfaces six 3" x 4" handhole inspection plates are provided. A 12" x 16" man hole is furnished for upper vessel inspection on boilers 80 horsepower and larger.

   1.8. Flame Observation Port
   For visual inspection of the pilot and main flame ignition, there are two flame observation ports. One flame observation port is provided integral to the burner and one is located in the rear furnace access door.

   1.9. Boiler Lifting Lugs
   Two lugs are provided to facilitate lifting and rigging the boiler into place. These lugs are located on the top centerline of the pressure vessel.

   1.10. Boiler Base
   A structural steel welded base is provided upon which the pressure vessel is placed. The minimum height of the structural base is 4" and the boiler is attached to the base at four points (legs). A short base extension may be incorporated to provide mounting for a separate oil pump or oversize control panel.
2. **Boiler Connections**

2.1. The following items are factory installed in accordance with the ASME Code:

2.1.1. **Steam Connection**

   The supply connection is located on the top centerline of the boiler and is either threaded or an ANSI flange design. The operating and design pressure of the boiler, in accordance with the ASME Code, determines the pressure rating of the flange.

2.1.2. **Boiler Blowdown or Connection Drain**

   Boilers under 80 horsepower have one threaded fitting on the bottom centerline at the rear of the pressure vessel. Boilers 80 horsepower and larger have two threaded fittings on the bottom centerline at the rear of the pressure vessel.

2.1.3. **Surface Blow-Off**

   A tapping is provided in the vessel near the normal water level line for connection to a manual or automatic surface contaminant removal system or metering valve.

2.1.4. **Feedwater Make-Up**

   A tapping is provided on each side of the pressure vessel for connection to the make-up and/or condensate return.

2.1.5. **Exhaust Gas Vent (Stack)**

   The connection for the stack or breaching is located at the rear on the top centerline of the boiler. This is a flanged connection, with the opening in accordance with the nominal dimension and rating sheets. A tapping is provided for a stack temperature probe or thermometer.

3. **Boiler Trim**

   The following are factory installed standard trim and control items. Trim items are supplied in accordance with the ASME Code. Controls are UL listed and comply with ASME CSD-1 requirements.

3.1. **Safety Relief Valve(s)**

   In compliance with the ASME Code, steam boiler pressure relief valves are provided. Size and quantity determined by the valve setting, valve capacity, and the ASME Code. These are shipped loose to prevent possible damage during shipment.

3.2. **Water Column**

   Furnished complete with gauge glass, gauge glass drain valve, gauge glass isolation valves, column try-cock tappings, column drain valve, minimum of 1” equalized piping and crosses for inspection and clean-out.

3.3. **Low Water Cut-Off**

   To prevent burner operation whenever a low water condition occurs, a single pole double throw float operated level switch is furnished in the water column. Cut-off is wired in series to the burner combustion safeguard control.

3.4. **Pump Control**

   A single pole single throw float level switch is provided in the water column for ON/OFF operation of a feedwater make-up pump, starter, or valve.

3.5. **Auxiliary Low Water Cut-Off**

   An additional control, separate from the primary low water cut-off control is provided to prevent burner operation if a low-low water condition exists. This device is an internal probe control located on the top centerline of the pressure vessel.

3.6. **Steam Pressure Gauge or Temperature/Pressure Gauge**

   3-1/2” dial pressure gauge is furnished as standard. The range of the gauge will be in accordance with the safety valve setting, based on 1.5 times the valve setting for high-pressure units, and 2 times the design pressure of low-pressure units.

3.7. **Pressure or Temperature Controls**

   3.7.1. **On/Off Operation**

      On/Off operation is available on boilers 10 through 20 horsepower. On/Off operation requires two pressure or temperature controls, a “Limit” and a “Controller”. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON. See Section II for control setting directions.

   3.7.2. **Low/High/Off Operation**

      Low/High/Off operation is available on boilers 10 through 100 horsepower. Low/High/Off operation requires two pressure or temperature controls, a “Limit” and a “Controller”. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON. See Section II for control setting directions.
3.7.3. Low/High/Low Operation
Low/High/Low operation is available on boilers 10 through 100 horsepower. Low/High/Low operation requires three pressure or temperature controls, a “Limit”, a “Controller”, and a “High Fire” device. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON at low fire. The “High Fire” device determines the pressure at which the burner cycles ON at high fire. See Section II for control setting directions.

3.7.4. Modulating Operation
Modulating operation is available on boilers 10 through 200 horsepower. Modulating operation requires three pressure or temperature controls, “Limit”, “Controller”, and “Modulating” devices. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON. The “Modulating” device regulates the rate at which the burner will fire (any rate between low and high fire). See Section II: Installation for control setting directions.

4. Fuel Burning System
The factory-assembled boiler is furnished with an UL approved and labeled fuel burning forced draft system. The system is mounted and wired integral with the front head of the boiler.

4.1. Burner Type
The burner is a forced draft (power burner) design, high radiant multi-port type for LP or Natural gas and mechanical pressure atomizing type for No. 2 fuel oil. The burner can be equipped to burn natural gas, oil, or a combination can be provided to manually switch between gas and oil fuels. The burner is not designed to burn both fuels simultaneously.

4.2. Burner Operation
The burner is designed to operate one of four modes:

4.2.1. On/Off
With the On/Off method of operation, the burner shuts off when the pressure reaches the set point of the “Controller” device. The burner turns on again when the differential set point on the “Controller” is exceeded.

4.2.2. Low/High/Off
With the Low/High/Off method of operation, the burner turns ON at low fire and shuts off when the pressure reaches the set point of the “Controller” device. The burner turns on again when the differential set point on the “Controller” is exceeded.

4.2.3. Low/High/Low
With the Low/High/Low method of operation, the burner fires on high fire until it reaches a predetermined pressure range. Once it reaches this range, the burner continues to fire on low fire as necessary until the boiler’s pressure drops below this range (in the case of a large steam demand) when the burner fires again at high fire.

4.2.4. Modulating
With the modulating method of operation, the burner fire rate is determined by the current demand. The burner modulates or throttles the input gas relative to constantly changing pressure requirements as determined by the “Modulate” pressure control.

4.3. Ignition and/or Pilot
For oil-fired units, a 10,000 volt ignition transformer is furnished for direct spark ignition. Gas-fired units are equipped with a spark-ignited gas pilot assembly. The gas pilot assembly includes a gas cock, gas pressure regulator, ignition transformer, pilot safety shutoff valve, and gas pilot pressure gauge.

4.4. Forced Draft Fan
An integral fan assembly directly connected to a NEMA-1 foot mounted fan motor supplies the required combustion air. As standard, the fan motor is an open drip-proof (ODP) high efficiency type operating at 3600 RPM.

4.5. Air Proving Switch
An air pressure-sensing switch is mounted on the burner to prevent burner operation if sufficient air is not available for proper combustion or pilot ignition.

5. Fuel/Air Control
The control of combustion air is managed with an integral inlet air damper operating as follows:

5.1. On/Off
With the On/Off method of operation, the burner air damper is mechanically fixed for the correct combustion air to fuel ratio for on/off firing.
5.2. Low/High/Off
With the Low/High/Off method of operation, the burner air damper is mechanically coupled to the damper motor and fuel input control valve(s). A Low/High/Off position control regulates the position of the damper and fuel input control valve(s) for either low fire input or high fire input.

5.3. Low/High/Low
With the Low/High/Off method of operation, the burner air damper is mechanically coupled to the damper motor and fuel input control valve(s). A Low/High/Low position control regulates the position of the damper and fuel input control valve(s) for either low fire input or high fire input.

5.4. Modulating
With the modulating method of operation, the burner air damper is controlled with potentiometer type positioning controls regulate the position of the damper and fuel input control valve(s) which are mechanically linked together. Integral switches of the damper motor provide proof of maximum airflow purge prior to ignition, and the safe start position at low fire, for pilot ignition.

6. Gas/Fuel Train
The burner is equipped with factory mounted fuel safety control and safety shut-off valves for either gas fuel or oil fuel. Each fuel piping assembly is equipped with the following:

6.1. Gas Assembly
Boiler base rail mounted, piped and wired gas piping assembly, consisting of main gas pressure regulator, safety shutoff valves, manual shutoff cocks, fuel input control valve, and gas pressure interlocks in accordance with the latest UL and CSD-1 requirements.

6.2. No. 2 Fuel Oil Assembly
For burners equipped to burn fuel oil, the boiler is equipped with dual safety shutoff valves, manual shutoff valve, oil discharge filter, and an oil pump. The oil pump is direct driven from the fan motor assembly and is used for mechanical pressure atomization of the fuel oil for proper combustion. This pump requires twice the burner firing delivery for suction line sizing.

A separate oil pump assembly with an integral oil pump motor can be furnished as an option and will be mounted on the boiler base extension or shipped loose for field installation by others. For units with this option, a Low Oil Pressure Safety Switch is provided.

7. Control Panel
A NEMA enclosed control panel is mounted integral to the burner or as an independent bracket mounted unit on the boiler base rail. This panel contains as a minimum the following components:

7.1. Combustion Flame Safeguard Control
This solid-state control provides for safe start sequencing of the burner from start-up, run, to safety shutdown. A flame-sensing device of the lead-sulphide scanning principle is furnished.

7.2. Burner On/Off Switch
A burner On/Off switch is provided to interrupt control power to the 120 volt control circuit. This switch does not disconnect the main power source.

7.3. Control Circuit Transformer
For burners above 2.5 million BTUs/Hr input (60 horsepower), a step-down transformer from the 3-phase power supply is furnished to provide the 120 volt single phase supply to the control circuit.

7.4. Indicating Lights
Indicating lights are mounted in the control panel door or switch ledge for “Load Demand”, “Power On”, “Fuel Valve On”, “Low Water”, and “Flame Failure”.

7.5. Manual/Auto Switch
For service checking and start up, a damper positioning switch is provided to allow the burner to be controlled via a manual positioning control in lieu of the automatic positioning device. This switch is furnished on Low/High/Off, Low/High/Low, and Modulating boiler/burner packages.

7.6. Main Flame Potentiometer
The main flame potentiometer is provided as a means to check the burner combustion process or base load the burner in multiple boiler installation. This control is furnished on units with modulating burners only.

7.7. Wiring & Controls
All devices and wiring are provided in accordance with the latest UL/NFPA 70 requirements. Each device is UL listed or recognized and bears the UL label and/or stamp.
8. Factory Tests

8.1. Pressure Vessel
The boiler is subjected to an ASME certified hydrostatic pressure test. This test, in accordance with the requirements of the ASME Code for Section IV Heating Boilers or Section I Power Boilers, is supervised by an independent inspection agency, to ensure the pressure vessel meets the standards of the ASME. Upon acceptance of the test by the independent inspector, the unit is stamped with the “H” symbol for 15 psig design units and with the “S” symbol for 150 psig and greater designs. One copy of the ASME data sheets is provided to the purchaser.

8.2. Boiler Piping Hydro (Optional)
As an option, Section I high pressure boiler (“S” stamped), built in accordance with the ASME Code, can be subjected to an additional hydrostatic pressure test. This test includes the integral steam and water trim piping and when included, the trim valves.

8.3. Burner & Controls
To ensure proper operation of the combustion safeguard control, ignition, and main fuel light off the burner manufacturer subjects the packaged burner to a preliminary factory fire test. All burner and boiler controls are checked for circuit continuity after mounting and wiring the burner onto the boiler.

9. Nameplates & Stamping

9.1. The National Board of Pressure Vessel Inspectors registration number is stamped on the pressure vessel with the boiler serial number, year built, maximum boiler output, and minimum safety valve capacity. This information is located on the pressure vessel beneath an inspection plate, near the upper rear of the boiler. A facsimile nameplate of this data stamping is mounted near or on the front door of the boiler.

9.2. A “red-line” mark is located on each front door, indicative of the lowest permissible water level within the boiler.

9.3. Boiler Feedwater care and maintenance information is provided on a nameplate located on the boiler near the water column.

10. Guarantees

10.1. Efficiency
The boiler package is guaranteed to operate at a minimum of 80% or greater, fuel input to steam pounds per hour output efficiency.

10.2. Warranty
The complete package is warranted for a period of one (1) year from the date of initial start-up or 18 months from the date of shipment or notice to ship, whichever occurs first. This guarantee does not include items that are damaged due to circumstances beyond the control of Lattner Manufacturing Company Inc., carelessness, or neglect. Refer to the Lattner’s standard warranty and terms and conditions documents for more detailed information.
Section II: Installation

**WARNING:** All installation procedures must be followed completely by a competent installer familiar with boilers and boiler accessories.

**CAUTION:** Read and follow all instructions before installing any boiler equipment. All cover plates, enclosures and guards must be maintained and in place at all times, except during maintenance and servicing.

1. **Unloading**
   The boiler was loaded by Lattner (including any accessories) and accepted by the transport company as undamaged. Before unloading the equipment, determine whether any shipping damage is apparent. Once the equipment is lifted from the trailer, any damage sustained during transit and not filed with the transport company will be the responsibility of the rigger or purchaser.

1.1. **Lifting**
   The boiler will arrive secured to a wooden skid/pallet and will include a lifting lug(s). When moving or lifting the unit, **DO NOT** attach sling around the boiler or to the burner in an attempt to pull the boiler.

1.2. **Forklift**
   If lifting with a forklift, extended forks should be used beneath the skid. Care must be taken to ensure that the boiler sits correctly on the forks such that the unit does not topple. Always note the weight of the boiler relative to the lifting capacity of the forklift.

1.3. **Crane or Boom**
   When lifting with a crane or boom, attach the hook to the lifting lug on top of the boiler. **DO NOT** attach slings or chains to any part of the boiler, boiler piping, or burner.

2. **Rigging**
   Always use a competent rigger that has experience moving and setting boilers. If the unit will be moved into the permanent location with a forklift, crane, or boom, follow the directions in Section I. However, if moving the unit through a tight space or into an area that will not permit a forklift, place the boiler on rollers or on 2’ pipes and roll the boiler into place. If the unit is dragged, attach chains to the base frame only.

   If the entry way is too narrow for the boiler and controls to pass through, removal of the trim and controls can be executed. One should properly denote all wiring and piping connections and match mark accordingly for attachment after the boiler is placed. It may be helpful to use a digital camera to record the location of trim items for reference.

3. **Placement of Boiler**

3.1. **Floor**
   Boiler must be placed on a level, non-combustible surface. **NEVER** install boiler on a wood floor or any other combustible surface (i.e., carpet, linoleum).

3.2. **Combustible Surfaces**
   UL specifies the following minimum clearance to combustible surfaces:
   - Top 48 inches
   - Sides 36 inches
   - Flue pipe 36 inches

3.3. **Non-Combustible Surfaces**
   When placing boiler near non-combustible surfaces (i.e., cement or cinder block walls), maintain 18” around the boiler for servicing. **NOTE:** Any state or local fire and/or building codes requiring additional clearances take precedence over the above requirements.

4. **Combustion Air**

4.1. **Ventilation**
   The boiler room must be adequately ventilated to supply combustion air to the boiler. The vent must be opened to the outside to allow air to flow into the room. Proper sizing of the vent is important to ensure that sufficient free air is available for complete combustion and proper venting of the flue gases.
4.2. Vent Size

Use the following chart to determine vent size for Lattner boilers. Chart based on 1 square inch per 2,000 BTUs input.

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>Required Vent Size</th>
<th>Sq. In. Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>15” x 15”</td>
<td>209 in²</td>
</tr>
<tr>
<td>15</td>
<td>18” x 18”</td>
<td>313 in²</td>
</tr>
<tr>
<td>20</td>
<td>21” x 21”</td>
<td>418 in²</td>
</tr>
<tr>
<td>25</td>
<td>23” x 23”</td>
<td>523 in²</td>
</tr>
<tr>
<td>30</td>
<td>25” x 25”</td>
<td>627 in²</td>
</tr>
<tr>
<td>40</td>
<td>29” x 29”</td>
<td>837 in²</td>
</tr>
<tr>
<td>50</td>
<td>33” x 33”</td>
<td>1046 in²</td>
</tr>
<tr>
<td>60</td>
<td>36” x 36”</td>
<td>1260 in²</td>
</tr>
<tr>
<td>80</td>
<td>41” x 41”</td>
<td>1680 in²</td>
</tr>
<tr>
<td>100</td>
<td>46” x 46”</td>
<td>2100 in²</td>
</tr>
<tr>
<td>125</td>
<td>52” x 52”</td>
<td>2625 in²</td>
</tr>
<tr>
<td>150</td>
<td>56” x 56”</td>
<td>3150 in²</td>
</tr>
<tr>
<td>200</td>
<td>65” x 65”</td>
<td>4200 in²</td>
</tr>
</tbody>
</table>

4.3. Additional Ventilation

The chart above shows vent sizes for one gas fired boiler. If there is other equipment in the room that uses air (large water heaters, air compressors, other boilers, exhaust fans, etc.), additional venting capacity is required.

