FB-X

OPERATING AND MAINTENANCE MANUAL

VERSON 03-03-15

This is engineered equipment. Only trained qualified service technicians should attempt to start and / or operate this equipment. Read and understand all manuals, product specification sheets, applicable codes and safety guidelines before performing any start up and / or service procedures. This manual is to be used as a guide for professional, trained technicians only. This guide, if followed should result in a successful start up / service program. It is good practice to know as much as possible about a piece of equipment before trying to install or operate it. Always refer to the OEM data sheets, drawings, specifications and operating instructions.

Information contained herein is to be used as a guide ONLY and not as the final authority. This manual does not relieve the customer from obtaining qualified site engineering, installation, and start-up support. Plant operating personnel should familiarize themselves with the content of this manual and the physical installation and equipment provided before attempting to start and operate equipment. It is not possible to cover in written form all possible operating scenarios and conditions. Any deviation from the operating discipline outlined in this document should be based on extensive operating experience, sound engineering judgment, and consultation with your Fulton contact. Trained personnel are responsible for the installation, operation, and maintenance of this product, and for the safety assurance of installation, operation, and maintenance processes. Do not install, operate, service or repair any component of this equipment unless you are qualified and fully understand all requirements and procedures. Trained personnel refers to those who have completed Fulton Service School training specific to this product**.** Fulton and it's employees assume no responsibility for any liability or damages caused by an inoperable, inadequate or unsafe boiler condition which is the result, either directly or indirectly, of any improper or inadequate condition.

INSTALLATION, OPERATION AND SERVICE MANUAL
To be used for reference with separate burner manual

Important Instructions For Receiving Unit In Case Of Loss Or Damage

1. Examine the shipment carefully before signing freight bill. If any DAMAGE is noted or if the number of pieces received DOES NOT agree with the BILL OF LADING, DO NOT ACCEPT SHIPMENT without shortage or damage noted on the freight bill by the carrier's agent. Failure to do so may jeopardize your recovery and at your own risk.

2. If any concealed DAMAGE OR SHORTAGE is discovered with unpacking, LEAVE MATERIAL AND PACKING AS IS and NOTIFY Agent or carrier to inspect and make reference thereto on the freight bill.

3. All packaged material should be unpacked and inspected within 24 hours after receipt of same. If damage could not be detected until goods were unpacked, contact the transportation company and request IMMEDIATE inspection. Require them to give you a “concealed” bid order report, stating the condition of the goods when examined. It is their duty to do this, and this service should be insisted upon. This, with other documents, will properly support your claim.

4. When the above instructions are complied with, we will assist you in establishing claims against the transportation companies for loss or damage in transit. We cannot, however, be responsible for entry or collection of claims or replacement of lost or damaged material.

5. Claims for loss or damage on transportation charges resulting there from must not be deducted from our invoice. Non-payment of invoices withheld awaiting adjustment of claims is not acceptable. It is the function of the carrier to guarantee safe delivery of the equipment.

6. **DO NOT RETURN GOODS WITHOUT WRITTEN AUTHORIZATION**. Returned goods will not be accepted from the transportation company unless written authorization has been issued by an official of our Company. Credit for goods returned by authorization will depend on the market value, less a fair charge to cover expense of shipping, rehandling, inspection, refinishing, etc., providing material is received in good condition.

Important Instructions for Owners, Operators or Maintenance Personnel

- No attempt to install or operate the boiler should be attempted until this manual is read and understood.

- This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood.

- Only trained and authorized personnel should be allowed to operate, adjust or repair this equipment.

- Fulton products are designed and engineered to provide long life and excellent service on the job. The devices supplied as part of the unit were chosen because of their known ability to perform. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in operating this equipment.

- It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning. This manual is not intended to relieve the operating personnel of the responsibility for proper operation.

- The operation of this equipment by the Owner and his operating personnel must comply with all requirements or regulations of his insurance company and/or any other authority having jurisdiction. These legal requirements take precedence over anything contained herein.

- Fulton Service Representatives, if present for start-up or service, are present only in an advisory capacity. The operation of the equipment is under the scope of work to be performed by the Owner's operating personnel at the Owner's risk, and under the Owner's insurance protection. Recommendation for proper adjustments required to make the equipment perform can be made by these Service Representatives.

INSTALLATION INFORMATION

Setting the Boiler

- The boiler should be located on a level concrete floor. A concrete foundation is preferable. The dimensions should be slightly larger than the outside dimensions of the boiler.

- If boiler is installed directly on a concrete floor where it is important that the floor be kept cool, such as an upper floor or mezzanine, set the boiler up on insulating tile or steel framework, so air can circulate underneath. There is little standby heat loss through the Fulton FB-X Boiler, but this precaution is considered good practice.

- The boiler may be mounted on vibration isolation pads in order to provide smooth and trouble free operation. Check local codes for seismic frequencies. Add keyed slots in the base rail to allow for expansion.

- Care should be taken in locating the boiler, so that all four sides are easily accessible for service. Check local codes. From 24” to 30” should be maintained around all four sides between any wall or obstruction, leaving room to clean and service the boiler.

- On boilers equipped with removable or swing type hinged burners for fireside inspection through the boiler front, the burner piping arrangement must be planned accordingly.

- Typically, boilers are rigged from the front and rear exposed upper drum ends. When using a sling for lifting ensure that spacers are used to avoid damaging jacket panels.

Boiler Clearances

- Tube removal is on each side. Refer to the product data submittal to determine required clearances for your boiler. Avoid running pipes along side of boiler as they will interfere with removing boiler panels. Gas trains should have strategically placed unions to allow for easy removal. Refer to “minimum recommended clearances” on boiler rating tag.

Heating Boilers

- These boilers have a flange at the upper drum front for connection to the heating system main. A non return stop valve should be provided between each boiler and the main, located as near the boiler as is practical, to provide for draining the boiler without draining the system.

- All piping should be designed and installed to relieve any possibility of stress or strain on boiler connections or the piping. All piping from the boiler to the first non return stop valve should be installed as per the appropriate ASME boiler code.