5. Stack

5.1. Specifications

Install all stacks in compliance with state and local codes. Lattner recommends double wall stack per ANSI Z2231.1, appliance category III for positive vent pressure systems for boilers operating with a maximum continuous temperature not exceeding 1000°F.

5.2. Stack Diameter

5.2.1. The entire stack must be the same size as the stack outlet on the boiler or one size larger.

5.2.2. If the boiler stack is connected to other equipment, the stack size must be increased.

5.3. Stack Connections/Sections

Limit connections to one of the following combinations:

- Two 90 degree elbows
- One 90 degree elbow and one tee
- One 90 degree elbow and two 45 degree elbows
- Four 45 degree elbows

5.4. Overall Length

Avoid long runs of stack. A general rule is not to exceed 15 feet for every inch of stack diameter. For example, if the stack is 6” diameter, then the overall stack should not exceed 90 feet (6’ x 15’) in length and height combined.

5.5. Horizontal Stack

Avoid any horizontal runs of stack. If unavoidable, horizontal runs should have a minimum incline of 3” per foot. If a long horizontal run (4’ or more) cannot be avoided, a draft inducer may be required to properly vent combustion gases.

5.6. Walls & Ceilings

When passing through combustible walls or ceilings, a stack thimble is required. The thimble must be double wall stack, 6 inches larger in diameter than the vent stack. The material used to close the opening between the stack and the stack thimble must be non-combustible.

6. Steam Outlet

6.1. Pipe Size

Size pipe according to system requirements.

6.2. Outlet Size

Refer to product literature sheet for steam outlet size on a particular boiler model.

6.3. Steam Stop Valve

Install a steam stop valve in the steam line as close to the boiler as is practical. Allows boiler to be isolated from the system during service work and may be helpful in throttling steam flow. Required by ASME Code if the boiler is operated over 15 psi.
6.4. Steam Piping
Steam line should be pitched downward slightly away from the boiler and toward a steam trap. If using a steam solenoid valve, the steam line should slope upward slightly to the solenoid valve, and after the solenoid valve, the steam line should slope downward.

6.5. Codes & Standards
Piping must comply with all industry standards (especially ANSI B31.1) and all state and local codes.

7. Blowdown Piping

7.1. Boiler Bottom Blowdown (See Diagram Below)

7.1.1. DO NOT REDUCE. Blowdown piping and all fittings must be the same size as the boiler blowdown connection.

7.1.2. Low pressure boilers, operating at 15 psi or less, require one blowdown or drain valve. The pressure rating of the valve must be equal to or greater than the pressure of the boiler safety valve but not lower than 30 psi.

7.1.3. Boilers operating 16 psi to 100 psi inclusive require a single blowdown form a pocket inside the valve are not acceptable blowdown valves. A Y-type or a ball valve is acceptable blowdown valves.

7.1.4. Boilers operating 101 psi to 150 psi require piping designed for a pressure of 125% of the boiler safety valve set pressure (schedule 80 blowdown piping) and two slow opening blowdown valves. If cast iron, these valves must be class 250, or if steel, these valves must be class 150, or if bronze, a WSP rating of at least 200.

7.1.5. Standard globe and gate valves that form a pocket inside the valve are not acceptable blowdown valves. Y-type and ball valves are acceptable blowdown valves.

7.1.6. All blowdown piping must meet ANSI B31.1 code and all city and state codes.

7.1.7. Galvanized piping is not acceptable for boiler blowdown piping.

7.2. Automatic Bottom Blowdown
A Lattner automatic bottom blowdown valve may be used in place of one of the manual blowdown valves.

7.3. Water Level Control Drain Valve
A water column type level control is supplied with one drain valve. Connect the control drain line into the bottom blowdown line after the second bottom blowdown valve.

7.4. Blowdown Discharge
All boiler blowdown water must be discharged to a safe location, specifically to a blowdown separator.

7.5. Blowdown Separator
Select a Lattner Blowdown Separator according to the size of the boiler blowdown connection:

<table>
<thead>
<tr>
<th>Size</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>810</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>1450 or 1455</td>
</tr>
<tr>
<td>2&quot;</td>
<td>1600</td>
</tr>
<tr>
<td>2-1/2&quot;</td>
<td>1800</td>
</tr>
</tbody>
</table>
7.6. **Blowdown Separator Inspection Opening**  
The extra coupling in the separator vessel is an inspection opening. The inspection opening will be plugged.

7.7. **Blowdown Separator Vent**  
The blowdown separator must be vented to atmosphere. Vent pipe must discharge outside through the roof. **DO NOT** reduce the vent pipe size. **NEVER** connect the vent pipe from the condensate tank to the separator vent.

7.8. **Blowdown Separator Drain**  
The water leaving the separator through the drain should be piped to the sewer. Some codes require the water to pass through an air gap before entering the sewer.

7.9. **Aftercooler**  
If the water must be cooled before entering the sewer (required by some codes), then an aftercooler must be used. The aftercooler attaches to the separator drain connection and mixes cold water with the hot drain water. Units may be either manual or automatic. Select the aftercooler according to blowdown separator drain size.

- 205A (auto) or 205M (manual) Model 810  
- 301A (auto) or 301M (manual) Model 1450 or 1455  
- 525A (auto) or 525M (manual) Model 1600  
- 625A (auto) or 625M (manual) Model 1800

7.10. **Cooling Water Supply**  
Connect cold water supply pipe to aftercooler:

- 205A (auto) or 205M (manual) 1/2” NPT  
- 301A (auto) or 301M (manual) 1” NPT  
- 525A (auto) or 525M (manual) 1-1/4” NPT  
- 625A (auto) or 625M (manual) 1-1/4” NPT

7.11. **Dead Boiler Drain Valve**  
For draining the boiler when it is cool and not under pressure, the entire drain line must be lower than the bottom of the boiler. Pipe to sewer or floor drain. Valve must be rated up to the MAWP of the boiler.

7.12. **Codes & Standards**  
All blowdown piping, drain and sewer connections, water piping and separator connections must be done in strict compliance with all applicable codes.

8. **Safety Valve**

8.1. **Installation**  
Be sure safety valve is threaded securely into the boiler or into the elbow supplied with boiler. The safety valve will always be installed in the upright position.

8.2. **Discharge**  
Pipe the safety valve outlet to a safe point of discharge. **DO NOT** reduce the safety valve discharge piping. **NEVER** plug the safety valve outlet.

8.3. **Supports**  
Safety valve piping should be secured by clamps or braces to a wall or structural member. Do not allow the discharge piping to hang on the safety valve.

8.4. **Codes & Standards**  
All safety valve piping and supports must conform to all applicable codes.

9. **Gas/Fuel Train Piping**

9.1. **Components**  
Generally, a gas train should include the following:

- Manual gas cock  
- Main gas pressure regulator  
- Main gas valve  
- Pilot gas pressure regulator  
- Pilot gas valve  
- Flame failure control
9.2. **Motorized Gas Valve**
The main gas valve and pressure regulator are two separate components. The motorized gas valve is a two-piece valve. The lower section is the valve body, which is a plunger valve. The upper section is the actuator. The actuator has a small built-in hydraulic system. The hydraulic system opens and closes the valve. The motorized gas valve is a gas valve only, and has no other functions. This gas train requires a separate main gas pressure regulator, pilot gas pressure regulator and pilot valve.

As an option, the combination gas valve can be supplied with an intermittent pilot. This system has a spark-ignited pilot and will shut off the gas within four seconds of a flame failure.

9.3. **Gas Supply Pipe**
The gas pipe to the boiler must be at least the same size as the gas train supplied with the boiler. **DO NOT** reduce.

9.4. **Drip Leg**
Gas supply piping must be installed with a proper drip leg ahead of any gas train components.

9.5. **Gas Supply Pressure**

**Natural Gas:** Supply pressure should be between 6” and 11” water column ahead of the gas pressure regulator when the boiler is running. Manifold pressure when the boiler is operating should be 4-1/4” to 4-1/2” water column.

**Liquid Propane (LP):** Gas supply pressure should be 11” water column. A pressure regulator will not be supplied with a propane fired boiler.

**WARNING:** **NEVER** use Teflon tape on any part of the gas train piping. This will void any warranty on the gas train assembly.

9.6. **Codes & Standards**
All gas piping must be done in accordance with all applicable codes (National Fuel Gas Code, utility company requirements, local building codes etc.).

10. **Boiler Feed Systems**

10.1. **Condensate Return Systems**

10.1.1. **Make-Up Water Supply**
Connect city water line to the float valve with the boiler feed system. Install a manual shut-off valve in the water line.

<table>
<thead>
<tr>
<th>HP Range</th>
<th>NPT Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 HP through 50 HP</td>
<td>1/2&quot; NPT</td>
</tr>
<tr>
<td>60 HP through 200 HP</td>
<td>3/4&quot; NPT</td>
</tr>
</tbody>
</table>

10.1.2. **Pump Suction Line**
This is pre-piped from the factory with an isolation valve and strainer.

10.1.3. **Pump Discharge Line**
**DO NOT** reduce. Use 1" NPT pipe and fittings between pump and boiler. Install two spring-loaded check valves. Install a hand shut-off valve between the last check valve and the boiler. Keep the number of elbows and fittings to a minimum.

10.1.4. **Condensate Return Line**
Condensate from all steam traps should be tied into a common return line. The condensate return line should be pitched downward toward the condensate return tank.

10.1.5. **Condensate Return System Vent**
Condensate return tank must be properly vented to atmosphere. Vent should discharge through the roof or through a wall to the outside. Do not reduce the vent pipe size.

<table>
<thead>
<tr>
<th>HP Range</th>
<th>NPT Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 HP through 50 HP</td>
<td>1&quot; NPT</td>
</tr>
<tr>
<td>60 HP through 200 HP</td>
<td>1-1/2&quot; NPT</td>
</tr>
</tbody>
</table>

10.1.6. **Condensate Return System Overflow**
Pipe to floor drain. Overflow connection should be at least as large as the condensate return.

10.1.7. **Condensate Return System Drain Connection**
Pipe to floor drain. Install a valve in the line. 1" NPT line is sufficient.
10.2. Solenoid Water Valve

10.2.1. Water Pressure
This system will work only if the water supply pressure is at least 10 psi higher than the boiler pressure.

10.2.2. Water Inlet
Refer to the boiler assembly print for correct connection and location of the feedwater inlet.

10.2.3. Piping
The solenoid water valve assembly will be piped in the following order: Y-type strainer, solenoid valve, spring-loaded check valve, globe valve, and boiler. All pipe is 1/2” NPT.

10.2.4. Water Supply
Connect water supply to the strainer.

11. Electrical Connections

11.1. Reconnecting Controls
If the boiler was shipped with controls removed, re-connect the wires according to the wiring diagram. All wires that need to be reconnected will have a tag indicating the control or terminals to which they must be connected.

11.2. Electrical Supply
Supply 120 volt single phase from a separate fused disconnect. Use a 30 amp circuit breaker or fused disconnect if the boiler has a 3/4 hp pump motor or larger. Refer to wiring diagram for specific instructions.

11.3. Wiring Water Feed System
Wire the solenoid water valve, boiler feed pump or pump motor starter as indicated on the wiring diagram.

11.4. Power Supply
Connect the power supply to the terminals in the panel box as shown on the wiring diagram. "Hot" side will be marked L1. Neutral will be marked L2.

11.5. Secure Connections
After all wiring is complete and before any power is supplied to the boiler, be sure all wiring connections are tight.

11.6. Turn Pump Switch “ON”
Turn on the pump switch. Pump or solenoid valve should start immediately. If not, see troubleshooting section.

11.7. Check for Leaks
While the boiler is filling, check for leaks in the piping and around boiler. If there are leaks, turn off the pump switch and fix all leaks before continuing.

12. Before Firing the Boiler

12.1. Spare Fittings
Check that all unused pipe nipples are plugged or capped.

12.2. Float Block
Remove the float block screwed into the body of the McDonnell Miller level control. Replace with a malleable iron plug.

12.3. Condensate Return System
Make sure there is make-up water supply to the tank. Make sure there is water in the tank.

12.4. Turn Pump Switch “ON”
Turn on the pump switch. Pump should start immediately. If not, see the troubleshooting section of this manual.

12.5. Check for Leaks
While the boiler is filling, check for leaks in the piping and around boiler. If there are leaks, turn off the pump switch and fix all leaks before continuing.
13. **Pressuretrols: Controller and Limit**

13.1. **Standard**
All Lattner boilers will have at least two pressure switches, a “controller” and a “limit”.

13.2. **Controller**
Before the boiler is started, the steam pressure is 0 psi. At this point, the controller is in the “on” condition and is calling for heat. When the boiler switch is turned on, the boiler will fire and start generating steam. As the boiler fires, the steam pressure will rise. When the steam pressure reaches the controller's set point, the controller will shut off the burner. As steam is used, the pressure will begin to drop. When steam pressure drops enough, the controller will start the burner again. The controller will continue to operate in this manner to maintain boiler pressure.

13.3. **Setting Controller**
On the left side of the pressuretrol is the set point indicating scale labeled “MAIN”. Turn the main scale adjustment screw until the set point indicator aligns with the desired operating pressure. Turn screw clockwise to increase pressure, counterclockwise to decrease pressure.

13.4. **Differential**
When the boiler pressure reaches the set point the controller shuts off the burner. The pressure must drop by a set amount before the controller will turn on the burner again. That amount is called the differential. The differential is adjustable.

13.5. **Setting the Differential**
On the far left side of the pressuretrols is the differential indicating scale labeled "DIFF". Turn the differential adjusting screw until the indicator aligns with the desired differential. A minimum differential will maintain the boiler pressure closer to the set point. A larger differential will help prevent rapid on and off cycling of the boiler.

13.6. **Limit**
The limit switch is similar in operation to the controller but has a slightly higher set point. If the controller fails to shut off the boiler and the steam pressure continues to rise, the limit switch will shut down the boiler. The controller is an operating switch; the limit serves as an auxiliary safety cut-off. The limit switch is supplied with a manual reset function. If the steam pressure trips the high limit switch, the limit locks in the off position. The limit switch will not reset until the manual reset lever is pressed.

13.7. **Setting the Limit**
This is done using the same procedure as for the controller. The limit setting will be slightly higher than the controller's set point. For low pressure boilers (15 psi or less), set the limit switch 4 psi higher than the controller and 3 psi lower than the safety valve setting. For high pressure boilers, set the limit switch at least 10 psi higher than the controller and 5 psi lower than the safety valve setting.
13.8. Night Operating Pressure Switch
A third pressure switch may be supplied as an option. This switch allows the boiler to operate at low pressure at night for heating the building. Set the night operating pressure switch at approximately 10 psi. The boiler panel box will also be wired with a High/Low selector switch. Setting the selector switch at “Low”, the boiler will operate at 10 psi. When the switch is turned to “High”, the night operating switch is by-passed and the boiler operates at the normal operating pressure.

13.9. Example
Boiler with a 100 psi safety valve. Set the controller at 80 psi with an 8-10 psi differential. Set the limit switch at 90 psi. Turn on the boiler, burner will fire. When the steam pressure reaches 80 psi, the controller shuts down the burner. When the pressure drops to 70-72 psi the burner restarts. The boiler continues to cycle to maintain 80 psi. If the steam pressure rises to 90 psi, the limit switch shuts off the boiler. The manual reset on the limit switch must then be reset before the boiler will operate again.

For any additional information on the Honeywell Pressuretrols, refer to the Honeywell product sheet in the back of this manual.

14. Firing the Boiler

14.1. Leave the Boiler Switch “OFF”

14.2. Purge the Gas Line

14.3. Gas Supply

14.4. Turn the Boiler Switch “ON”

14.5. The Burner should Fire

If burner fails to fire, refer to troubleshooting section of this manual (Section IV).

14.6. Burner Head Pressure
Check gas pressure at burner head. Burner head pressure should be as specified in the burner manual.

14.7. Adjust Pressure
If the burner head pressure is not within the range specified, adjust gas pressure regulator. Motorized gas trains have separate gas pressure regulators. Removed large slotted cover screw and turn adjusting screw underneath. Refer to Maxitrol manual.

14.8. Check for Gas Leaks
Brush a soapy water solution on each connection in the main gas and pilot gas lines. Look for bubbles. If there are any gas leaks, shut off the main gas supply and fix any leaks before continuing. Repeat steps 1 through 6.

14.9. Adjust the Burners
Forced draft burners can only be properly set up by using combustion test equipment. These burners cannot be set up solely on the appearance of the flame. Refer to the burner manual in the product literature section for proper carbon monoxide, carbon dioxide, and excess oxygen levels.