- The system return connection is located at the back of the bottom drum on water boilers. On Steam boilers the feed water supply connections are on the rear downcomer. A non return stop valve should be installed in the return line as near the boiler as is practical, to provide for draining the boiler without draining the system.

- NOTE: Non-return stop valves are not supplied as standard with the Fulton package.

- Each boiler has a drain connection located at the bottom drum. Boilers up to and including size 400 have one drain connection at the rear of the bottom drum. All boilers from size 500 and larger have two drain connections, located at the front and back of the bottom drum. A drain valve and piping to drain should be installed to provide for draining the boiler.

- Each hot water boiler is supplied with an open pipe connection at the highest point off the boiler pressure vessel for venting of air which may have entered the boiler from the system. This point is tagged on all hot water boilers with “To Vent” for proper connection by the installing contractor.

- Tappings for the one or more boiler safety relief valves are at the boiler top rear. The discharge from the relief valves should be piped to a safe location. The discharge should be as short and direct as possible. It should be supported to prevent any strain on the valve. The ASME boiler code should be followed.

- The chimney must be of sufficient size and height to provide proper draft and venting. Contact boiler stack manufacturers for venting system recommendations and design. Follow local utility and municipal codes for breeching and chimney requirements.

TRIM & CONTROLS

There are three distinct control systems on any boiler: the **Firing Rate Controller**, the **Flame Safeguard**, and the **Operating Controller**. Other controllers and devices may be subsets of these systems.

Firing Rate Control

Refer to detailed burner manual for actual control and operating sequences before operating burner. *

Start up should be performed by a qualified start up technician only. Contact Fulton or your Fulton representative for start-up technician support.

Boiler controls should never be bypassed.

Never dry-fire a boiler!

The Firing Rate Controls regulate the firing rate of the burner to track load change. Regulating the firing rate is defined as maintaining a specific fuel-air ratio for a required rate of fire at a given demand point. Load change is defined as the demand of the system for the output of the boiler, either hot water or steam as is interpreted in the following way:

- Hot Water Boiler – If the temperature of the supply water falls below the preset temperature then the firing rate control interprets this as a system demand therefore increasing firing rate. Likewise if the supply temperature begins to exceed the preset temperature then this is interpreted as a reduction in system demand therefore reducing the fuel input to the boiler.

- Steam Boiler – if the pressure inside of the steam drum begins to fall then this is interpreted by the firing rate control as an increase in system demand and the firing rate is increased. Likewise when the pressure inside of the steam drum increases above the preset point then this is interpreted as a reduction in demand and the firing rate is reduced.

Firing rate control is measured as turndown. The turndown of the boiler is the ability of the burner to control firing rate between the Manufacturers Continuous Rating (MCR) and some minimum value. There are two types of firing rate control: **Step Firing** and **Modulating Firing Rate**.

- Stepped firing rates operate the burner at a few specific preset firing rate positions, examples would be On-Off combustion where the burner is either On or Off. Another example of stepped firing is Low-High-Low-Off, a method commonly used on Fulton FB-X boilers

- A modulating burner has the ability to vary the firing rate to any point between maximum fire and a minimum firing rate. A fully modulating burner utilizes an actuator to modulate the fuel flow control valve and fan air damper position. Modulating firing rate controls are also called Proportional Controllers.

Turndown is measured as a ratio of MCR to the minimum firing rate. An On-Off burner has a turndown ratio of 1:1 meaning it can only fire at its maximum input or shut off. The turndown of a fully modulating burner will vary with the firing rate control scheme as well as the fuels fired. On natural gas most burners will vary between 10:1 and 4:1 meaning the burner can fully modulate between 100% firing rate to 10% firing rate for a 10:1 burner or 100% to 25% of firing rate for a 4:1 turndown boiler.

#2 fuel oil firing turndown is typically not as low as gas firing because of the difficulty of maintaining proper firing at the lower end. #2 oil burners typical at best can achieve 8:1 turndown but commonly are less than 6:1 to as low as 3:1

Almost all Fulton FB-X boilers will utilize one of the following two firing rate control schemes: single point positioning or parallel point positioning that is also commonly called linkageless positioning. Proper combustion requires the firing rate controller to maintain a precise fuel-air ratio. The forced draft fan provides combustion air and the fuel delivery system provides natural gas or fuel oil. It is the responsibility of the firing rate controller to control the amounts of both that are fed to the burner at the requiring firing rate at any given time. An improper fuel-air ratio can lead to poor efficiency at best and an explosive situation at worst.

A description of the two firing rate control schemes is as follows:

- Single Point Positioning: This is the most common firing rate control utilized on Fulton FB-X boilers. The firing rate controller interprets a required firing rate based on system demand. A control signal is sent to the actuator on the burner. The actuator has a linkage that physically connects the fan damper and fuel flow control valve to the damper allowing the actuator to move the damper and fuel valve in unison. The fuel valve is supplied with a cam assembly that creates a curve which allows for the start-up technician to fine tune the fuel-air ratio for the full range of the turndown.

- Parallel Point / Linkageless Systems: this type of system replaces the linkage between the actuator, fuel valve, and air damper with individual actuators on both the fuel valve and the air damper. This system allows the firing rate controller to actuate each independently. Feedback potentiometers in the actuators provide a signal back to the firing rate controller to insure the actuators are moving in the manner that the firing rate controller requires. This is called Cross Limiting and is a very important safety feature on these types of systems.

Fulton FB-X Boilers normally feature **Low-High-Low** operation for models 100 – 400 as standard and **Full Modulation** for models 500 and up.

Full Modulation is available as an option for all boilers. The standard burner package meets all of the requirements of UL and CGA.

For the standard Fulton FB-X steam boiler package the burner master function is accomplished with the Honeywell 404 for step firing burners and the Honeywell L91 for modulating burners. Hot water boilers utilize the Honeywell 4008. The Controls & Trim list provided on following pages define the types of control, model, and manufacturer supplied as a standard by Fulton.

If required, your burner may be equipped to meet the requirements of Factory Mutual, Industrial Risk Insurers, National Fire Protection Association, Improved Risk Insurers.