14.10. Burner Tuning Objectives
The following measures are approximations only. Data may vary by location, environment, fuel, gas pressure, BTU content and more. Refer to burner manual for more specific instructions, including low-NOx burner instructions for California and Texas.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Supply Pressure</td>
<td>6&quot; w.c. (minimum)</td>
</tr>
<tr>
<td>Manifold Pressure</td>
<td>4-1/4&quot; w.c. (minimum)</td>
</tr>
<tr>
<td>O₂</td>
<td>4.5% to 7.5%</td>
</tr>
<tr>
<td>CO₂</td>
<td>8% to 10%</td>
</tr>
<tr>
<td>CO</td>
<td>Less than 100 ppm</td>
</tr>
<tr>
<td>NO₂</td>
<td>Less than 60 ppm</td>
</tr>
<tr>
<td>Stack Temperature</td>
<td>425°F to 500°F</td>
</tr>
<tr>
<td>Efficiency</td>
<td>80% to 83%</td>
</tr>
</tbody>
</table>

14.11. Pressuretrols
Allow the boiler to reach its operating pressure. Check the pressuretrols to be certain they’re are set as described and functioning properly.

14.12. Level Controls
Make certain the level control feeds water into the boiler and maintains a proper water level.

14.13. Odors
It is normal for a new boiler to give an odor when it first fires. This odor will generally subside within two days.
15. Boil Out recommendations for New Boilers
With proper operation and maintenance you can expect years of trouble free service from your new Lattner boiler. The procedure for correct operation and care of your unit is not complicated, nor is it time consuming. It is necessary to clean the inside of the new boiler of oil and grease used as tube rolling lubricants, threading, and/or other various reasons beyond the manufacturer’s control. Since these coatings may lower the heat transfer rate of the heating surfaces, failure to remove these coatings will result in your unit foaming, priming, carry-over or other damage. The boil out operation is easily accomplished by following the procedure as outlined below:

15.1. Fill the boiler to the normal water line. Close boiler steam stop valve in the steam line.

15.2. Remove safety valves at the top of the boiler. The safety valves must be removed to prevent any contaminants or boil out solution from entering them.

15.3. Tri-sodium phosphate and caustic soda each in the amount of one pound per 50 gallons of water are the suggested chemicals for cleaning boilers. Dissolve these compounds in water and add dissolved chemicals through an opening at the top of the boiler. NOTE: When dissolving and mixing the boil-out chemicals, the use of a suitable face mask, goggles, rubber gloves, and protective clothing is mandatory. DO NOT permit the dry chemicals or the concentrated solution to come in contact with skin or clothing.

15.4. It is necessary to connect an overflow pipe from the safety valve opening in the boiler to a safe point of discharge. After adding the boil out solution, add water to the boiler until it is completely filled.

15.5. Fire the boiler intermittently at low fire for 4 to 5 hours. Maintain just enough heat to hold the solution at the boiling point. IT IS CRITICAL THAT YOU DO NOT OVER FIRE BOILER DURING THIS PORTION OF THE START UP. Do not allow boiler to produce any steam pressure. During this procedure, allow just a small amount of water to enter the boiler to carry off any surface impurities through the overflow pipe. Continue the process until the overflow water appears clear.

15.6. Stop the burner and allow the water to cool to about 120°F. Drain the boiler while the water is still warm. NOTE: Prior to draining the boiler, check with local water treatment facilities to determine whether special instructions or permits are required to dispose of the water.

15.7. Remove the handhole (and manhole) plates from the boiler and wash the interior with tap water at full pressure through a nozzle. Wash until all evidence of dirt, mud, and impurities are removed through the bottom handhole openings. Inspect the internal surfaces. If not clean, repeat the boil out procedure.

15.8. After closing the openings and reinstalling the safety valves, fill the boiler to its normal water level and fire it until the water temperature is at least 180°F to drive off any dissolves gasses and oxygen which might otherwise corrode the metal.

On a steam system, the condensate should be wasted until test show the elimination of undesirable impurities. During the period the condensate is wasted, attention must be given to the treatment of the raw water used as make up so that an accumulation of unwanted materials or corrosion does not occur. Follow the advice of you water treating company.

On a hot water system, chemical cleaning of the entire system is generally necessary and the entire system should be drained after treatment. Consult a water treatment company for recommendations, cleaning compounds, and applicable procedures.

16. Standard Maintenance Items

16.1. General
There are three standard maintenance items which should be kept in stock at all times to unnecessary shut down, handhole gaskets, McDonnell Miller head gaskets, and sight glasses.

16.1.1. Gaskets
The handhole gaskets and the McDonnell Miller head gasket must be replaced after each internal inspection. If any leaks are present around the gasket surfaces, replace the gasket immediately. High pressure water and steam leaks will erode the metal surfaces and cause expensive repairs. Keep a full set of handhole and McDonnell Miller head gaskets in stock at all times.

16.1.2. Sight Glasses
A sight glass with gaskets and washers should be in stock. Replace the sight glass with new gaskets and washers.

16.2. Routine Service
These standard maintenance items are considered routine repair parts and are not covered under warranty.
## 17. Water Quality Limits for Lattner Steam Boilers

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Recommended Value or Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>0 parts per million</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0 parts per million</td>
</tr>
<tr>
<td>pH</td>
<td>9.0 to 10.0</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>1 parts per million as CaCO₃</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>600 parts per million as CaCO₃</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>2200 to 2500 parts per million</td>
</tr>
<tr>
<td>Total Iron</td>
<td>&lt;0.1 parts per million</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>3500 umho/cm non-neutralized</td>
</tr>
<tr>
<td>Silica</td>
<td>&lt;150 parts per million</td>
</tr>
<tr>
<td>Oily Matter</td>
<td>&lt;0.1 parts per million</td>
</tr>
</tbody>
</table>
Section III: Boiler Care & Maintenance

WARNING: All maintenance procedures must be performed by competent personnel familiar with boilers and boiler accessories.

CAUTION: Read and follow all instructions before working on any boiler equipment.

NOTE: Certain maintenance items concerning specific components may be found in the product literature specifications of this manual.

1. Daily Procedures
   1.1. Blowdown primary low water cut-off while burner is firing.
   1.2. Verify that feedwater pump cycles normally and that burner shut off.
   1.3. Observe the burner starting sequence and flame characteristics to verify normal behavior.
   1.4. Conduct visual check of all pressure and temperature gauge readings.
   1.5. Check safety valve, handholes, and manway for signs of leakage.

2. Weekly Procedures
   2.1. Check function of auxiliary low water cut-off while burner is firing. Verify proper response of alarms.
   2.2. Check flame safety control’s response to lack of flame with main gas OFF. Start burner with pilot OFF, verify lock-out.
   2.3. During and after flame failure test, observe ignition spark and pilot flame for abnormalities.
   2.4. Record pilot and main flame signals if digital display module is available.
   2.5. If boiler is equipped with modulating burner, verify that adequate differential exists between operating and modulating controls to prevent short cycling.
   2.6. Verify that main fuel valves are closing within specified times. Check valve position indicators.

3. Monthly Procedures
   3.1. Check air flow switches mechanically and electrically. Snap switches can stick in closed position if shaft is dirty. Disconnect wire, start burner, verify that pilot does not light.
   3.2. Check low fire start proving switch circuit with voltmeter. Terminal must not be powered until motor returns to low fire position. If wire is disconnected, verify that pilot does not light.
   3.3. Check open damper proving switch circuit with voltmeter. Terminal must not be powered until motor reaches high fire position. If wire is disconnected, verify that motor remains at high fire position.
   3.4. Test main gas valves for leakage. Close checking cock, connect hoses to open lead test valves, submerge hose ends in water, and watch for bubbling.
   3.5. Test fuel pressure interlock switches. With burner in normal operation (preferably at high fire), raise low gas or oil pressure switch setpoint above available fuel pressure. Burner must shut off when visual indicator trips. Test high gas pressure switch by reducing setpoint below existing manifold pressure. Again, burner must shut off when indicator trips.
   3.6. After returning to normal setpoints, burner must no restart until switches have been manually rest.
   3.7. Test oil atomizing medium interlock by interrupting flow of compressed air or steam to burner. Oil valves must close, with subsequent flame safeguard lock-out.
   3.8. Manually lift safety valve set with test level while boiler is at normal operation pressure.
   3.9. Check flame safety control’s response to lack of flame with main gas OFF. Start burner with pilot OFF, verify lock-out.
4. Annual Procedures

4.1. Since the low water cut-off wiring terminal strips tend to be at the highest operating temperatures found in the boiler control circuit, check wire insulation for brittleness, cracking, or missing patches.

4.2. Clean all safety control related piping, including low water cut-off equalizers, pressure control manifolds, and air flow switch tubes.

4.3. Check boiler pressure gauge against calibrated master gauge or with a dead weight tester. New gauges are built to 1% accuracy.

4.4. Jumper operation control and run boiler under manual control at reduced load to determine proper operation of limit.

4.5. Bypass both operating and high limit controls under manually controlled low load condition. Gradually bring boiler pressure up to safety valve setpoint. 15 psi valves must open at 15 psi. Valves rated 15 psi to 69 psi are permitted 2 psi tolerance, and 70 psi to 300 psi valve vary 3%.

4.6. Remove gas line strainer basket and clean.

5. Care of Idle Boilers

Boilers used on a seasonal basis that will be idle for a long period of time (in excess of 30 days) should be laid up either under a dry or wet method during periods of inactivity.

5.1. Boilers Laid Up Dry

In the event that the boiler could be subject to freezing temperatures or if the boiler is to be idle for an excessive period of time, the following preparation should be made and carried out so that the boiler is not damaged over its period of inactivity:

5.1.1. Drain and clean the boiler thoroughly (both fire and water sides) and dry the boiler out.

5.1.2. Place lime or another water absorbing substance in open trays inside the boiler and close the unit tight to exclude all moisture and air.

5.1.3. All allied equipment such as condensate tanks, pumps, etc., should be thoroughly drained.

5.2. Boilers Laid Up Wet

In order to protect the boiler during the short periods of idleness, the boiler be laid up wet in the following manner:

5.2.1. Fill the boiler to overflowing with hot water. The water should be approximately 120°F to help drive out the free oxygen. Add enough caustic soda to the hot water to maintain approximately 350 parts per million of alkalinity and also add enough sodium sulphide to produce a residue of 50 to 60 parts per million of this chemical.

5.2.2. Check all boiler connections for leaks and take a weekly water sample to make sure that the alkalinity and sulphide are stable.

When cleaning a boiler in preparation to laying up the boiler, the water side of the unit should be cleaned and then the unit fired to drive off gases. The fire side should then be cleaned. An oil coating of fire side metal surfaces is beneficial when the boiler is not used for extended periods of time. This will prevent oxidation of the metal. Fuel oil lines should be drained and flushed of residual oil and refilled with distillate fuel. If oil boilers are to be laid up, care of oil tanks, lines, pumps and heaters is similarly required.

6. Care & Service of Boiler Tubes

6.1. Hard water causes short tube life in scotch marine boilers. Chemical action from hard water plus oxygen in the water will attack the boiler tubes. This action can be so drastic that tubes may be pitted through in a few months.

6.2. Water that is too soft (zero soft) causes pitting of tubes and boiler plates below the water line. Ideal feedwater is 3 to 6 grains in hardness. Water that is too soft is usually apparent because it causes a bouncing water level in the gauge glass and usually causes foaming and priming, throwing water into the main steam piping.

6.3. When first installed, new boiler may develop leaks around the tube ends. While the boiler was tight and showed no leaks during final hydrostatic testing by the ASME inspector (third party), leaks often develop after the boiler has been shipped some distance. If leaks do not take up and stop after the boiler has been operated for 24 hours, tubes that are leaking must be slightly re-rolled.

6.4. Re-rolling of the tubes to stop leaks, when the boiler is new or if it has been in service for some time, is a very delicate procedure. There is danger of over-rolling. When the tubes are installed in a new boiler, they are rolled just enough to prevent leakage. Re-rolling must be done on the same basis. The boiler should be subjected to a small amount of water pressure when tubes are being re-rolled. The tube roller can then be used sparingly and just enough to stop the leaks. Even one turn of the tube roller may be too much. Over-rolling makes the tubes so thin that during expansion and contraction boiler pressure will bend the thin part of the tube inward. The tube will then leak constantly, making it necessary to replace the tube.
6.5. If tubes leak at rolled joints after boiler had been in service for some time, the cause of such leaks is usually one of the following:

6.5.1. Firing the boiler when it is low water.

6.5.2. Lime and scale deposits around the tubes near the rolled joints. This insulates the joint from the water and permits overheating of the tube ends, causing leakage.

6.5.3. Feeding water to the boiler at any point near tube sheets may cause the boiler leak. Instruction sheets show the proper feedwater inlet. Scotch marine boilers have water inlets halfway up the side of the boiler shell.

6.5.4. Boiler can be chilled causing leaks by blowing the boiler completely down when it is too hot. Boiler pressure should not exceed 15 psi for complete blowdown.

6.5.5. Boiler can be chilled causing leaks by filling with cold water too soon after blowdown. After complete blowdown and before filling with water, the boiler should be allowed to cool for two hours if there is no internal firebrick and three hours if there is an internal firebrick-lined combustion chamber.

7. Boiler Tube Replacement

7.1. Prior to tube replacement, it is necessary to have these tools available:

7.1.1. Tube driving mandrel and sledge hammer, or cutting torch
7.1.2. Chisel
7.1.3. Tube roller, properly sized for boiler tube diameter and thickness
7.1.4. Flaring tool
7.1.5. Beading tool
7.1.6. Socket wrench
7.1.7. Oil

7.2. In addition to these basic tubes, tube replacement is simplified with the following equipment:

7.2.1. Air compressor or air source
7.2.2. Small air hammer
7.2.3. Impact wrench or tube rolling motor

7.3. Boiler Tube Removal, Method A

7.3.1. In most cases the boiler tube will be covered with scale, therefore it is extremely difficult to pull the tube out of the tube sheet. Equipment is available that can easily remove scale encrusted tubes through their respective tube holes; however these tools are very costly.

7.3.2. Using a chisel, carefully remove the bead from one end of the tube to be replaced. IMPORTANT: Extreme care must be exercised when using the chisel so the tube sheet and the tube hole are not damaged.

7.3.3. A special driving mandrel must be placed into the tube end from which the bead has been removed. The mandrel must fit inside the end of the tube and its shoulder must be able to pass through the tube hole in the tube sheet. Preferably the mandrel should be attached to the end of a steel rod about 2’ or 3’ in length. After inserting the mandrel with its rod into the tube, a sledge hammer can be used to drive the tube out of the tube sheet. After the tube extends about 2’ from the opposite tube sheet, it can generally be manipulated to crush the adhering scale as it is physically removed. As mentioned above, tube removal by this method is very difficult.

7.4. Boiler Tube Removal, Method B

7.4.1. IMPORTANT: This method of tube removal with a cutting torch can be used ONLY if the tube to be removed can be withdrawn from a handhole opening. It is not possible to remove a tube severed with a cutting torch from a tube hole.

7.4.2. In this method the tube is severed with a cutting torch and is removed through a handhole opening.
8. Handhole Plate Removal & Installation

8.1. Disconnect all power to the boiler. The boiler must be cool and drained of all water.

8.2. Remove the handhole plate nut. Remove arch over handhole plate. Remove handhole plate. Sometimes it is necessary to tap on the handhole plate to loosen it. Make sure the handhole plate does not fall inside the boiler.

8.3. Scrape the inside of the boiler around the handhole area to remove any scale or old gasket material. Scrape the old gasket material off the handhole plate. Make sure there are no burrs around the handhole opening. Remove any burrs with a file.

8.4. Place the handhole plate back into the boiler handhole plate opening without the gasket. If the plate rocks back and forth, remove the high spots on the handhole plate with a file. **DO NOT LEAVE THE HANDHOLE PLATE INSTALLED IN THE BOILER WITHOUT THE GASKET.**

8.5. Install the gasket on the handhole plate. Make sure the gasket is pressed firmly down on to the handhole plate. **DO NOT USE ANY GREASE, LUBRICANTS OR ADHESIVES WHEN INSTALLING HANDHOLE GASKETS.**

8.6. Reinstall the handhole plate into the boiler. Replace the arch over the stud of the handhole plate. The arch should extend across the width (short way) of the handhole opening.

8.7. Replace the nut on the handhole plate stud. Tighten the nut hand tight, then turn the nut ¼ turn with a socket. **DO NOT COMPRESS THE GASKET EXCESSIVELY.** This will only shorten the life of the gasket.

8.8. Reconnect the power to the boiler.

8.9. Check the handhole plate for leakage with pressure on the boiler. If leaks are noted, remove the pressure from the boiler, let the boiler cool and drain to reposition the handhole plate. Repeat steps 12 through 16.
9. Sight Glass Removal & Installation

9.1. Boiler and pump should be switched off. Boiler should be cool and the water level should be below the lower water gauge fixture. Close the upper and lower water gauge valves.