Typical Hot Water Boiler Burner Firing Sequence – On a call for heat, the burner will light up in the sequence below. Steam systems will operate in similar fashion except it will be based on steam drum pressure, not water temperature.

TIME[1]	Event	WATER TEMPERATURE (F)
0	Burner Off	140
1	Call for Heat	138
	Call for Heat	
	Call for Heat - Pre-purge	
	Call for Heat	138
60	Pilot lights and establishes	138
70	Lo fire lights and establishes	139
80	Hi fire	140
“		
“		
“	No call for heat	180
	Burner switches off	

[1] Time in Seconds

Flame Safeguard (BMS)

The flame safeguard, also known as a Burner Management System (BMS), has three functions:

I. To control the sequence of events that lead to the burner firing. (starting and stopping the burner)

II. To ensure that all operating and safety limits (controls, switches) are in the correct position to ensure safe operation throughout the burner firing cycle.

III. To instantly shut off the fuel supply in the event of a flame failure during normal operation or to stop the start-up procedure if an adequate pilot or low fire is not detected within a code dictated time period.

The flame safeguard should not be confused with the firing rate controller. Most insurance agencies do not permit a single controller to handle both flame safeguard and firing rate control functions for reasons of redundancy for safety. The flame safeguard, also commonly referred to as the Burner Management Systems (BMS), is a microprocessor-controlled devise that monitors the burner for safe operation. The most common BMS systems are the Fireye E110 or the Honeywell 7800 series controllers. Supply of the BMS is by the burner vendor.

The flame safeguard is responsible for the safe starting of the burner as well as monitoring the burner during operation. The flame safeguard will monitor parameters such as windbox pressure, fuel supply pressures, flame strength, and other safety-related parameters. Should the safeguard detect an improper signal it will shut the burner off. Any safety trip will require a manual reset requiring the operator to acknowledge and understand the reason for the shut-down. This is a key safety requirement.

NOTE: A flame safeguard that is in the safety position requiring a manual user to re-establish burner operation should not be reset until the boiler and burner are checked to ensure that a safe start can be made.

Flame Safeguard (cont)

Component	Explanation
AIR SWITCH	The air switch checks that the burner fan is running and supplying sufficient air for combustion.
GAS TRAIN	The gas train is a series of valves, switches and regulators connected by pipe to supply gas at the correct pressure and at the appropriate time.
OIL TRAIN	The oil train is a similar device to a gas train in that it supplies oil to the burner at the correct pressure and at the appropriate rate. An oil train will usually include an oil pump.
COMBUSTION AIR FAN	The combustion air fan supplies air to the burner for purging and for combustion.
PILOT	The pilot supplies a small amount of gas to the burner to ignite the main flame

Multiple Boiler Installation Controllers

Multiple boiler installations introduce unique operating requirements. A device that is commonly utilized is called a Lead-lag Sequencer. A lead-lag system has the ability to control multiple boilers and circulating pumps for hot water systems. A lead-lag sequencer will coordinate the operation of multiple boilers to act as a single system. A lead-lag sequencer will control the firing rates of the multiple boilers based off of a single system demand signal. The sequencer will override the firing rate signal generated on each individual boiler. For example a plant with three boilers could operate their units in the following method: The load can be evenly distributed between the three units with each boiler supplying 33% of the total load; two boilers can each meet 50% of the total load with the third serving as a standby, or one boiler can be firing to full load and if demand is not met then the next boiler is started and modulated until load is satisfied.

- Hot Water Boilers: A lead-lag sequencer will have a temperature controller in the common supply line to the plant, not on each individual boiler. The sequencer can then operate the multiple boilers in a preset method to meet system demand.

- Steam Boilers: A lead-lag sequencer will have a pressure transmitter in the common steam header to the plant, not on each individual steam drum. The sequencer can then operate the multiple boilers in a preset method to meet system demand.

Lead-lag sequencers are not required, however they provide for a much more efficient and orderly operation of multiple boilers. It is easy to understand the control issues that can result from allowing the individual firing rate controllers to compete with each other to meet the system demand.

Sequencers can also be used to set the control point of the burner firing rate controller with respect to outside air temperature. For example, on a cold day the boiler water temperature may be 180°F whereas on a warmer day the temperature may be set to a lower value.

Water Flow Control

All Fulton FB-X boilers are typically equipped with water flow control devices. Hot water boilers are of a forced circulation-type requiring a positive and constant water flow through the boiler. A circulation pump accomplishes flow through a hot water boiler. Steam boilers utilize a natural circulation pattern inside of the boiler but require a feedwater source to maintain proper water level inside of the drum.

- Hot Water Boilers: These systems are relatively straightforward. A pump circulates water through a system. The cold water entering the boiler is defined as the **Return Water**, the heated water discharged from the boiler is known as the **Supply Water**. A detailed typical scope of supply is on a following page. Check this list for the type of pump controller that would be installed on your boiler.

- Steam Boilers: Maintaining a proper water level inside of the steam drum is critical to proper operation of a steam boiler. There are two distinct methods of water level control inside of the steam drum: On-Off or Modulating. Similar in operation to the Firing rate Controller boilers can be supplied with water in an intermittent manner, On-Off, or a Modulating controller can be supplied for a more precise level control. Modulating feedwater control systems are further defined based on the number of parameters that are measured. The three different types of modulating feedwater control are as follows:

    - Single Element: the most common type of control is a single element feedwater level control. This uses a water level device to transmit an analog signal to a modulating feedwater valve.

- Two-Element: A two-element feedwater control system combines a steam flow meter located in the steam header leaving the boiler with the water level transmitter to add a second signal to the feedwater level controller. The level controller will interpret both the steam flow signal as well as the drum level signal to determine the optimum position of the feedwater regulating valve. A two-element system will level out the peaks and troughs associated with drum swell and shrinkage to provide a more accurate level control signal.

- Three-Element: A three element system incorporates a boiler feedwater flow meter into the two-element system to provide for the most precise level control possible. Three-element systems are rarely utilized.