9.2. Loosen both sight glass packing nuts (top and bottom) with a wrench. Slide glass carefully upward into the upper fixture. Glass should lift out of the lower fixture.

9.3. Pull glass down, out of the upper fixture tilting the glass slightly to clear the lower fixture. Be careful not to break the sight glass when removing. Assemble the new sight glass as shown. ALWAYS replace the gaskets and brass washers when installing a new sight glass.

9.4. Slide the new glass into the upper fixture. Glass should clear the lower fixture and tilt into position. Slide the sight glass down into the lower fixture. Equalize the gap between the upper and lower fixtures.

9.5. Tighten the sight glass packing nuts hand tight. Use a wrench to tighten 1/4 turn past hand tight. NEVER over tighten the sight glass. This will crack the glass and cause it to shatter under pressure.

9.6. Open the upper and lower gauge valves. Switch on boiler and pump.
10. McDonnell Miller Servicing

10.1. Disconnect all power to the boiler. The boiler should be cool and drained of all water just below the McDonnell Miller control. Make sure all water is drained from the McDonnell Miller control by opening the control blowdown valve.

10.2. Disconnect the wiring and conduit connection to the McDonnell Miller. Tag all wires to ensure they are reconnected properly.

10.3. Remove the eight bolts holding the operating mechanism to the McDonnell Miller body. Use a 9/16" wrench or a crescent wrench. It may be necessary to tap near the base of the operating mechanism to free it from the body.

10.4. Lift the McDonnell Miller operating mechanism out of the body. Be careful to avoid damaging the float and float arm which extend into the body of the McDonnell Miller.

10.5. Carefully scrape the old gasket from the body and the operating mechanism of the McDonnell Miller. Remove any scale in the McDonnell Miller body. Always check the operating mechanism for any scale that might be blocking the float or float arm.

10.6. Check the float for any holes. Hold the float submerged in a bucket of water and look for any air bubbles coming from the float. Always reassemble the McDonnell Miller operating mechanism to the body with a new gasket.

10.7. Reinstall the eight bolts to the operating mechanism. Draw up the bolts evenly to prevent damage to the gasket, body or operating mechanism. Do not over tighten the bolts.

10.8. Reconnect the McDonnell Miller per wiring diagram. Reconnect all power to the boiler.
11. Warrick Relay Replacement

11.1. Disconnect all power to the boiler.
11.2. Pull relay out by hand. This may take a little force but be careful. Replace the Warrick with a new 26M series Warrick. The relay has a small tab so that it can be installed only one way.
11.3. Reconnect the power to the boiler.

12. Auxiliary Low Water Cut-Off Probe Cleaning

12.1.1. Disconnect all power to the boiler.
12.1.2. Remove the four screws on top of the probe enclosure with a Phillips screwdriver. Remove the wire from the probe using a 5/16" wrench or a crescent wrench. Only the wire on the probe is to be removed.
12.1.3. Use a 13/16" spark plug socket and remove the probe. Clean the stainless steel probe and probe fitting. Reinsert the probe using a 13/16" spark plug socket. Only tighten the probe enough to stop any steam leaks. Over-tightening will destroy the threads of the enclosure.
12.1.4. Reinstall the probe wire to the probe. Reassemble the cover to the enclosure with the four Phillips screws. Reconnect power to the boiler.
Section IV: Troubleshooting

WARNING: All troubleshooting procedures must be followed completely by competent personnel familiar with scotch marine boilers and accessories.

CAUTION: Read and follow all instructions before troubleshooting any boiler equipment.

1. Normal Operation
   All Lattner forced draft gas-fired boilers follow the same operating sequence:
   1.1. Turn the pump switch on.
   1.2. McDonnell Miller pump control turns on the pump or solenoid water valve.
   1.3. Pump or solenoid valve fills boiler.
   1.4. McDonnell Miller shuts off the pump or solenoid water valve when water is at normal operating level.
   1.5. Turn boiler switch to the on position.
   1.6. Gas valve opens and main burners light.
   1.7. Boiler pressure will rise to the pressure controller's set point. The then controller will shut off the gas valve.
   1.8. When the boiler calls for water, the McDonnell Miller level control will turn on the pump or solenoid water valve.
   1.9. If the pump cannot fill the boiler, the McDonnell Miller low water cut-off will shut down the boiler.
   1.10. If the McDonnell Miller does not shut down the boiler, the auxiliary low water cut-off will shut down the boiler.
   1.11. If the boiler has optional controls, refer to the wiring diagram.

2. Basic Service Tools
   The following basic equipment will aid in troubleshooting Lattner boilers:
   2.1. Schematic diagram of the boiler
   2.2. Volt/ohm meter
   2.3. Gas pressure gauge(s)
   2.4. Combustion Analyzer

3. Before You Begin
   Before you begin any troubleshooting procedures, check the following:
   3.1. Make sure the pilot is lit.
   3.2. Be certain boiler switch is on and that there are 115 volts supplied to the boiler control circuit.
   3.3. Be certain pump switch is on and check for proper pump voltage and phase if different from boiler circuit.
   3.4. Check if breaker is tripped or if fuse is blown.
   3.5. Make sure there is water in the boiler.
   3.6. Be certain manual gas cock is open and that gas is supplied to the boiler.
   3.7. Be certain that all manual resets, if supplied with the boiler, are reset.

Note: Generally, all Lattner boiler controls are wired in series. The boiler operating controls and limits form a series circuit. When all switches close, the boiler should fire.
4. Troubleshooting

The chart below is a general chart that shows common problems that may occur in boiler operation. This chart is only to be used by competent service personnel familiar with Lattner boiler equipment and controls. To use this chart, read down the side of the chart from the problem, then read the right side for possible causes. The causes are arranged with the most common first. If the problem is not on the chart below, consult a trained boiler service company.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler and pump switches are ON, pump does not run, low water level in boiler.</td>
<td>1. Circuit breaker tripped or fuse blown.</td>
</tr>
<tr>
<td></td>
<td>2. McDonnell Miller piping is plugged.</td>
</tr>
<tr>
<td></td>
<td>3. McDonnell Miller float is stuck.</td>
</tr>
<tr>
<td></td>
<td>4. McDonnell Miller is wired incorrectly.</td>
</tr>
<tr>
<td></td>
<td>5. Pump or solenoid water valve is wired incorrectly.</td>
</tr>
<tr>
<td>Pump runs but does not maintain water level in boiler.</td>
<td>1. Hand valve between pump and boiler is closed.</td>
</tr>
<tr>
<td></td>
<td>2. Bad check valve. Always replace with a spring-loaded check valve.</td>
</tr>
<tr>
<td></td>
<td>3. Bad steam traps.</td>
</tr>
<tr>
<td></td>
<td>4. Water temperature is too hot.</td>
</tr>
<tr>
<td></td>
<td>5. Strainer is plugged.</td>
</tr>
<tr>
<td></td>
<td>6. Pump isolation valve is closed.</td>
</tr>
<tr>
<td></td>
<td>7. No water is supplied to the pump.</td>
</tr>
<tr>
<td></td>
<td>8. Pump out of adjustment.</td>
</tr>
<tr>
<td>Pump or solenoid overfills the boiler.</td>
<td>1. Solenoid water valve is not seating properly.</td>
</tr>
<tr>
<td></td>
<td>2. McDonnell Miller float is operating incorrectly.</td>
</tr>
<tr>
<td></td>
<td>3. McDonnell Miller mercury tube is malfunctioning.</td>
</tr>
<tr>
<td></td>
<td>4. McDonnell Miller is wired incorrectly.</td>
</tr>
<tr>
<td></td>
<td>5. Pump is wired incorrectly.</td>
</tr>
<tr>
<td>Boiler takes excessive time to reach pressure.</td>
<td>1. Burners out of adjustment.</td>
</tr>
<tr>
<td></td>
<td>2. Improper gas pressure.</td>
</tr>
<tr>
<td></td>
<td>3. Insufficient quantity of gas supplied to the boiler.</td>
</tr>
<tr>
<td></td>
<td>4. Boiler flue passages need to be cleaned.</td>
</tr>
<tr>
<td></td>
<td>5. Gas valves firing on low fire only.</td>
</tr>
<tr>
<td></td>
<td>6. Scale build-up inside boiler.</td>
</tr>
<tr>
<td>Limit switch always shuts down boiler.</td>
<td>1. Scale build-up inside of the boiler.</td>
</tr>
<tr>
<td></td>
<td>2. Operating pressure switch is set higher than limit switch.</td>
</tr>
<tr>
<td></td>
<td>3. Operating pressure switch is not operating properly.</td>
</tr>
<tr>
<td>Boiler shuts down with auxiliary low water cut-off.</td>
<td>1. Pump switch is turned off.</td>
</tr>
<tr>
<td></td>
<td>2. Probe wired incorrectly.</td>
</tr>
<tr>
<td></td>
<td>3. Auxiliary level control relay wired incorrectly.</td>
</tr>
<tr>
<td></td>
<td>4. Probe has scale, dirt, or debris on it.</td>
</tr>
<tr>
<td></td>
<td>5. Foaming problem in boiler.</td>
</tr>
<tr>
<td></td>
<td>6. Water in boiler is too soft.</td>
</tr>
<tr>
<td></td>
<td>7. McDonnell Miller is not operating correctly.</td>
</tr>
<tr>
<td></td>
<td>8. Pump is not functioning properly.</td>
</tr>
<tr>
<td></td>
<td>10. No water supplied to the pump.</td>
</tr>
<tr>
<td></td>
<td>11. Probe is out of probe socket.</td>
</tr>
<tr>
<td>Flashback or rough light-off of main burners.</td>
<td>1. Air shutters/louvers on the burner are open too wide.</td>
</tr>
<tr>
<td></td>
<td>2. Pressure switch differential set to close.</td>
</tr>
<tr>
<td></td>
<td>3. Drafty conditions around the boiler.</td>
</tr>
<tr>
<td></td>
<td>4. Lack of free air in the boiler room.</td>
</tr>
<tr>
<td></td>
<td>5. Pilot burner not functioning properly.</td>
</tr>
<tr>
<td></td>
<td>6. Incoming gas line to gas valve is too small.</td>
</tr>
<tr>
<td></td>
<td>7. Pressure regulator not functioning properly.</td>
</tr>
<tr>
<td></td>
<td>Pilot fails to light or stay lit.</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Pilot gas pressure too high or too low.</td>
</tr>
<tr>
<td>2</td>
<td>Main or pilot gas line not purged.</td>
</tr>
<tr>
<td>3</td>
<td>Excessive draft around the boiler.</td>
</tr>
<tr>
<td>4</td>
<td>Pilot tubing blocked or kinked.</td>
</tr>
<tr>
<td>5</td>
<td>Pilot gas valve not functioning properly.</td>
</tr>
<tr>
<td>6</td>
<td>Pilot safety switch.</td>
</tr>
</tbody>
</table>
LATTNER BOILER LIMITED WARRANTY

A Lattner boiler shell is guaranteed to be constructed in accordance with the ASME Code. An independent ASME boiler inspector inspects the construction of each boiler and: (1) checks mill test reports on all materials used to ensure that the chemical and physical analysis of such materials complies with the ASME Code; (2) inspects each boiler shell during construction to see that workmanship complies with the Code; and (3) witnesses the final hydrostatic test and then places the ASME stamp on the boiler shell and signs an ASME data report certifying the boiler is ASME approved.

Lattner warrants the boiler and any other equipment of its manufacture to be free from defects in material and workmanship for one (1) year from the date of shipment from the factory, provided the boiler is operated under the normal use and service for which it was intended, and only if the boiler has been properly installed by a qualified technician in accordance with but not limited to ASME, ANSI, and NFPA Codes and applicable local, state, and national codes.

Lattner’s obligation under this Warranty is limited, at Lattner’s option, to replacing or repairing any defective part of the boiler or other equipment it manufactures. No allowance will be made for labor, transportation, or other charges incurred in the replacement or repair of defective parts. Merchandise not manufactured by the Company, supplied in one piece or in component assemblies, is not covered by the above warranty, but the Company will give the Purchaser the benefit of such adjustment as it can make with the manufacturer of such items.

Lattner shall not be liable for special, indirect, or consequential damages. Lattner shall not be liable for any loss or damage resulting, directly or indirectly, from the use or loss of use of the boiler. This exclusion from liability includes the Purchaser's expenses for downtime or for making up downtime, damages for which the Purchaser may be liable to other persons, or damages to property.

The remedies set forth in this Warranty are exclusive, and the liability of Lattner with respect to any contract or sale shall not exceed the cost of repair or replacement of the boiler or other equipment manufactured by Lattner.

The above Warranty shall not apply to any boiler or other equipment manufactured by Lattner which:

1) has been repaired or altered without Lattner’s written consent;
2) has been altered in any way so as, in the judgment of Lattner, to adversely affect the stability or reliability of the boiler;
3) has been subject to improper water treatment, scale, corrosion, misuse, negligence, or accident;
4) has not been operated in accordance with Lattner’s printed instructions or specifications;
5) has been operated under conditions more severe than or otherwise exceeding those set forth in the specifications for such boiler; or
6) has not been properly installed by a qualified technician in accordance with but not limited to ASME, ANSI and NFPA Codes and all applicable local, state and national codes.

THIS WARRANTY IS EXPRESSLY MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. LATTNER MAKES NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE.

Purchaser must notify Lattner of a breach of Warranty within thirty (30) days after discovery thereof, but not later than the one-year guarantee period; otherwise, such claims shall be deemed waived. No allowance will be granted for any repairs or alterations made by Purchaser without Lattner’s prior verbal or written consent. Items returned to Lattner must be accompanied by a factory-supplied return goods authorization (RGA). Such authorization may be obtained by calling the factory at 319/366-0778 or by writing to P.O. Box 1527, Cedar Rapids, IA 52406.

Lattner neither assumes nor authorizes any person to assume for it any other liability in connection with the sale or use of the boiler or other equipment manufactured by Lattner, and there are no oral agreements or warranties collateral to or affecting this Agreement.

LATTNER BOILER COMPANY
Cedar Rapids, IA USA

2-98-06
STANDARD TERMS & CONDITIONS

LIMITATION ON QUOTATION
Unless otherwise stated in the quotation, the quotation will remain valid for a period of thirty (30) days from the date hereof, at which time it will automatically expire unless extended by a signed document issued by the Company, from its headquarters in Cedar Rapids, IA.

EQUIPMENT SELECTION
The Purchaser’s selection of sizes, types, capacities, and specifications and suitability thereof for the specific application shall be the unshared responsibility of the Purchaser or Purchaser’s representative or consultant.

PERMISSABLE VARIATIONS, STANDARDS, AND TOLERANCES
Except in the particulars specified by the Purchaser and expressly agreed to in writing by the Company, all materials shall be produced in accordance with the Company’s standard practices. The Company reserves the right to deviate from tolerances and variations in the equipment without notice, provided that the substitute part(s) or deviation(s) are consistent with the usage and performance of the product.

PRICES
Unless defined otherwise in the quotation, prices are F.O.B. Cedar Rapids, IA USA, exclusive of freight, storage, off-loading, installation, service, start-up, extended warranty or local delivery charges, if any.

TAXES
Purchaser shall be liable for all Federal, State, and local taxes with respect to the purchase of the equipment proposed, unless exclusively exempted from any taxes and proof thereof is on file with the Company.

PAYMENT
Purchaser shall pay with US funds, the full amount of the invoiced purchase price within thirty (30) days of the Company’s invoice, whether the equipment has shipped or has been delayed through no fault of the Company and subject to approved credit. Beginning thirty (30) days after the invoice date, Purchaser shall pay a late payment charge of two percent (2%) per month, which is an annual rate of 24%, on any unpaid portion of the purchase price. The Company reserves the right to revoke or modify these credit terms.

SHIPMENT
Any shipping date shown in the body of the quotation or order acknowledgement, represents the Company’s approximated schedule as of the date of the quotation, and is subject to change as determined by shop loading if and when this quotation should be realized as an actual sale. The Company shall not incur any liability of any kind for failure to ship on any particular date unless a firm shipping date has been expressly agreed to by an officer of the Company, in a separate written document.

CANCELLATION AND DELAYS
Subsequent to the receipt of Purchaser’s Purchase Order and the Company’s issued order acknowledgement, the Purchaser may not change or cancel the order in whole or in part without the written approval and acceptance by the Company of such cancellation or change. The Company may condition its approval of a change or cancellation upon a price change to reflect the Company’s cost to implement the change, or to offset costs incurred by the Company in order preparation, engineering, purchasing, or in actual production of the order. In the event that the Purchaser delays shipment of the equipment upon the Company’s notice to ship, the equipment shall be placed in storage at the Purchaser’s risk and expense, and shall be invoiced as if shipped.

RETURNS AND RE STOCKING
Equipment may be returned to Lattner at 1411 9th Street SW, Cedar Rapids, IA 52404, only upon prior written authorization of the Company. Consent, if given, will be upon the condition the Purchaser assumes all carrier charges, responsibility for damages in transit, and a minimum 15% restocking charge, and only if the authorized material is in new and unused condition and returned within one year from original date of shipment. The credit will be based on the original invoice price or the current price; whichever is lower, less the applicable restocking charge.

SECURITY INTEREST
For the purposes of securing payment, the Company may issue a lien on the equipment, for past due accounts, until such time that payment has been received in full. Upon receipt of payment in full, the Company will rescind the lien.

FORCE MAJEURE
In no event shall the Company be liable for loss or damage resulting from any delay or failure to ship or other failure, loss, or damage that is the proximate result of any act of government authority, revolution, riot, civil disorder, act of war, delay or default in transportation, inability to obtain materials or facilities from normal sources, fire, flood, act of God, or any cause not within the reasonable control of the Company. The Company may, without causing a breach or incurring liability, allocate goods which are in short supply irrespective of the reasons therefore among customers in any manner which the Company in its sole discretion deems advisable. If an event occurs that is beyond the control of the Company, and that event delays the Company’s performance and causes its cost of production to increase because of the delay, the Company may pass such increased cost(s) on to the Purchaser.

DAMAGE LIMITATION
Under no circumstance shall the Company be held liable for any loss of profits, down time, or any incidental or consequential damages of any kind with respect to its products or the transaction by which its products are sold.

WARRANTY AND PERFORMANCE
Products shall be warranted in accordance with the Company’s standard warranty statement, form No. 2-98-R06. The Company’s warranty shall be voided by any abuse, misuse, neglect, unauthorized modification or service, lack of maintenance and service, or use not in accordance with the Company’s instructions. Warranty shall also be voided if water treatment has not been provided or by improper start-up of the equipment. The Company’s warranty statement and this paragraph contain the Company’s sole warranty and the Company makes no implied warranty, and there is no implied warranty of merchantability or fitness for any particular purpose.

SERVICE
Unless otherwise noted herein, the cost of the equipment does not include service or installation. All services performed by the Company are subject to the Purchaser’s payment of the Company’s prevailing charges plus necessary travel and living expenses. Whenever service is quoted, please refer to Lattner’s Service Policy for specific details.

EXCLUSION OF OTHER TERMS
This constitutes an offer on behalf of Lattner Boiler Manufacturing (the Company); to sell the goods described in the quotation, exclusively on the terms and conditions stated. Acceptance of this by the Purchaser is hereby expressly limited to these Terms and Conditions and shall be applicable to any order issued by the Purchaser unless other terms have been agreed to in a written document issued by the Company.

GOVERNING LAW
The transaction with respect to the goods, which are subject hereof, shall be governed by, interpreted, and construed in accordance with the laws of the State of Iowa. The Courts in the State of Iowa will have the sole jurisdiction over any claim arising under this contract of sale.

ASSIGNMENT
All sales as evidenced by the Company’s acknowledgement shall be binding upon and insure to the benefit of the Purchaser and the Company and their respective heirs, successors, or assigns.

LATTNER BOILER COMPANY
Cedar Rapids, IA USA

TC06
Easy Topog-E® Boiler Installation Instructions

1. Remove old gasket and thoroughly clean the surface on boiler and on cover plate. Sometimes it is necessary to buff each surface.

2. Place Topog-E® Gasket on handhole cover plate. Be sure the gasket is pushed down tight on the plate. Do not use any grease, lubricant, or adhesive.

3. After cover plate is in boiler and gasket is in place, make one last cleaning swipe of the mating surface in the boiler. Use a rag wrapped around your finger.

4. Set crab, then center plate in opening and tighten nut enough to give a snug fit. Then, snug up with 1/4 turn of wrench.

SPECIAL NOTES:

- If gasket leaks while pressure is being built up, tighten only enough to stop leakage. Never over-compress a gasket.

- Gaskets on the bottom of a boiler shell are usually hard to install without leaking because particles of scale or sand tend to run down onto the mating surface between the time the surface is cleaned and the handhole cover plate is put into place ready
to be tightened. When this happens, drain the boiler again and start over, or expect to replace the gasket in a very short time.

- As pressure builds up in the boiler the bolt and crab will loosen. It takes some time for the gasket to reach its ultimate compression, so the operator should watch this for several days and keep the bolt tight until it no longer loosens. This is especially true if the boiler is operated intermittently; i.e., shut off at night to allow pressure to drop. In this case, vacuum pressure in the boiler would suck the cover plate in and allow the water to leak out of the boiler.

- Re-using gaskets after they have been in service is not recommended!

**Topog-E® Bolt Gaskets (when required) should be used with Topog-E® Handhole Gaskets.**

Topog-E® Gaskets are sold for use in steam, water, air, and other selected applications only. Recommendations for use of Topog-E Gaskets are based on tests believed to be reliable and on actual customer experience. Since their installation and use is beyond our control we cannot guarantee the results, whether or not such use is in accordance with directions. We disclaim any responsibility.
INSTALLATION

Only properly trained personnel should install and maintain water gauge glass and connections. Remember to wear safety gloves and glasses during installation. Before installing, make sure all parts are free of chips and debris.

1. Apply Teflon tape or pipe dope to pipe threads. Install top gauge fitting (fitting without a drain valve) into the uppermost tapping. Wrench tighten the fitting until it is snug and the glass outlet is pointing at five o'clock (about 1/8 turn from its final downward vertical position).

2. Install the bottom gauge fitting (the fitting with a drain valve) until it is snug and the glass outlet is pointing directly upward. Verify top and bottom fittings are threaded into the tappings the same number of turns (distance A=distance B).

3. Remove glass packing nut, friction washer (or packing gland, depending upon the model), and glass packing from the fittings, and place them, in the same order, on to both ends of the gauge glass. Push both packings about an inch up the gauge glass.

4. Gently insert one end of the glass into the top gauge fitting. Keeping the glass inside the top fitting, gently rotate the top gauge fitting clockwise until vertically aligned with the bottom gauge fitting, then insert glass into bottom fitting until glass bottoms out on the shoulder inside the bottom fitting.

5. Carefully raise glass bout 1/16" and slide lower glass packing down until the glass packing contacts the lower gauge fitting. **DO NOT** allow the metal to remain in contact with any metal!

6. Carefully slide upper glass packing up as far as possible.

7. Hand tighten both glass packing nuts, then tighten 1/2 turn more by wrench. Tighten only enough to prevent leakage. **DO NOT OVER TIGHTEN**! If any leakage should occur, tighten slightly, a quarter turn at a time, checking for leakage after each turn.
DO’S
DO verify proper gauge has been supplied.
DO examine gauge glass and packings carefully for damage before installation.
DO install protective guards and utilize automatic ball checks where necessary to help prevent injury in case of glass breakage.
DO inspect the gauge glass daily, keep maintenance records, and conduct routine replacements.
DO protect glass from sudden changes in temperatures such as drafts, water spray, etc.

MAINTENANCE
Examine the gauge glass regularly for any signs of clouding, scratching, erosion, or corrosion. The glass should be inspected daily until the need for replacement becomes apparent. This will help establish the routine inspection and routine replacement schedules.

DO NOT’S
DO NOT use glass if it contains any scratches, chips, or any other visible signs of damage.
DO NOT reuse any tubular glass or glass packings.
DO NOT subject gauge glass to bending or torsional stresses.
DO NOT over tighten glass packing nuts.
DO NOT allow glass to touch any metal parts.
DO NOT exceed the recommended pressure of the gauge or gauge glass.
DO NOT clean the gauge or gauge glass while pressurized or in operation.

CLEANING
Use commercial non-abrasive glass cleaners to keep glass clean. Use diluted acids such as Hydrochloric (muriatic) acid when regular cleaners do not seem to work. Do not use wire brushes or any other abrasive materials which could scratch the glass.

INSPECTION
Examine the surface of the glass for scratches, corrosion, chips, cracks, surface flaws, or nicks. To do this, shine a very bright concentrated light at an angle of about 45 degrees. A defective glass will glisten as the light strikes imperfections. Glass which appears cloudy or roughened, and will not respond to cleaning, should be replaced.

STORING
Keep gauge glass in original packaging until ready to install.

1-5334-00 Rev. C

CONBRACO INDUSTRIES, INC.
P.O. BOX 247
MATTHEWS, NORTH CAROLINA 28106
MADE IN U.S.A.
L4079A,B,W
PressureTrol® Limit Control

FEATURES

- L4079A has two ganged SPST switches; breaks two circuits (may be both sides of the power supply) simultaneously.
- L4079B has one SPST switch.
- L4079W is the same as L4079B, but with seals for oil applications.
- MICRO SWITCH® snap-acting switches are visible through transparent cover.
- Switches open automatically, but must be reset manually.
- Trip-free reset mechanisms do not permit the limiting role of the PressureTrol® Control to be defeated by jamming the reset lever.
- Control does not need leveling.
- The L4079 is unaffected by moderate vibration.

APPLICATION

The L4079A,B, and W PressureTrol® Limit Controls are high pressure limit switches which break electrical circuits when pressure rises to a preset value.

The L4079A and B can be used with steam, air, noncombustible gases, and fluids noncorrosive to the sensing element.

L4079W is for use on oil burner systems.

Contents

Application ......................................................... 1
Features ............................................................. 1
Specifications ...................................................... 2
POUR COMMANDER .......................................... 2
French
Installation .......................................................... 3
Wiring ................................................................. 3
SPECIFICATIONS

Models: Pressure and Electrical Specifications: See Table 1.

Table 1. Pressure and Electrical Ratings.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Range</th>
<th>Maximum Diaphragm Pressure</th>
<th>Ratings in Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psi</td>
<td>kPa</td>
<td>120 Vac</td>
</tr>
<tr>
<td>L4079A&lt;sup&gt;a&lt;/sup&gt; and L4079B&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2 to 15</td>
<td>15 to 100</td>
<td>25</td>
</tr>
<tr>
<td>L4079B1066&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5 to 50</td>
<td>35 to 350</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>10 to 150</td>
<td>70 to 1035</td>
<td>225</td>
</tr>
<tr>
<td>L4079W1000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10 to 300</td>
<td>140 to 2070</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>10 to 150</td>
<td>70 to 1035</td>
<td>225</td>
</tr>
</tbody>
</table>

<sup>a</sup> Ratings apply to each of two separate circuits.

<sup>b</sup> One circuit only.

Switching Action:
L4079A—Snap-switch. Breaks two circuits automatically on pressure rise. Each circuit must be manually reset.
L4079B,W—Snap-switch. Breaks one circuit automatically on pressure rise. Circuit must be manually reset.

Adjustment means: External adjustment screw. Scale is calibrated in psi and kPa.

Maximum Ambient Temperature: 150°F (66°C).

Mounting Means:
Pipe fitting—1/4-18 NPT. Steam trap for mounting furnished on some models. These devices may be either boiler mounted directly to a boiler fitting, or may be surface mounted, such as on a wall, by using the knockouts in the case.

Approvals:
Underwriters Laboratories Inc. (UL) Listed: File No. MP466, Guide No. MBPR.
Canadian Standards Association (CSA): File No. L95329, Certificate No. 1720340

Fig. 1. L4079A,B,W PressureTrol® Limit Control dimensions in inches.

ACCESSORIES:
14026 Steam Trap.
33312B Knurled adjustment knob.

Dimensions: See Fig. 1.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:
1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1855 Douglas Drive North
   Minneapolis, Minnesota 55422-4386
In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.
INSTALLATION

When Installing This Product...
1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check on the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

Location
PressureTrol® Limit Controllers must be mounted above the water line in steam boilers. They can be mounted alongside the pressure gauge, at a remote location, in a fitting provided by the boiler manufacturer, or in special mountings on low-water cutoffs.

Mounting
See Fig. 1 for mounting dimensions.

A steam trap must always be connected between the PressureTrol® unit and the boiler. The steam trap prevents boiler scale and corrosive vapors from attacking the diaphragm.

Pressure Gauge Mounting:
To mount the limit control beside a pressure gauge, remove the gauge and install in its place a steam trap with a tee on top. Mount the PressureTrol® unit and pressure gauge on the side of the tee by means of nipples and elbows.

Remote Mounting:
If excessive vibration seems likely to affect the operation of the control, it may be located remotely, as long as all piping is suitable and properly pitched to drain all condensation back to the boiler.

Boiler Mounting:
If it is not convenient to mount the control adjacent to the pressure gauge, install a steam trap at a location on the boiler recommended by the boiler manufacturer and screw the unit directly to the steam trap.

WIRING

⚠️ WARNING
Electrical Shock Hazard. Can cause severe injury, death or property damage. Disconnect the power supply before beginning wiring. More than one power supply disconnect may be required.

All wiring must comply with local codes and ordinances. See Fig. 2 for internal schematics and wiring.

Fig. 2. Schematics and wiring. L4079A breaks both sides of power supply; L4079B,W breaks hot side only.

Setting
To set the control, turn the pressure adjusting screw (see Fig. 3) until the pressure setting indicator on the front of the case is in line with the required control pressure setpoint. The indicator setting is the point at which the switch breaks contact.

Fig. 3. Controls and indicators on L4079A. L4079B,W is the same except for having only one reset button.
Manual Resetting

When the circuits have broken automatically, they must be manually reset. After the pressure returns to normal, manually reset by depressing the manual reset button(s) firmly and releasing. The circuit is not complete until the reset button is released. The trip-free manual reset mechanism prevents the limit controller from operating as an automatic controller (self-resetting) even if the manual reset button has been tied down.

CHECKOUT

After the control has been installed and wired, test as follows:

Note the boiler pressure by checking the boiler pressure gauge (boiler pressure should be near the middle of the PressureTrol® pressure scale to perform this test properly).

Rotate the PressureTrol® pressure adjusting screw (see Fig. 3) until the pressure setting indicator on the front of the case corresponds to the boiler pressure gauge reading.

The limit control should break the control circuit(s) when the boiler pressure gauge reading equals or slightly exceeds the PressureTrol® pressure setting.

If the limit control is operating properly, manually reset it and adjust the pressure adjusting screw until the pressure setting indicator is in line with the required limit setpoint.
L404F, T, V
PressureTrol® Controllers

FEATURES

- Models available in a series of control ranges, and pressure scales in kPa and psi.
- All models automatically reset and have an adjustable differential.
- Models have snap switch to open or close a circuit on a pressure rise.
- Case has a clear plastic cover so setpoints can be observed.
- 1/4 inch—18 NPT connection for pipe on diaphragm assembly.
- Ground screw terminal.

L404F:

- Controllers may be used with steam, air, or noncombustible gases, or fluids noncorrosive to the pressure sensing element.

L404T:

- High pressure limits, break a circuit on oil pressure rise above setpoint.

L404V:

- Low pressure limits, makes a circuit on oil pressure rise above setpoint.

APPLICATION

L404F PressureTrol® Controllers provide operating control with automatic limit protection for pressure systems of up to 2070 kPa, or 300 psi.

L404T,V PressureTrol® Controllers are for use on oil burner systems for pressures up to 1035 kPa or 150 psi.