Two and three element feedwater control systems will require a Proportional, Integral, Derivative (PID) loop controller capable of interpolating the correct feedwater valve output based on the given inputs from the steam drum level and steam and feedwater flow meters. Fulton does not typically supply these controllers.

Recycling

Recycling is the boiler's ability to automatically restart when the burner is tripped due to low demand. A boiler that is tripped because of a safety-related event can never automatically restart and must be manually reset by the operator. Some customers do not wish to ever have a boiler automatically start without an operator nearby therefore may not want or require a recycling feature. Check the detailed scope of supply for your specific burner to see if the unit is capable of recycling.

Fulton FB-X boilers supplied with modulating firing rate controls will utilize the Honeywell 404 series controls for high and low pressure settings for recycling.

The following pages will detail the types of controls and trim typically supplied on Fulton FB-X steam and hot water boilers.

Standard Controls & Trim Supplied on Fulton FB-X Hot Water Boilers.

Operation	Component	Function
To CONTROL the burner operation to provide the desired water TEMPERATURE	Aquastat L4006 or T991	Control
To SHUT-OFF burner in the event of excessive water TEMPERATURE	. Aquastat L4006	Safety
To INDICATE the pressure and temperature of the hot water	Thermometer and Pressure Gauge	Indicator
To SHUT-OFF the burner in the event of a falling water level	Low Water Cut-off Probe Type	Safety
To VENT excess pressure out of the boiler	Safety Relief Valve per ASME Code	Safety

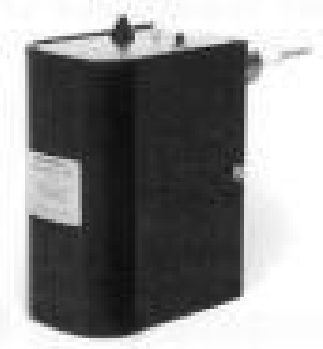
Other components which are not supplied as standard but which may be required for proper operation.

Component	Explanation
Expansion Tank	Provides a cushion for water expansion.
Stack Thermometer	A thermometer indicating the temperature of the combustion gases leaving the boiler
Drain Valve	A valve piped into the bottom of the boiler to drain the boiler
Stop Valve	Installed as close as possible to boiler inlet and outlet to drain boiler without draining the system.

Key Controls Overview and Picture Identification

Not all of these components may be installed on your boiler. Check your submittal package for components included as well as the specific model numbers.

Hot Water Boilers

Component Overview	Picture
T991 Series Controller For modulating control of water temperature in boilers.	
L4006 Series Controller Aquastat® Controllers are immersion type devices for limiting or regulating the temperature of liquids in boilers.	
PS-851-M-120 McDonnell Miller Low water Cut Out is a safety devise to insure burner shut down in the event of a low water condition inside of the boiler.	

Standard Boiler Trim List – Hot Water Boilers

On-Off Firing Rate Control

Description	Quantity	Model	Manufacturer
Operating Aquastat	One	L4008A1015	Honeywell
Low-High Aquastat W/ Manual Reset	One	L4008E1040	Honeywell
Aquastat Well	Two	121371A	Honeywell
Pressure Gauge (xxx psig)	One	Q32-xxx	Winters
B-Metal Thermometer	One	30060B8	Winters
Probe Type LWCO[2] w/ Manual Reset	One	PS-851-M-120	McDonnell Miller
Safety Relief Valve	One	174A or 740 10-61-xxx	Watts or Conbraco