Contents

Application ............................................................... 1
Features ................................................................. 1
Specifications ......................................................... 2
Ordering Information ................................................ 2
Installation ............................................................. 3
Settings and Adjustments ........................................... 6
Checkout ............................................................... 6
L404F,T,V PRESSURETROL® CONTROLLERS

SPECIFICATIONS

Model:
L404F,T,V PressureTrol® Controllers. See Table 1.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Operating Ranges</th>
<th>Subtractive Differential</th>
<th>Maximum Diaphragm pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kPa</td>
<td>psi</td>
<td>kPa</td>
</tr>
<tr>
<td>L404F1060</td>
<td>15 to 100</td>
<td>2 to 15</td>
<td>15 to 40</td>
</tr>
<tr>
<td>L404F1078</td>
<td>35 to 350</td>
<td>5 to 50</td>
<td>40 to 100</td>
</tr>
<tr>
<td>L404F1094</td>
<td>140 to 2070</td>
<td>20 to 300</td>
<td>140 to 345</td>
</tr>
<tr>
<td>L404F1102</td>
<td>70 to 1035</td>
<td>10 to 150</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404F1219c</td>
<td>15 to 100</td>
<td>2 to 15</td>
<td>15 to 40</td>
</tr>
<tr>
<td>L404F1243c</td>
<td>35 to 350</td>
<td>5 to 50</td>
<td>40 to 100</td>
</tr>
<tr>
<td>L404F1227c</td>
<td>70 to 1035</td>
<td>10 to 150</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404F1235c</td>
<td>140 to 2070</td>
<td>20 to 300</td>
<td>140 to 345</td>
</tr>
<tr>
<td>L404F1300c</td>
<td>415 to 1240</td>
<td>60 to 180</td>
<td>40 fixed</td>
</tr>
<tr>
<td>L404F1326</td>
<td>0 to 100</td>
<td>0 to 15</td>
<td>15 to 40</td>
</tr>
<tr>
<td>L404F1334</td>
<td>0 to 350</td>
<td>0 to 50</td>
<td>40 to 100</td>
</tr>
<tr>
<td>L404F1342</td>
<td>35 to 1000</td>
<td>5 to 145</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404F1359</td>
<td>70 to 2000</td>
<td>10 to 290</td>
<td>140 to 345</td>
</tr>
<tr>
<td>L404F1367</td>
<td>7 to 55</td>
<td>1 to 8</td>
<td>5 to 14</td>
</tr>
<tr>
<td>L404F1375c</td>
<td>35 to 350</td>
<td>5 to 50</td>
<td>40 to 100</td>
</tr>
<tr>
<td>L404F1383c</td>
<td>70 to 1035</td>
<td>10 to 150</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404F1391c</td>
<td>140 to 2070</td>
<td>20 to 300</td>
<td>140 to 345</td>
</tr>
<tr>
<td>L404F1409d</td>
<td>15 to 100</td>
<td>2 to 15</td>
<td>15 to 40</td>
</tr>
<tr>
<td>L404T1055</td>
<td>35 to 350</td>
<td>5 to 50</td>
<td>40 to 100</td>
</tr>
<tr>
<td>L404T1063</td>
<td>70 to 1035</td>
<td>10 to 150</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404V1087d</td>
<td>70 to 1035</td>
<td>10 to 150</td>
<td>70 to 150</td>
</tr>
<tr>
<td>L404V1095d</td>
<td>35 to 350</td>
<td>5 to 50</td>
<td>40 to 100</td>
</tr>
</tbody>
</table>

a Nominal at midscale operating range.

b Brass bellows instead of stainless steel diaphragm.
c Models with 1/4-19 BSPT thread instead of 1/4-18 NPT thread.
d Make-on-rise models with terminal B omitted for miswiring compliance.

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Honeywell Automation and Control Products Sales Office (check white pages of your phone directory).
2. Honeywell Customer Care
   1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.
Table 2. Conversion Table.

<table>
<thead>
<tr>
<th></th>
<th>Operating Range Conversions</th>
<th>Subtractive Differential Conversions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/cm²</td>
<td>kPa</td>
</tr>
<tr>
<td>0.1 to 1.05</td>
<td>15 to 100</td>
<td>2 to 15</td>
</tr>
<tr>
<td>0.4 to 3.5</td>
<td>35 to 350</td>
<td>5 to 50</td>
</tr>
<tr>
<td>0.7 to 10.0</td>
<td>70 to 1035</td>
<td>10 to 150</td>
</tr>
<tr>
<td>1.5 to 20.0</td>
<td>140 to 2070</td>
<td>20 to 300</td>
</tr>
</tbody>
</table>

Table 3. Switch Ratings (Amperes).

<table>
<thead>
<tr>
<th>Switch State</th>
<th>120 Vac</th>
<th>240 Vac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Load</td>
<td>8.0</td>
<td>5.1</td>
</tr>
<tr>
<td>Locked Rotor</td>
<td>48.0</td>
<td>30.6</td>
</tr>
</tbody>
</table>

Pressure Sensing Element: Stainless steel diaphragm (140 to 2070 kPa models) has brass bellows.

Maximum Ambient Temperature: 68°C (150°F). Also, refer to note under Mounting.

Adjustment Means: Screws on top of control case. Scales are marked in psi or kPa.

Mounting Means: 1/4 inch-18 NPT connection on diaphragm assembly; or surface mounts using holes in back of case.

Dimensions: See Fig. 1.

Switching Action: Snap switch breaks R-B (closes R-W) on pressure rise. Make-on-rise devices omit terminal B.

Grounding Means: Ground screw terminal marked with a circled ground symbol.

Accessories:
14026 Steam Trap (118023 for BSPT models),
333128 Knurled Knob—fits on top of adjusting screws,
128564 Range Stop—range stop screw, Part No. 107194, and wrench, Part No. 23466, to limit setpoint range.

Approvals:
Underwriters Laboratories Inc. Listed: file no. MP466, vol. 10, guide no. MBPR.
Canadian Standard Association certified: file no. LR1620, guide no. 400E-0.

Fig. 1. L404F,T,V approximate dimensions in inches (millimeters in parentheses).

**INSTALLATION**

When Installing This Product...
1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check on the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

**IMPORTANT**

When making pipe connections, use pipe dope sparingly to seal the joints; any excess dope may clog the small hole in the fitting and prevent the controller from operating properly.

**Location and Mounting (L404F)**

Locate the L404F where the ambient temperature will not exceed 65°C (150°F). The L404F can be mounted near the pressure gauge, at a remote location, in a fitting provided by the boiler manufacturer, or in a special mounting on low water cutoffs. The L404F should always be mounted above the water line in steam boiler applications.

**NOTE:** For accurate operation, supplemental heat should be added to installations where temperatures fall below -29°C (-20°F).

A steam trap must be connected between the L404F and the boiler (see Fig. 2) to prevent boiler scale and corrosive vapors from attacking the elbows or diaphragm.

![Steam trap mounting](image)

**Fig. 2. Steam trap mounting.**

**Pressure Gauge Mounting**

To mount beside a pressure gauge, remove the gauge, and install its place the steam trap with a tee on top. Mount the PressureTrol® unit and pressure gauge on the side of the tee by means of nipples and elbows (see Fig. 2).

**Remote Mounting**

Excessive vibration at the boiler may affect the operation of the L404F. In these cases, the L404F should be remotely located, subject to the following:

1. All piping must be suitable and properly pitched to drain all condensation back to the boiler.
2. The remote mounting must be solid.
3. A steam trap must be used at one end of the piping.

**Boiler Mounting**

If it is not convenient to mount the L404F adjacent to the pressure gauge, install a steam trap at the location recommended by the boiler manufacturer, then screw the device directly to the steam trap.

**Location and Mounting (L404T,V)**

**Location**

**NOTE:** For most accurate operation, supplemental heat should be added to installations where the temperature falls below -20°F (-29°C). These controllers can be mounted at any location in the oil supply line, depending on the application. Typical locations are shown in Fig. 3. The low oil pressure controller should be located upstream from the safety shutoff valve(s). In a downstream location, there would be zero pressure when the burner is not running and the safety shutoff valve(s) is (are) closed. This could prevent startup or require manual reset every time the burner is started. The high oil pressure controller should be located as near to the burner as possible.

**Mounting**

Mount the oil pressure controller directly on the main pipe. Insert a tee in the pipe line, and connect a pipe nipple of appropriate size to the tee (see Fig. 4). Screw the hexagonal fitting (1/4-18 NPT internal thread) of the pressure controller to the pipe nipple. To avoid leaks and damage to the case, use a parallel jaw wrench on the hexagonal fitting close to the pipe nipple. Do not tighten the pressure controller by hand by holding the case.

Make all pipe connections in accordance with approved standards. Use only a small amount of pipe compound to seal the connection joints. Excess pipe compound may clog the orifice in the pipe fitting and prevent the controller from operating properly.

![Typical locations of pressure controllers in an oil burner system](image)

**Fig. 3. Typical locations of pressure controllers in an oil burner system.**
Using with Preheated Oil
When used with preheated oil, a siphon loop (part number 14026) must always be connected between the controller and the main pipe (see Fig. 5) to provide thermal buffering.

WIRING

**WARNING**

Electrical Shock Hazard.
Can cause severe injury, death or property damage.
Disconnect the power supply before beginning wiring.
More than one power supply disconnect may be required.

All wiring must comply with applicable codes and ordinances.
All models have terminals (on the MicroSwitch® snap-acting switch) inside the cover and knockouts for conduit and cable.
Refer to manufacturer installation and wiring instructions, if available, and to typical hookups shown in Fig. 6 to 10.
SETTLEMENTS AND ADJUSTMENTS

When the pressure at the control rises above the L404 setpoint, a circuit opens between the R-B terminals. During a pressure fall, R-B will close at the setpoint pressure minus the switch differential.

For example, if a controller is set to differential B (see Fig. 11) with a controller setpoint of A, R-B will open when the pressure rises to A. Then during a pressure fall, the R-B terminals will close when the pressure drops to C (A minus differential B).

For make on rise applications, the switch is wired to R-W terminals. The R-W circuit will close on pressure rise to the setpoint. R-W will open again on a pressure drop past the switch differential.

Scaleplate Adjustment

The L404F,T,V has been carefully calibrated during manufacture and should not require recalibration.

However, if recalibration is necessary, remove the cover and loosen the setscrews which hold the scaleplate. Adjust the plate up or down, as required, to bring the device into calibration. Tighten the setscrews securely and replace the cover.

CHECKOUT

After the controller has been installed, wired and adjusted, it should be tested with the system in operation. First, allow the system to stabilize. Then, observe the operation of the controller while raising and lowering its setpoint. Pressure should increase when the setpoint is raised and decrease when the setpoint is lowered.

Also, check the make and break points of the controller. If they do not agree with a separate, accurately calibrated pressure gauge, a slight adjustment of the scaleplate(s) may be necessary.

Use accurate pressure testing equipment when checking out the controller. Do not rely on inexpensive gauges. The controllers are carefully calibrated at the factory.
Pre-Installation Handling
This pressure relief valve is designed to protect equipment from overpressure. The valve should be handled with care, not subjected to heavy shock loads, and protected to prevent contamination from getting inside. It should be installed correctly per A.S.M.E. Boiler & Pressure Vessel Code requirements. Failure to do so could result in property damage or serious injury to personnel. When hoisting the valve into position for installation, care should be exercised so that lifting straps do not contact the valve lift lever.

Installation
Always wear proper safety equipment, including safety glasses and ear protection.

1. Mount the valve in a vertical position so that the valve body is self-draining. If a body drain port is provided, make sure it is open when required by the ASME code. Do not plug any bonnet vent openings. The inlet piping should be as short as possible, with no elbows, and equal to or greater than the size of the pressure relief valve inlet connection. This will help to limit the inlet pressure drop to 3% or less when the valve is relieving.

2. When discharge piping is connected to valve outlet, make sure it is self draining if a body drain port is not used. The valve should not be connected to any discharge pipe that contains pressure before the valve opens or to any pipe where the pressure build-up is greater than 10% of the set pressure when the valve is open and relieving.

Discharge piping, other than a short tailpipe, must be supported. For steam service, a drip pan elbow or flexible connection between the valve and the pipe should be used to prevent excessive pipe stress, due to thermal expansion, from being imposed on the valve body.

3. For threaded valves, to prevent sealing compound from entering and damaging the valve, apply a small amount of pipe thread sealing compound to external threads only. Do not put any sealing compound on the first thread or on any internal threads. To do so may cause the sealing compound to enter the valve and cause seat leakage.

Do not use the valve body or bonnet for installing the valve in threaded connections. Use the wrench flats provided to tighten the valve to the connecting pipe, and do not overtighten. To do so may cause valve leakage.

4. For flanged valves, use new gaskets and tighten the mounting studs evenly.

Operation
1. Maintain a system operating pressure at least 5 psig or 10% below the set pressure of the valve, whichever is greater. Operating too close to the valve set pressure will cause seat leakage and will shorten the time between valve maintenance.

2. Do not use the safety valve as a control valve to regulate system operating pressure. Excessive operation will cause the seat to leak and will require more frequent valve maintenance.

3. ASME Section I and VIII valves equipped with lift levers are designed to be operated only when the system pressure is 75% of set pressure or greater. ASME Section IV valves may be operated at any set pressure. When hand operating the valve, hold it open long enough to purge any foreign matter from the seat area. If a cable or wire is attached to the lift lever for remote actuation, make sure the direction of pull is the same as it would be if the lever were pulled directly by hand.

Maintenance
Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions and the condition of the valve, the inspection interval may be decreased or increased. Use only Kunkle parts for repair. Depending on the local jurisdictional requirements where the valve is installed, repairs may have to be made by a repair facility holding a VR stamp.

WARNING!
Removal of the seal wires or any attempt to adjust, repair or modify this product by non-qualified or non-authorized persons voids the product guarantee and may cause serious damage to equipment, personal injury, and death. Kunkle Valve is not liable for any damage resulting from misuse or misapplication of its products.
Gas Appliance
Pressure Regulators

Straight-Thru-Flow Design

RV52, RV53, RV61, RV81, RV91, RV111, and RV131
1/2", 3/4", 1", 1¼", 1½", 2", 2½", 3" & 4"

Maximum Pressure
CSA Rated (except RV131) ............ 1/2 psi (35 mbar)
Maxitrol Tested*
RV52 & RV53 ......................... 1/2 psi (35 mbar)
RV61, RV81, RV91, & RV111 ...... 1 psi (70 mbar)
RV131 .................................. 2 psi (140 mbar)
* Do not use if inlet pressure is more than 10 times
   desired outlet pressure

EMERGENCY EXPOSURE LIMITS (Maxitrol Tested)
RV52 & RV53 .......................... 3 psi (210 mbar)
RV61, RV81, RV91 & RV111 ........ 5 psi (350 mbar)
RV131 .................................. 15 psi (1050 mbar)

GAS CONTAINMENT EXPOSURE LIMITS*
RV52 & RV53 .......................... 15 psi (1050 mbar)
RV61, RV81, RV91, RV111,
& RV131 ................................. 25 psi (1750 mbar)
* Please note that internal damage may occur when
   exposed to these pressures.

AMBIENT TEMPERATURE LIMITS
RV52, RV53, RV61, RV81,
RV91 & RV111 ...................... -40° to 205° F (-40° to 96° C)
RV131 .................................. -40 to 125° F (-40 to 52° C)

GASES: Natural, manufactured, mixed, liquefied
   petroleum, or LP gas-air mixture.
All models except RV131 are CSA design certified for 1/2 psi rated pressure under the ANSI standard for gas pressure regulators; and CSA listed to certify compliance with nationally published safety, construction, and performance standards.

They are main burner only, non-lockup type. They should not be used as a line gas pressure regulator ahead of low pressure controls. Use only where downstream controls can operate at line pressure. Refer to other Maxitrol sales bulletins for proper types.

The RV52, RV53, & RV61 are suitable for multipoise mounting. The RV81, RV91, RV111, & RV131 are recommended for normal horizontal position only.

Maxitrol’s original Straight-Thru-Flow design meets your needs for high capacities at low inlet pressures. The basic difference between S-T-F design and other type regulators lies in the conical valve. The cone principal permits gas to flow straight through the regulator without changing directions. Frictional flow resistance is reduced, resulting in greater capacity.

The improved flow pattern provides accurate sensitive regulation at extremely low pressure differentials. The ability of the regulator to handle large capacity appliances with limited supply pressure offers a definite advantage to designers of commercial and industrial gas-fired equipment. Models up to the three inch pipe size have high strength pressure cast aluminum housings. The RV131 four inch model is of cast iron and steel construction. RV61, RV81, RV91, RV111, & RV131 internal conical valves are coated with Teflon® for long life. Diaphragm material is cut from the finest synthetic coated fabrics available. All other parts are carefully specified corrosion-resistant or plated material.

Pipe sizes of 1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", and 4" are available. Models through the 3" size are threaded, the 4" RV131 is flanged.

At the emergency exposure limits, there may be no regulation, but all models will contain gas. They will suffer no internal damage and will resume regulation when normal pressure is restored.

Straight-Thru-Flow appliance regulators are intended for use with all fuel gases, and may also be used with air or other noncorrosive gases within their pressure limits.

Typical applications include all types of residential, commercial and industrial gas-fired appliances and equipment used on low pressure gas supply. See Maxitrol’s “Spring Selection Chart” for part numbers, color and size of springs.

NOTE: All Maxitrol appliance regulators should be installed in accordance with Maxitrol’s “Safety Warning” bulletin.

Teflon is a registered trademark of DuPont Corporation.
Sizing Instructions

In order to select the proper size regulator, you must know the available inlet pressure, desired outlet pressure, and the required maximum flow rate.

Example No. 1—To select a regulator of ample capacity to handle flow.

**KNOWN:**
Pipe size 2-1/2", flow rate 8,000 CFH (0.64 sp gr), inlet pressure 9" w.c., desired outlet pressure 5" w.c.

**SOLUTION:**
1. Determine differential pressure available:
   - Inlet pressure 9" w.c.
   - Subtract outlet pressure 5" w.c.
   - Available differential pressure 4" w.c.

2. When determining capacity, Maxitrol recommends that the pressure drop not exceed 1/2 of available differential pressure (1/2 of 4" w.c. = 2" w.c.).