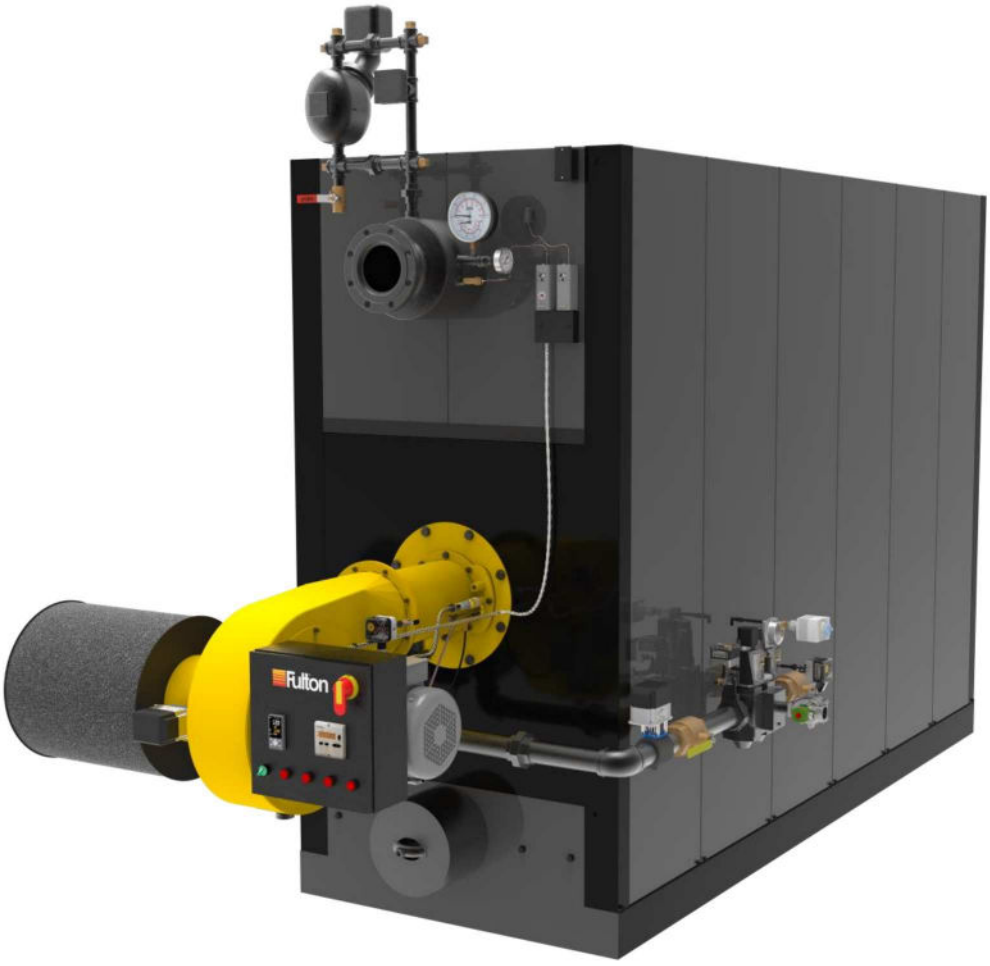
Low-High-Low Firing Rate Control

Description	Quantity	Model	Manufacturer
Proportional Aquastat	One	T991AN61	Honeywell
Operating Aquastat	One	L4008A1015	Honeywell
High Limit Aquastat W/ Manual Reset	One	L4008E1040	Honeywell
Aquastat Well	Three	121371A	Honeywell
Pressure Gauge (xxx psig)	One	Q32-xxx	Winters
B-Metal Thermometer	One	30060B8	Winters
Probe Type LWCO w/ Manual Reset	One	PS-851-M-120	McDonnell Miller
Safety Relief Valve	One	174A or 740 10-61-xxx	Watts or Conbraco

Modulating Firing Rate Control

Description	Quantity	Model	Manufacturer
Proportional Aquastat	One	L4008A1015	Honeywell
Operating Aquastat	One	L4008A1015	Honeywell
High Limit Aquastat W/ Manual Reset	One	L4008E1040	Honeywell
Aquastat Well	Three	121371A	Honeywell
Pressure Gauge (xxx psig)	One	Q32-xxx	Winters
B-Metal Thermometer	One	30060B8	Winters
Probe Type LWCO w/ Manual Reset	One	PS-851-M-120	McDonnell Miller
Safety Relief Valve	One	174A or 740 10-61-xxx	Watts or Conbraco

[2] Low Water Cut Off



Picture of Typical Fulton FB-X Hot Water Boiler

Standard Controls & Trim Supplied on Fulton FB-X Steam Boilers.

Operation	Component	Function
To CONTROL – the burner operation to provide the desired steam PRESSURE	Pressuretrol – L404 or L91/P78	Control
To SHUT-OFF the burner event of excessive steam PRESSURE	Pressuretrol – L404/P78	Safety
To INDICATE the PRESSURE of the steam	Pressure Gauge	Indicator
To CONTROL the operation of feedwater pump to provide the correct water level inside the boiler	Pump Control As required	Control
To INDICATE the water level in the boiler	Gauge Glass	Indicator
To INDICATE the water level in the boiler	Trycocks	Control
To SHUT-OFF the burner if the boiler water level falls to a dangerous level (primary)	Low-water-cut-off – Float type	Safety
To SHUT-OFF the burner if the boiler water level falls to a dangerous level (secondary)	Auxiliary Low-water-cut-off – Probe type	Safety
To VENT excess pressure out of the boiler safety valve	Per ASME Code	Safety

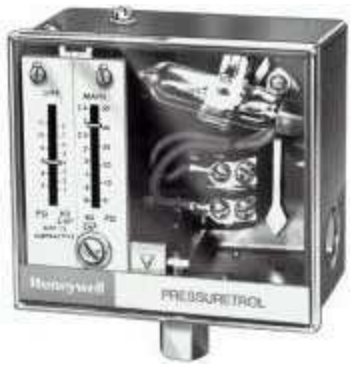
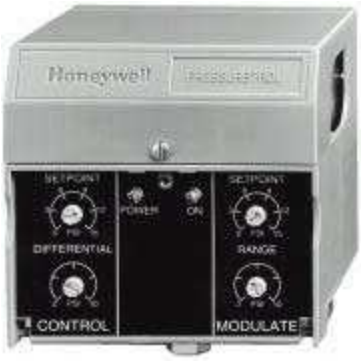
Other components which are not supplied as standard but which may be required for proper operation.

Component	Explanation
Blowdown Valves	Slow and quick opening valves connected to the bottom of the boiler to allow sediment to be removed
Modulating Feedwater Controls	Feedwater pump controls which will incrementally increase or decrease the feedwater flow rate to maintain a precise control
Regulating Valve	For controlling feedwater flow from the feedwater system into the boiler
Surface Blowdown Valve	Slow opening valve connected to the water level to filter suspended solids out of the boiler

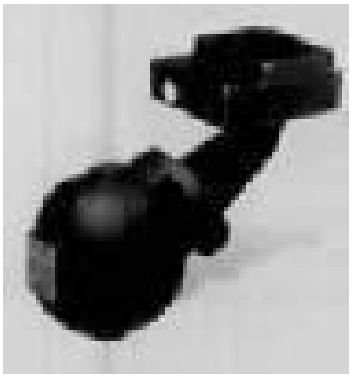
Key Controls Overview and Picture Identification

Not all of these components may be installed on your boiler. Check your submittal package for components included as well as the specific model numbers.

Steam Boilers

L404 Series Controller Provide operating control, automatic or manual reset limit protection for pressure systems up to 300 psi (2068 kPa).	
L91 Series Controller Modulating pressure operating control for regulation of liquid or air and other non-corrosive gases.	
P78 Series Controller Line voltage pressure controller that provides automatic operating control, automatic limit protection, manual reset limit protection, and 4-20ma modulating firing rate control for pressure systems up to 300 psi.	

Steam Boiler (cont)

MM 157 Mechanical Low Water Cutoff / Pump Controller for Steam Boilers For residential, commercial, or industrial low or high pressure boiler applications.	
Conbraco Gauge Glass Set Use for steam drum liquid level verification. Aluminum hand wheels; EPDM gauge glass gaskets standard.	
Conbraco Tricock Set Allows for water level verification in event of gauge glass failure.	