3. Check Capacity Chart to determine which regulator has a pressure drop of 2" w.c. or less at 8,000 CFH. The RV111 meets this standard with a flow rate of 12,134 CFH for the 2-1/2" pipe size at 2" w.c. pressure drop. The 2-1/2" RV91 flows 5422 CFH at 2" w.c. pressure drop. Therefore, the RV111—2-1/2" is the correct regulator to use.

Example No. 2—To determine maximum recommended operating outlet pressure.

**KNOWN:**
Pipe size 4", flow rate 21,000 CFH, inlet pressure 10" w.c.

**SOLUTION:**
1. Check capacity Chart above for 4" regulator, RV131.
2. Note that at a flow rate of 21,172 CFH the pressure drop is 2" w.c.
3. Multiply this by two to obtain recommended differential pressure (4" w.c.).
4. Subtract 4" differential pressure from 10" w.c. inlet pressure to obtain maximum recommended outlet pressure setting of 6" w.c.
Dimensions and Spring Ranges

DIMENSIONS*—inches (millimeters)

<table>
<thead>
<tr>
<th>Model &amp; Illustration Number</th>
<th>Vent Tap</th>
<th>Swing Radius</th>
<th>Call-Outs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>RV52</td>
<td>1/8&quot; NPT</td>
<td>3.6 (91)</td>
<td>4.9 (124)</td>
</tr>
<tr>
<td>RV53</td>
<td>1/8&quot; NPT</td>
<td>3.9 (99)</td>
<td>5.2 (132)</td>
</tr>
<tr>
<td>RV61</td>
<td>1/8&quot; NPT</td>
<td>4.8 (122)</td>
<td>6.4 (164)</td>
</tr>
<tr>
<td>RV81</td>
<td>3/8&quot; NPT</td>
<td>6.4 (162)</td>
<td>8.4 (213)</td>
</tr>
<tr>
<td>RV91 2° pipe</td>
<td>1/2&quot; NPT</td>
<td>8.5 (216)</td>
<td>10.8 (275)</td>
</tr>
<tr>
<td>RV91 2.5&quot; pipe</td>
<td>1/4&quot; NPT</td>
<td>8.3 (212)</td>
<td>10.5 (267)</td>
</tr>
<tr>
<td>RV111</td>
<td>3/4&quot; NPT</td>
<td>11.5 (284)</td>
<td>15.1 (373)</td>
</tr>
<tr>
<td>RV131</td>
<td>3/4&quot; NPT</td>
<td>18.2 (462)</td>
<td>23.25 (590)</td>
</tr>
</tbody>
</table>

* Dimensions are to be used only as an aid in designing clearance for the valve. Actual production dimensions may vary somewhat from those shown.

SPRING SELECTION CHART—inches w.c. (mbar)

<table>
<thead>
<tr>
<th>Model Number</th>
<th>CSA Certified Springs</th>
<th>Other Springs Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV52</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV53</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV61</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV81</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV91</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV111</td>
<td>3 to 6 (7.5-15)</td>
<td>4-8 (10-20)</td>
</tr>
<tr>
<td>RV131</td>
<td>3 to 6 (7.5-15)</td>
<td>5-12 (12.5-30)</td>
</tr>
</tbody>
</table>

NOTE: The area within the heavy line indicates CSA certified springs.

A copyrighted publication of Maxitrol Company

www.maxitrol.com

Maxitrol Company
23555 Telegraph Rd., P.O. Box 2230
Southfield, MI 48037-2230 U.S.A.
248.356.1400 • Fax 248.356.0829

European Representatives
Warnstedter Strasse 3 06502 Thale, Germany
49.3947.400.0 • Fax 49.3947.400.200
Industriestrasse 1 48308 Senden, Germany
49.2597.9632.0 • Fax 49.2597.9632.99
SAFETY WARNING INSTRUCTIONS
FOR MAXITROL GAS PRESSURE REGULATORS

NOTE: GAS PRESSURE REGULATORS WILL NOT TURN OFF THE FLOW OF GAS.

SPECIAL WARNINGS
IF YOU DO NOT FOLLOW THESE INSTRUCTIONS EXACTLY, A FIRE OR EXPLOSION MAY RESULT CAUSING PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE. NO UNTRAINED PERSON SHOULD ATTEMPT TO INSTALL, MAINTAIN OR SERVICE GAS PRESSURE REGULATORS.

To minimize the possibility of FIRE, EXPLOSION, and OTHER HAZARDS:

1. All products, including gas pressure regulators, used with combustible gas must be installed and used strictly in accordance with the instructions of the manufacturer, with government codes and regulations, and plumbing codes and practices.

2. Do not use a gas pressure regulator if it appears to have been subjected to high temperatures, damaged in any way, or to have been taken apart or tampered with. Any of these may be signs of possible leakage or other damage that may affect proper operation and cause potentially dangerous combustion problems.

3. 
   a. Install the regulator properly with gas flowing as indicated by the arrow on the casting.
   b. Use pipe compound or thread sealant, properly threaded pipes and careful assembly procedure so that there is no cross threading, etc., which might cause damage or leakage.
   c. Apply wrench or vise pressure only to the flat areas around the pipe tappings at the end being threaded to the pipe to avoid possible fracture of the regulator body which could result in leakage.
   d. Make sure markings or wording on regulator are not painted over or obliterated.

4. Check carefully for gas leaks immediately after the regulator has been installed and the gas turned on. Do this before attempting to operate the appliance or other gas burning device. Use a rich soap solution (or other accepted leak tester) around the diaphragm flanges, bottom plate, vent opening, seal cap, pipe connections, and all other joints. Wipe clean with a damp rag. It is a good practice to periodically check for leakage during use of the appliance. Absolutely no leakage should occur, otherwise there is a danger of fire or explosion depending upon conditions. Never use if leakage is detected.

CAUTION
NEVER CONNECT REGULATOR DIRECTLY TO THE PROPANE SUPPLY SOURCE. MAXITROL REGULATORS REQUIRE AN EXTERNAL REGULATOR (NOT SUPPLIED). INSTALL THE EXTERNAL REGULATOR BETWEEN THE PROPANE SUPPLY SOURCE AND MAXITROL REGULATOR.

5. Very high pressure surges in the gas supply line (or as a result of exposing the system to high pressure) may result in serious internal damage and cause leakage or affect regulator operation. If you suspect that a Maxitrol regulator has been exposed to more than twice the maximum operating inlet pressure, as shown in the following chart, turn off the gas and have the system checked by an expert.

INTRUCCIONES PARA PRECAUCIONES DE SEGURIDAD
PARA REGULADORES DE PRESION DE GAS MAXITROL

NOTA: LOS REGULADORES DE PRESION DE GAS NO CORTAN EL FLUJO DE GAS

¡PRECAUCIONES ESPECIALES!
SI USTED NO SIGUE ESTAS INSTRUCCIONES EXACTAMENTE, PUEDE OCURRIR UN INCENDIO O UNA EXPLOSION, CAUSANDO DANOS A LA PROPIEDAD, LESIONES PERSONALES O PERDIDA DE VIDAS. NADIE QUE NO HAYA SIDO ENTRENADO DEBERA DE TRATAR DE INSTALAR, DAR SERVICIO O DAR MANTENIMIENTO A LOS REGULADORES DE PRESION DE GAS

Para reducir la posibilidad de INCENDIO, EXPLOSION Y OTROS RIESGOS:

1. Todos los productos, incluyendo los reguladores de presión de gas, que se usan con gases combustibles deberán instalarse y usarse estrictamente de acuerdo con las instrucciones del fabricante, usando los códigos y reglamentos gubernamentales así como los códigos y prácticas de plomería.

2. No usar un regulador de presión de gas si parece haber estado expuesto a altas temperaturas, dañado en alguna forma o que se haya desmantelado o maltratado. Cualquiera de éstas pueden ser señales de posibles fugas u otros daños que pueden afectar el funcionamiento correcto y causar problemas de combustión potencialmente peligrosos.

3. 
   a. Instalar el regulador correctamente con el gas fluyendo como se indica en la flecha en la carcasa de fundición.
   b. Usar un compuesto sellador de tubería o hilo sellador de rosca, tuberías correctamente roscadas y procedimientos de ensamble cuidadosos, asegurándose de que no haya trasroscados, lo cual podría causar daños o fugas.
   c. Aplicar únicamente la presión de una llave o tornillo de banco en las áreas planas alrededor de las roscas de la tubería del extremo a enroscar para evitar la posible rotura del cuerpo del regulador que podría resultar en fugas.

4. Verificar inmediatamente que no haya fugas de gas después de que el regulador haya sido instalado y se haya abierto el paso del gas. Este deberá hacerse antes de tratar de operar el aparato electrodoméstico o cualquier otro dispositivo quemador de gas. Usar una solución espesa de jabón (u otro probador de fugas aceptado) alrededor de las bridas del diaphragma, el fondo del plato, la apertura de ventilación, la tapa selladora y las conexiones de la tubería y todas las demás juntas. Limpiar con un trapo húmedo. Es una buena práctica verificar periódicamente que no haya fugas durante el uso del aparato electrodoméstico. Absolutamente no deberá haber ninguna fugas. De otra forma hay peligro de incendio o explosión dependiendo de las condiciones. Nunca deberá usarse si se detectan fugas.

CAUTION
NUNCA CONECTAR EL REGULADOR DIRECTAMENTE AL SUMINISTRO DE PROPANO. LOS REGULADORES MAXITROL REQUIEREN UN REGULADOR EXTERNO (NO PROVISTO). INSTALAR EL REGULADOR EXTERNO ENTRE EL SUMINISTRO DE PROPANO Y EL REGULADOR MAXITROL.

5. Aumentos grandes de presión en la línea de suministro de gas (o como resultado de exponer el sistema a alta presión) pueden resultar en daños internos y causar fugas o afectar el funcionamiento del regulador. Si usted sospecha que un regulador Maxitrol ha sido expuesto a más del doble de la presión máxima de entrada, como se muestra en la tabla siguiente, cierre el paso del gas y haga que el sistema sea verificado por un experto.

(over)

MAXITROL®
23555 Telegraph Rd. • P.O. Box 2230 • Southfield, MI U.S.A. 48037-2230
Phone 248.356.1400 • Fax 248.356.0829
www.maxitrol.com
6. Venting must be controlled in accordance with government and plumbing codes and regulations to avoid the danger of escaping gas should there be internal leakage. Vent pipes must be open and the open end protected against entry of foreign matter, including water.

7. The outlet pressure of the regulator must be measured to make sure its is in accordance with intended usage. If a spring change is required to develop the required outlet pressure, the spring must be one specified by MAXITROL.

8. Caution should be used to guarantee that there is sufficient inlet pressure to achieve the desired outlet pressure and no readjustment of the outlet pressure setting should be made unless the inlet pressure is within the proper limits for the regulator. Failure to follow this may result in overfiring of the appliance or other gas burning device. The MAXITROL bulletin for the regulator should be consulted for specific inlet and outlet pressure relationships.

9. A MAXITROL regulator must be used within the temperature range and not in excess of the maximum inlet pressure shown in the following table and should be in the mounting position indicated. Maxitrol regulators can be used with all fuel gases.

10. In case of any doubt, please contact the Service Manager, Maxitrol Company, Southfield, MI USA. Phone: 248/356-1400.

<table>
<thead>
<tr>
<th>Model Number (Número de Modelo)</th>
<th>Maximum Operating Inlet Pressure (Presión Mínima de Entrada para Operación)</th>
<th>Ambient Temperature Range (Rango de Temperatura Ambiente)</th>
<th>Mounting Position [see below] (Posición de Montaje) [ver abajo]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV12LT, RV20LT</td>
<td>1/2 psi (34 mbar)</td>
<td>-40° to 275° F (-40° to 135° C)</td>
<td>A, B, C, D</td>
</tr>
<tr>
<td>RV20L</td>
<td>2 psi (138 mbar)</td>
<td>-40° to 225° F (-40° to 107° C)</td>
<td>A, B, C, D</td>
</tr>
<tr>
<td>RV47, RV48 (*1)</td>
<td>1/2 psi (34 mbar)</td>
<td>32° to 225° F (0° to 107° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>RV48T (*1)</td>
<td>1/2 psi (34 mbar)</td>
<td>32° to 275° F (0° to 135° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>RV52, RV53, (*1)</td>
<td>1/2 psi (34 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>RV61, (*1)</td>
<td>1 psi (69 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>RV81, RV91</td>
<td>1 psi (69 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>RV111</td>
<td>1 psi (69 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>RV131</td>
<td>2 psi (138 mbar)</td>
<td>-40° to 125° F (-40° to 52° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>R400, R500, R600, (*1)</td>
<td>1 psi (69 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>R400S, R500S, R600S, (*1)</td>
<td>5 psi (345 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>R400Z, R500Z, R600Z</td>
<td>1 psi (69 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
<tr>
<td>210D, E, G, J</td>
<td>10 psi (690 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>210DZ, EZ, GZ, JZ</td>
<td>5 psi (345 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>220D, E, G, J</td>
<td>10 psi (690 mbar)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A only (unicamente)</td>
</tr>
<tr>
<td>325-3 (*1), 325-5A (*1), 325-7</td>
<td>10 psi (690 mbar) (*1)</td>
<td>-40° to 205° F (-40° to 96° C)</td>
<td>A, B, C, D, (*1)</td>
</tr>
</tbody>
</table>

(*1) When equipped with a ball-check type automatic vent limiting device (12A04, 12A09, 12A39), regulators must be in upright position (A) with non-integral vent limiter installed directly into vent threads. Any other mounting position may interfere with lockup or cause pilot outage, where applicable. Maximum inlet pressure for regulators with 12A09 or 12A39 is 2 psi (LP) or 5 psi (natural). Inlet pressures exceeding 2 psi (LP) or 5 psi (natural) require a vent line.

(*1) Para estar seguro que el regulador responde con rapidez cuando está equipado con un dispositivo limitador de ventilación automática tipo bola (12A04, 12A09, 12A39), los reguladores deberán estar en posición vertical (A) con el limitador de ventilación instalado directamente a las roscas del tubo de ventilación. Si se usa cualquier otra posición durante su instalación, esto podrá interferir con el cierre o causar que el piloto se apague. La presión máxima de admisión para reguladores con los dispositivos 12A09 o 12A39 es de 2 psi (gas licuado) o 5 psi (gas natural). Las presiones de admisión que excedan 2 psi (gas licuado) o 5 psi (gas natural) requerirán una línea de ventilación.
Series 150 and 157
(Mercury Switch)

Series 150S and 157S
(Snap Switch, All Models except 157S-RB-P)

Low Water Cut-Off/Pump Controllers
For Steam Boilers and Other Level Control Applications

Typical Applications:
– Primary or secondary pump controller/
  low water fuel cut-off
  for steam boilers
– Motorized valve controller
– Low water cut-off
– High water cut-off
– Alarm actuator

⚠️ WARNING

• Before using this product read and understand instructions.
• Save these instructions for future reference.
• All work must be performed by qualified personnel trained in the proper application, installation, and maintenance of plumbing, steam, and electrical equipment and/or systems in accordance with all applicable codes and ordinances.
• To prevent serious burns, the boiler must be cooled to 80°F (27°C) and the pressure must be 0 psi (0 bar) before servicing.
• To prevent electrical shock, turn off the electrical power before making electrical connections.
• This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.
• We recommend that secondary (redundant) Low Water Cut-Off controls be installed on all steam boilers with heat input greater than 400,000 BTU/hour or operating above 15 psi of steam pressure. At least two controls should be connected in series with the burner control circuit to provide safety redundancy protection should the boiler experience a low water condition. Moreover, at each annual outage, the low water cut-offs should be dismantled, inspected, cleaned, and checked for proper calibration and performance.
• To prevent serious personal injury from steam blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.
• To prevent a fire, do not use this low water cut-off to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.

Failure to follow this warning could cause property damage, personal injury or death.
OPERATION

**Maximum Pressure:** 150 psi (10.5 kg/cm²)

**Enclosure rating:** NEMA 1 General Purpose

### Electrical Ratings

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Pump Circuit Rating (Amperes)</th>
<th>Pilot Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 VAC</td>
<td>7.4</td>
<td>44.4</td>
</tr>
<tr>
<td>240 VAC</td>
<td>3.7</td>
<td>22.2</td>
</tr>
</tbody>
</table>

120 or 240 VAC

### Alarm Circuit Rating

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 VAC</td>
<td>1</td>
</tr>
<tr>
<td>240 VAC</td>
<td>1/2</td>
</tr>
</tbody>
</table>

### Motor Horsepower

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Hp</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 VAC</td>
<td>1/3</td>
</tr>
<tr>
<td>240 VAC</td>
<td>1/3</td>
</tr>
</tbody>
</table>

### Settings and Differential Pressures

Values are ± 1/8” (3.2mm).