Standard Boiler Trim List – Low Pressure Steam Boilers

Low-High-Low Firing Rate Control

Description	Quantity	Model	Manufacturer
Low-High Pressuretrol	One	L404A1588	Honeywell
Operating Pressuretrol	One	L404A1588	Honeywell
High Limit Pressuretrol W/ Manual Reset	One	L404C1147	Honeywell
Pressure Gauge (0-30 psig)	One	Q321	Winters
Probe Type LWCO w/ Manual Reset	One	PCH-G-M-1K	McDonnell Miller
LWCO Sensor	One	RS-1-BR-1	McDonnell Miller
LWCO Probe	One	P-2-SS	McDonnell Miller
Feedwater Control / Auxiliary LWCO – auto reset	One	157	McDonnell Miller
½" Gauge Glass Set	One	20 104 00	Conbraco
½" Tricock Set	Three	26 305 28	Conbraco
Safety Relief Valve	One	TBA	Watts

Fully Modulating Firing Rate Control

Description	Quantity	Model	Manufacturer
Proportional Pressuretrol	One	L91B1035	Honeywell
Operating Pressuretrol	One	L404A1588	Honeywell
High Limit Pressuretrol W/ Manual Reset	One	L404C1147	Honeywell
Pressure Gauge (0-30 psig)	One	Q321	Winters
Probe Type LWCO w/ Manual Reset	One	PCH-G-M-1K	McDonnell Miller
LWCO Sensor	One	RS-1-BR-1	McDonnell Miller
LWCO Probe	One	P-2-SS	McDonnell Miller
Feedwater Control / Auxiliary LWCO – auto reset	One	157	McDonnell Miller
½" Gauge Glass Set	One	20 104 00	Conbraco
½" Tricock Set	Three	26 305 28	Conbraco
Safety Relief Valve	One	TBA	Watts

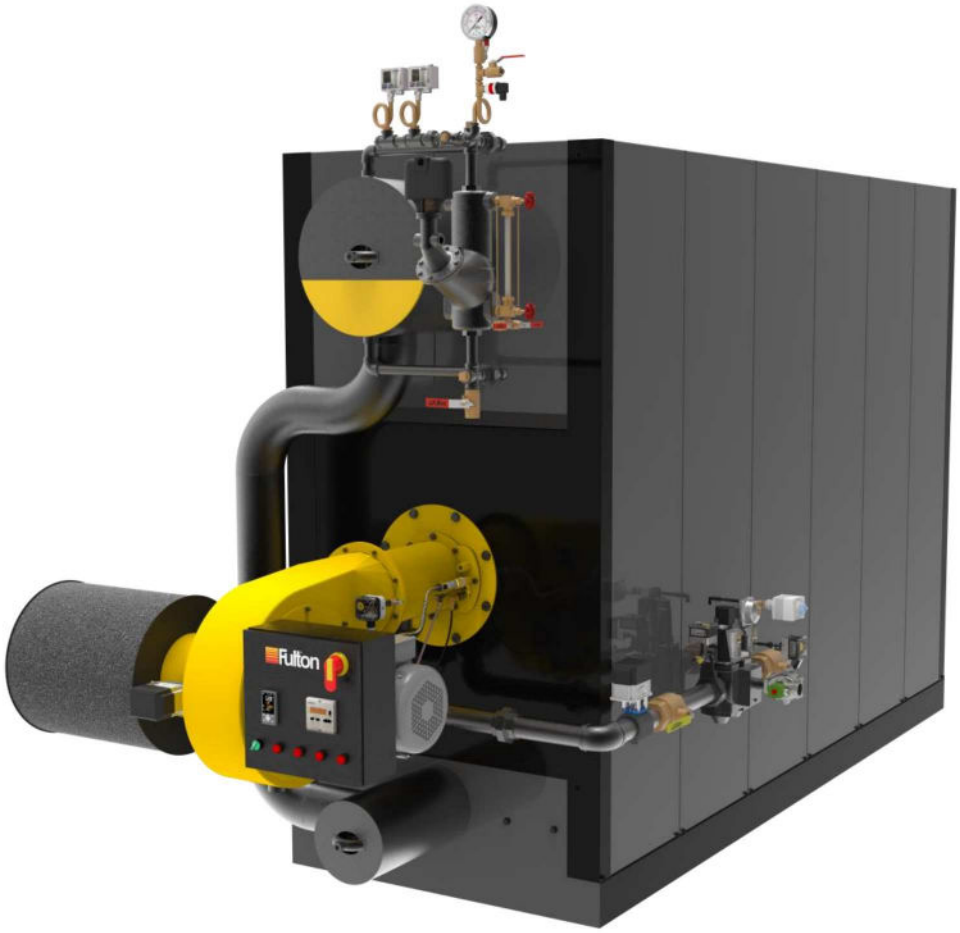
Standard Boiler Trim List – High Pressure Steam Boilers

Low-High-Low Firing Rate Control

Description	Quantity	Model	Manufacturer
Low-High Pressuretrol	One	L404A1602	Honeywell
Operating Pressuretrol	One	L404A1602	Honeywell
High Limit Pressuretrol W/ Manual Reset	One	L404C1162	Honeywell
Pressure Gauge (0-300 psig)	One	Q326	Winters
Probe Type LWCO w/ Manual Reset	One	PCH-G-M-1K	McDonnell Miller
LWCO Sensor	One	RS-1-BR-1	McDonnell Miller
LWCO Probe	One	P-2-SS	McDonnell Miller
Feedwater Control / Auxiliary LWCO – auto reset	One	157	McDonnell Miller
½" Gauge Glass Set	One	20 250 00	Conbraco
½" Tricock Set	Three	26 705 01	Conbraco
Safety Relief Valve	One	TBA	Watts

Fully Modulating Firing Rate Control

Description	Quantity	Model	Manufacturer
Proportional Pressuretrol	One	L91B1050	Honeywell
Operating Pressuretrol	One	L404A1602	Honeywell
High Limit Pressuretrol W/ Manual Reset	One	L404C1162	Honeywell
Pressure Gauge (0-300 psig)	One	Q326	Winters
Probe Type LWCO w/ Manual Reset	One	PCH-G-M-1K	McDonnell Miller
LWCO Sensor	One	RS-1-BR-1	McDonnell Miller
LWCO Probe	One	P-2-SS	McDonnell Miller
Feedwater Control / Auxiliary LWCO – auto reset	One	157	McDonnell Miller
½" Gauge Glass Set	One	20 250 00	Conbraco
½" Tricock Set	Three	26 705 01	Conbraco
Safety Relief Valve	One	TBA	Watts



Picture of Typical Fulton FB-X Steam Boiler

INSTALLATION

Combustion Air Supply

IMPORTANT: Positive means for supplying an ample amount of outside air to permit combustion of the fuel must be provided. Automatic or manually adjustable control devices for outside air intake can be interlocked with the burner. Air openings must never be obstructed. To determine minimum size (free area) of ventilation openings, the following guidelines may be applied:

OPENING TO INTERIOR SPACE – In confined boiler rooms, two openings should be provided, one near the top and one near the bottom of the boiler room. Each opening should have 1 sq. in. of free opening for each 1,000 BTU of boiler input rating.

OPENINGS TO OUTDOORS – Openings to outdoors are required if boiler room is confined or if building is of tight construction. Two openings, one near the top and one near the floor of the boiler room, each opening having 1 sq. in. per 2,000 BTU per hour of input rating must be provided if attached to horizontal ducts, and 1 sq. in. per 4,000 BTU if attached to vertical ducts. Rectangular ducts shall not have dimensions of less than 3 inches. The requirements of the local utility take precedence over these guidelines.

Gas Supply Connection

- Consult the local gas utility company for authorization and inspection of all gas supply piping and flue connections.
- Installation must conform to the requirements of the authority having jurisdiction or, absence of such requirements, refer to the National Fuel Gas Code, ANSIZ223.1-1974 and addenda, Z223.1a-1978.
- Regulator vent line must be vented to atmosphere (outside building) on all boilers equipped with electric pilot ignition.
- Drip leg must be installed on gas supply piping.

The following is only a general recommendation. It is the responsibility of the installing contractor or customer appointed engineer to insure compliance with all required codes and procedures.

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, refer to the National Fuel Gas Code, ANSI Z223.1-1974 and addenda, Z223.1a-1978. Consult the local gas utility company to authorize and inspect all gas connections and flue connections. A drip leg must be connected to a supply main at least as large as the gas fittings supplied with the boiler. Use local gas company charts for sizing gas piping from the gas meter to the boiler. This connection should be made with a union so that the boiler gas train components and burner may be easily removed if necessary for service. Upon completion of the gas piping hookup, the installation should be checked for gas leaks, using soap and water solution. Disconnect the boiler and gas train from the gas supply piping during any pressure testing of the gas supply system.

Venting – Gas pressure regulator – On boilers equipped with electrically ignited pilot(s), the regulator vent must be vented to the outside air, using minimum ¼" tubing or pipe. The vent line should terminate in a downward direction to be free of restriction.

Electrical Connection

IMPORTANT: Electrical work should be performed by a trained electrical Tech. All electrical connections must conform to the National Electrical Codes and all applicable State and Local Codes. This manual is to be used as a guide only.

Equipment Grounding – The boiler must be grounded in accordance with the American National Standard National Electrical Code, ANSI/NFPA #70-1978.

Hydrostatic Test of System Piping

After completing the boiler and burner installations, the boiler connections, fittings, attachments and adjacent piping should be checked for leaks by filling with water. The pressure should be increased to a level just below the boiler safety relief valve setting. Although the boiler is hydrostatically tested at the factory, minor leaks in fittings can develop from shipping vibration or from installation procedures. It may be necessary to retighten such fittings after installation and after the boiler has been operated for some time.

Fulton BOIL-OUT OF A NEW UNIT

The internal surfaces of a newly installed boiler may have oil, grease or other protective coatings used in manufacturing. Such coatings must be removed since they lower the heat transfer rate and could cause over heating of the tube. Before boiling out procedures begin, the burner should be ready for firing. The operator must be familiar with the procedure outlined under burner operation and in accordance with the detailed burner manufacturer's start up procedure.

Suggested procedure for boiling out new units prior to initial firing as follows:

I. Consult a local water treatment professional. They will know the characteristics of the water being introduced to the boiler.

II. When dissolving chemicals, the following procedure is suggested. Warm water should be put into a suitable container. Slowly introduce the dry chemical into the water stirring at all times until the chemical is completely dissolved. Add the chemical slowly and in small amounts to prevent excessive heat and turbulence.

CAUTION

Use suitable facemask, goggles, rubber gloves and protective garments are strongly recommended when handling or mixing caustic chemicals. Do not permit the dry material or the concentrated solution to come in contact with skin or clothing.

III. An overflow pipe should be attached to one of the top boiler openings and routed to a safe point of discharge. A relief or safety valve tapping is usually used.

IV. Water relief valves and steam safety valves must be removed before adding the boil-out solution so that neither it nor the grease which it may carry will contaminate these valves. Use care in removing and reinstalling valves.

V. All valves in the piping leading to or from the system must be closed to prevent cleaning solution from getting into the system.

VI. Fill pressure vessel with clean water until top of tubes are covered. Add the cleaning solution and then fill up to the top. The temperature of the water used in this initial fill should be at ambient temperature.

VII. The boiler should then be fired intermittently at a low rate sufficient to hold solution just at the boiling point. Boil the water for at least five hours. Do not produce steam pressure.

VIII. Allow a small amount of fresh water to enter boiler to create slight overflow that will carry off surface impurities.

IX. Continue boil and overflow until water clears. Shut burner down.

X. Let boiler cool to 120°F or less, and then drain using caution that the water is discharged safely and in accordance with local codes.

XI. Remove hand hole plates and wash the waterside surfaces thoroughly.

XII. Inspect surfaces and if not clean, repeat the boil out.

XIII. After closing openings and reinstalling safety or relief valves, fill boiler and fire until water is heated to at least 180°F to drive off any dissolved gases which might otherwise corrode metal. On a steam system, the condensate should not be returned until tests show the elimination of undesirable impurities. During the period that condensate is not returned, attention must be given to the treatment of the raw water used as makeup so that an accumulation of unwanted materials or corrosion does not occur. Follow the advice of your local water treatment company.

On hot water systems, chemical cleaning is generally necessary and the entire system should be drained after treatment. Consult water treatment companies for recommendations, cleaning compounds and application procedure. Do not flush the system through the boiler.