#### Series 150, 150S, 157 and 157S

<table>
<thead>
<tr>
<th>Pressure (0 kg/cm²)</th>
<th>Setting</th>
<th>Differential Setting</th>
<th>Approximate Distance Above Cast Line In. (mm)</th>
<th>Differential In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 psi (0 kg/cm²)</td>
<td>Pump Off</td>
<td>15/16 (24)</td>
<td>5/16 (8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump On</td>
<td>5/8 (16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner On</td>
<td>5/8 (16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>1/4 (6.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 psi (10.5 kg/cm²)</td>
<td>Pump Off</td>
<td>13/8 (41)</td>
<td>3/4 (19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump On</td>
<td>5/8 (16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner On</td>
<td>7/8 (22)</td>
<td>7/8 (22)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Model 150-MD, 150S-MD, 157-MD and 157S-MD

<table>
<thead>
<tr>
<th>Pressure (0 kg/cm²)</th>
<th>Setting</th>
<th>Differential Setting</th>
<th>Approximate Distance Above Cast Line In. (mm)</th>
<th>Differential In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 psi (0 kg/cm²)</td>
<td>Pump Off</td>
<td>15/16 (24)</td>
<td>3/8 (16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump On</td>
<td>9/16 (14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 psi (10.5 kg/cm²)</td>
<td>Pump Off</td>
<td>17/16 (37)</td>
<td>3/4 (19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump On</td>
<td>11/16 (17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>- 3/8 (-16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 150 psi (10.5 kg/cm²) Levels

- **13/16” DIFFERENTIAL** (35mm)
  - Normal Boiler Water Line
  - Burner "Cut-Off Level" at Cast Line
- **3/4” DIFFERENTIAL** (19mm)
  - Pump Off
  - Pump On
- **7/8” DIFFERENTIAL** (22mm)
  - Burner On
  - Burner Off
- **113/16” DIFFERENTIAL** (46mm)
  - Normal Boiler Water Line
  - Burner Cut-Off Level 3/8” (9.5mm) Below Cast Line
Settings and Differential Pressures (continued)

Values are ± ¼” (3.2mm).

### Model 158/158S

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Setting</th>
<th>Approximate Distance Above Cast Line In. (mm)</th>
<th>Differential In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 psi (0 kg/cm²)</td>
<td>Motorized Valve Closed</td>
<td>15/16 (24)</td>
<td>5/16 (8)</td>
</tr>
<tr>
<td></td>
<td>Motorized Valve Open</td>
<td>5/8 (16)</td>
<td>3/8 (16)</td>
</tr>
<tr>
<td></td>
<td>Burner On</td>
<td>5/8 (16)</td>
<td>3/8 (16)</td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>1/4 (6.4)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td>150 psi (10.5 kg/cm²)</td>
<td>Motorized Valve Closed</td>
<td>13/8 (41)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>Motorized Valve Open</td>
<td>5/8 (16)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>Burner On</td>
<td>7/8 (22)</td>
<td>7/8 (22)</td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

150 psi (10.5 kg/cm²) Levels

- **13/8” (35mm) Differential**: When the motorized valve is closed, the burner is below the normal boiler water line. When the motorized valve is open, the burner is 3/4” (19mm) above the cast line.
- **7/8” (22mm) Differential**: When the motorized valve is closed, the burner is below the normal boiler water line. When the motorized valve is open, the burner is 7/8” (22mm) below the normal boiler water line.

NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

### Model 158-MD/158S-MD

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Setting</th>
<th>Approximate Distance Above Cast Line In. (mm)</th>
<th>Differential In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 psi (0 kg/cm²)</td>
<td>Pump Off</td>
<td>15/16 (24)</td>
<td>3/8 (16)</td>
</tr>
<tr>
<td></td>
<td>Pump On</td>
<td>9/16 (14)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>0 (0)</td>
<td>N/A</td>
</tr>
<tr>
<td>150 psi (10.5 kg/cm²)</td>
<td>Pump Off</td>
<td>11/16 (17)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>Burner Off</td>
<td>- 3/8 (-16)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

150 psi (10.5 kg/cm²) Levels

- **13/16” (36mm) Differential**: When the motorized valve is closed, the burner is below the normal boiler water line. When the motorized valve is open, the burner is 3/4” (9.5mm) below the cast line.

NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.
Settings and Differential Pressures (continued)

Values are ± 1/6” (3.2mm).

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Setting</th>
<th>Approximate Distance Above Cast Line In. (mm)</th>
<th>Differential In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 psi (0 kg/cm²)</td>
<td>Pump #1 Off</td>
<td>15/16 (24)</td>
<td>5/16 (8)</td>
</tr>
<tr>
<td></td>
<td>Pump #1 On</td>
<td>5/8 (16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump #2 Off</td>
<td>5/8 (16)</td>
<td>3/8 (16)</td>
</tr>
<tr>
<td></td>
<td>Pump #2 On</td>
<td>1/4 (6.4)</td>
<td></td>
</tr>
<tr>
<td>150 psi (10.5 kg/cm²)</td>
<td>Pump #1 Off</td>
<td>13/8 (41)</td>
<td>3/4 (19)</td>
</tr>
<tr>
<td></td>
<td>Pump #1 On</td>
<td>5/8 (16)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump #2 Off</td>
<td>7/8 (22)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump #2 On</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

150 psi (10.5 kg/cm²) Levels

- 1 3/8” Differential (35mm)
- 3/4” Differential (19mm)
- 7/8” Differential (22mm)
INSTALLATION

TOOLS NEEDED:
Two (2) pipe wrenches, one (1) flathead screw driver, and pipe sealing compound.

IMPORTANT: Follow the boiler manufacturer’s instructions along with all applicable codes and ordinances for piping, blow down valve and water gauge glass requirements.

STEP 1 - Determine the Elevation at Which the Low Water Cut-Off/Pump Controller Must be Installed

If the control will be the primary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is 1 3/8” (35mm) below the boiler’s normal water level, but not lower than the lowest, safe permissible water level, as determined by the boiler manufacturer.

OR

If the control will be the secondary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is at or above, the lowest, safe permissible water level, as determined by the boiler manufacturer.

STEP 2 - Installing the Low Water Cut-Off

a. Using a pipe wrench, unscrew the plastic float blocking plug (A) from the low water cut-off body (B).

Series 150 and 150S (except Model 150-B and 150S-B)
Models 150-B and 150S-B
Series 157 and 157S
b. For Models 150-B and 150S-B and Series 157 and 157S (For all other models, proceed to Step 3).

Screw the ¾” NPT steel plug (C) (provided) in tapping (A).

**CAUTION**

The plug must be reinstalled before control is shipped installed on the boiler, and removed when boiler is installed after shipment. Failure to follow this caution may damage float and operating mechanism.

---

c. Mount and pipe the low water cut-off (D) on a vertical equalizing pipe (E) at the required elevation level, as determined in Step 1.

Install a full ported blow down valve (G) directly below the lower cross of the water equalizing pipe (F).

**Note:** 1" NPT tappings are provided, with the exception of some 157 and 157S models which are 1¼" NPT.

---

**STEP 3 - Installing a Water Gauge Glass (Required on all steam boilers)**

a. Install a water column (H) (not included with product) for all models except Series 157 and 157S (with integral water column).

b. Install a water gauge glass (J).

**Note:** Gauge glass and tri-cocks not included with product.
STEP 4 - Electrical Wiring

**WARNING**

- To prevent a fire, do not use this product to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.
- To prevent electrical shock, turn off the electrical power before making electrical connections.
- This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.
- Modification of the switch assembly before or after installation could cause damage to the boiler and/or boiler system.

Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

### Switch Operation

**For all Models except 158/158S and 159/159S**

- Boiler feed pump off, burner on, alarm off.
- Boiler feed pump on, burner on, alarm off.
- Boiler feed pump on, burner off, alarm on.

**For Models 158 and 158S**

- Motorized valve closed, burner on, alarm off.
- Motorized valve open, burner on, alarm off.
- Motorized valve open, burner off, alarm on.

**For Models 159 and 159S**

- Pump #1 off, pump #2 off.
- Pump #1 on, pump #2 off.
- Pump #1 on, pump #2 on.

---

![Using a flathead screwdriver, remove the junction box cover (K).](image)
b. Following the appropriate wiring diagram, (refer to page 9) based on your application requirements, and using BX armored cable or Thinwall electrical metal tubing connector fittings, make electrical connections to the junction box (L).

**IMPORTANT:** There must be a minimum space of 1/2" (13mm) between connector fittings and electrical live metal parts.

**Snap Switches (Series 150S and 157S)**

**Automatic Reset (All models except 158S and 159S)**

**Automatic Reset Model 158S**

**Automatic Reset Model 159S**

**Manual Reset (All models except 158S)**

**Manual Reset Model 158S-M**

**Mercury Switches (Series 150 and 157)**

(All models except 158 and 159)

Model 158

Model 159
WIRING DIAGRAMS

For Motorized Valves, refer to the valve manufacturer’s wiring instructions.

Low Water Cut-Off Only

1. Main Line Switch - For burner circuits within the switch’s electrical rating.
2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch’s electrical rating.

Pump Control Only

1. Main Line Switch - For pump motors within the switch’s electrical rating.
2. Pilot Switch - To holding coil of a starter when the pump circuit exceeds the switch’s electrical rating.

Note: For Models 159 and 159S, use terminals 5 and 6 for pump #2.

Alarm Circuit Only

1. Low Water Alarm
2. High Water Alarm

Combination Pump Control, Low Water Cut-Off and Alarm

1. Main Line Switch - For burner circuits within the switch’s electrical rating.
2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch’s electrical rating.
6. Re-attach the junction box cover (K).

**Note:**
Cover must be installed correctly as shown

---

**STEP 5 - Testing**

This control is factory calibrated for specific applications. The following testing procedure is only meant to serve as a verification of proper operating sequence. Dimensions provided are typical for a boiler not being fired and/or not at pressure. Actual operating ranges are shown on page 2 in the "Operation" section.

**IMPORTANT:** Follow the boiler manufacturer’s start-up and operating instructions along with all applicable codes and ordinances. **Note:** Water levels stated below are only for 150 psi (10.5 kg/cm²) operation.

---

**a.** Turn on the electric power to the boiler. With the boiler empty the pump should go on and the burner must remain off.

**WARNING**

If the burner comes on, immediately turn the boiler off and make the necessary corrections.

Failure to follow this warning could cause an explosion or fire and result in property damage, personal injury or death.

---

**b.** The boiler should begin to fill with water. Watch the gauge glass (J) until the water level reaches approximately \( \frac{7}{8} \) (22mm) above the horizontal cast line (M) on the low water cut-off.

**IMPORTANT:** If water does not start filling the boiler, immediately turn off the boiler and make the necessary corrections.
c. **For automatic reset models only.** When the water level reaches approximately 7/8" (22mm) above the horizontal cast line (lower for MD models) the burner should come on (pump #2 should shut off with Models 159 and 159S).

**CAUTION**

To prevent serious personal injury from steam pipe blow down, connect a pipe to avoid exposure to steam discharge.

Failure to follow this caution could cause personal injury.

For manual reset models only. When the water level reaches approximately 7/8" (22mm) above the horizontal cast line press the reset button (N). The burner should then come on.

---

**Snapswitch Models**

**Mercury Switch Models**

**d.** Continue watching the gauge glass (J) to see that the water continues to rise to approximately 1 3/8" (35mm) (1 7/16" (37mm) for MD models) above the horizontal cast line (M). The pump should shut off (the motorized valve should close with Models 158 and 158S, or with Models 159 and 159S, pump #1 should shut off).

---

**CAUTION**

**e.** Blow down the control when the water in the boiler is at its normal level and the burner is on. Follow Blow Down Procedure found in Maintenance Section on the last page of these instructions.
MAINTENANCE

SCHEDULE:
- Blow down control as follows when boiler is in operation.
  - Daily if operating pressure is above 15 psi.
  - Weekly if operating pressure is below 15 psi.

- Disassemble and inspect annually. Replace the low water cut-off/pump controller if it is worn, corroded, or if components no longer operate properly.
- Inspect the float chamber and equalizing piping annually. Remove all sediment and debris.
- Replace head mechanism every 5 years. More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- We recommend head mechanism replacement when the switch(es) no longer operate properly. If you choose to replace the switch(es), order the proper McDonnell & Miller replacement switch or switch assembly and follow the Repair Procedure provided.

NOTE
More frequent blow-down may be necessary due to dirty boiler water and/or local codes.

BLOW DOWN PROCEDURE:

CAUTION
To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge. Failure to follow this caution could cause personal injury.

Blow down the control when the water in the boiler is at its normal level and the burner is on. Slowly open the upper then the lower blow-down valves and observe the water level fall in the sight glass. Close the valves (lower first then upper) after verifying that the pump contacts have closed and the burner shuts off. If this does not happen, immediately shut off the boiler, correct the problem and retest.

For Models 158 and 158S, close the blow down valve after the motorized valve opens and the burner shuts off. For Models 159 and 159S, close the blow down valve after both pumps come on. If this does not happen, immediately shut off the boiler and correct the problem.

To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge. Failure to follow this caution could cause personal injury.

CAUTION
Snap switches must be replaced as an assembly.

McDonnell & Miller
Specifications


Contact Design: SPDT (1 form C): One normally open (N.O.) and one normally closed (N.C.) powered contacts.

Contact Ratings: 10 A @ 120, 240 VAC resistive (120°F), 1A @ 120, 240 VAC resistive (150°F), 1/3 H.P. @ 120, 240 VAC (120°F)

Contact Life: Mechanical- 5 million operations Electrical-100,000 operations minimum at rated load.

Supply Voltage: 120, 240 or 24 VAC models: +10% -15% 50/60 Hz. 208/240 model: 187 Vmin to 255 Vmax. VAC 50/60Hz

Supply Current: Relay energized at 4.4 VA

Secondary Circuit: 12 VAC RMS Voltage on probes. 1.5 milli-amp Current.

Sensitivity: Models operate from 4.7K to 100K maximum specific resistance.

Temperature: -40 TO 150°F ambient

Terminals: All connections #6-32 screw type terminals with pressure clamps.

Time Delays: Standard – LLCO probe, 3 seconds standard for lowering level.

Listings: U.L. limit control recognition (353). 240 and 208 volt units are not U.L. limit control recognized.

Installation

1. Install octal socket in appropriate enclosure using two #6 or #8 metal screws.
1A. Install rail mount socket on appropriate rail (DIN mount) in appropriate enclosure if applicable.
2. Wire control per wiring diagram, following N.E.C. and local codes
3. Install control module in socket.

Sensitivities vs Maximum Probe Wire Distance*

<table>
<thead>
<tr>
<th>SENSITIVITY CHARACTER</th>
<th>SENSITIVITY (KOHMS)</th>
<th>DISTANCE (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.7</td>
<td>900</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>600</td>
</tr>
<tr>
<td>C</td>
<td>26</td>
<td>250</td>
</tr>
<tr>
<td>D</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>E</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

* Based on type MTW or THHN wire, #14 or #16 Awg
Options:

**Automatic Reset**: (Reset terminals not used): When the liquid rises to the electrode on terminal 6, the control energizes, changing state of the load contacts. (LED will be lit) The control remains energized until the liquid level recedes below electrode on terminal 6. The control then de-energizes, (LED will not be lit) returning load contacts to original state. Unless otherwise specified, there is a three second time delay on decreasing level. Liquid must be below probe on terminal 6 for a full three seconds before control de-energizes.

**Manual Reset**: (Normally closed pushbutton across terminals #7 and #8): When the liquid rises to the electrode on terminal 6, the control will remain de-energized until the pushbutton is depressed. The control will then energize, (LED will be lit) changing the state of the contacts. The control remains energized until the liquid level recedes below electrode on terminal 6. The control then de-energizes, (LED will not be lit) returning load contacts to their original state. Unless otherwise specified, there is a three second time delay on decreasing level. Liquid must be below probe on terminal 6 for full three seconds before control de-energizes.

**Manual Reset with Optional Power Outage Feature**: (Normally closed pushbutton across reset terminals) Control will ignore power loss to control. With liquid above electrode on terminal 6, a power outage will cause the control to de-energize, but will automatically energize upon return of power. However, loss of liquid will cause control to de-energize and remain so until liquid again rises to electrode and pushbutton is depressed.

**Dirty Electrode Detection**: The LED will flash every half-second once the probe resistance reaches a value greater than the nominal control sensitivity rating. The relay state will not change until it exceeds the nominal sensitivity by more than 25% (typically) at nominal input voltage. At which time the LED and relay contact return to the dry state. Such a condition may suggest electrode maintance is required.

**Test Feature** Allows LLCO circuit to be tested. Holding down the reset button for 3 seconds will allow the LLCO circuit to trip which simulates the loss of water, without the need of draining the water level in the boiler. The control will return to normal operation once the reset button is pressed a second time.