WASHING OUT

Fulton FB-X Steam Boiler

No later than 3 months after initially placing the boiler into operation and starting service, and thereafter as conditions warrant, the pressure vessel should be drained after being properly cooled to near ambient temperature, handhole covers removed and internal waterside surfaces inspected for corrosion, pitting or formation of deposits.

Fulton FB-X Hot Water Boiler

In theory, a hot water system and boiler that has initially been cleaned, filled with raw water (and that water treated) and with no make-up water added will require no further cleaning or treatment. However, since the system (new or old) may allow entrance of air and unnoticed or undetected leakage of water, introductions of raw water make-up or air may lead to pitting, corrosion and formation of sludge, sediment, scale, etc., on the pressure vessel waterside.

If the operator is absolutely certain that the system is tight, then, an annual waterside inspection may be sufficient. If there is any doubt, then the pressure vessel waterside should be inspected no later than 3 months after initially placing the boiler into operation and periodically thereafter as indicated by conditions observed during inspections.

Starting Procedure

- Be sure that the installation is complete and that all electrical, fuel, water and vent stack connections have been made.
- The operator should be familiar with the burner, all operating and safety controls and other components prior to attempting start up operation.
- Make sure that manhole and handhole covers have been replaced and that the pressure section of the boiler is ready for operation.
- Verify supply of fuel and proper voltage.
- Check for blown fuses; open circuit breakers, chopped out overloads, etc.
- Check resets of all starters and controls having manual reset features.
- Check the flame safeguard lockout or safety switch and be sure the programmer is in the start position.
-

Never dry-fire the boiler. Always ensure the correct water level is inside of the boiler prior to firing

Caution: Do not bypass the pre-purge cycle, as four (4) complete air changes are required through the furnace prior to ignition.

- Before any start, be sure there is no trace of fuel oil, gas or fumes.

Caution: Carefully check the fireside prior to attempting "light off".

- Check the main stop valve. Be sure it is closed.
- Check the safety valve for correct setting.
- Make sure that discharge piping from safety valves is piped to a SAFE point of discharge.

Caution: The emission of hot water or steam can cause serious injury to personnel or damage to property. Make sure the system is "SAFE".

- Steam Boilers should be filled with water to proper operating level (refer to point marked on steam drum) using water or ambient temperature. Make sure that treated feedwater is available and used. Open the test valve to vent air displaced during filling. Leave test valve open until escape of steam is noted after burner is operating.
- Watch the water level as the boiler is being warmed.
- When the steam gage records a pressure on the boiler, blow down the gage glass, water column and LWCO.
- When the boiler is a few pounds below the header pressure slowly crack the main boiler stop valve and allow the pressure to equalize, then open the main boiler stop valve slowly until it is wide open. The steam boiler is now on-line.

This is the recommended firing schedule for refractory curing and only for initial boiler commissioning. This does not need to be repeated at every start up

1St. Hour – 15 minute intervals, (ie; fire 1 minute) at low fire

HOLD 8 hours at 200-700 F
Raise at 75 degrees Fahrenheit per hour to 50% firing rate (1200 F)
HOLD 8 hours at 1200 F
Raise at 100 degrees Fahrenheit per hour to 75% firing rate (2000 F)
HOLD 8 hours at 2000 F
Raise at 150 degrees Fahrenheit per hour to operating firing rate

The schedule is designed to maximize the service life of refractories. Where time does not permit adherence to these procedures, greater stress will be generated and may reduce the service life through increases in crack formation. Fulton utilizes a multi-layer refractory wall system that should stop any cracks from affecting steel but in no case does this design compensate for improper curing.

- Hot Water heating applications require the entire system to be filled and vented. A hot water boiler that has been cleaned and filled with raw water (and that water treated) and with no make-up water added will require no further cleaning or treatment. If the system allows the entrance of air or unnoticed or undetected leakage of water, introduction of raw water make-up or air may lead to pitting, corrosion and formation of sludge, sediment, scale etc., on the pressure vessel waterside.
- If the system is tight, an annual waterside inspection is adequate. If there are any doubts, then the pressure vessel waterside should be inspected within 3 months after placing the boiler in service.
- A hot water system not properly vented could cause air pockets to fool the low water cut-off causing a manual reset. Check for proper venting.
- Check all linkage for full and free movement of the damper, metering valves and cams.
- Check for rotation of all motors by momentarily closing the motor starter or relay.
- Be sure that boiler feed pump or oil supply pump valves are properly positioned.
- Inspect operating limit control for proper setting.

(a) The pressure control on a steam boiler should be set slightly above the highest desired steam pressure, but at least 10% lower than the setting of the safety valves.

(b) The temperature control on a hot water boiler should be set slightly above the highest desired water temperature and within the limits of the pressure vessel.

- Inspect the high limit control for proper setting.

(a) On a high pressure steam boiler this should be set approximately 10 lbs. above the operating limit pressure control setting, if feasible, or midway between operating limit pressure and safety valve setting. The setting on a low pressure steam boiler may be 2 or 3 lbs. above the operating limit setting but must not exceed valve setting.

(b) On a hot water boiler the temperature control should be 5 to 10° above the operation limit temperature control setting.

- Inspect the modulating control for proper setting.

  This control must be set and adjusted so that the modulating motor returns to low fire position before the operating limit control opens.

NOTE: The settings of all the above controls may require some re-adjustment after boiler is started and running for a short period. The scale settings on the controls are relatively accurate, but are principally for use as guides. Final adjustment should be based on and agree with the reading of the steam pressure gauge or the water temperature thermometer.

- Inspect the low water cut-off and pump control as well as the auxiliary low water cut-off (if your boiler is equipped with this optional device). Normally no adjustment is required since these controls are pre-set by the original manufacturer. Check for freedom of movement. Float movement can be verified by observing the level of water in the gauge glass when the water supply has been cut-off either by the stopping of the feed pump or by the closing of a valve, and the restarting of the pump or opening of the valve when water is drained from the pressure vessel. The importance of proper functioning of low water controls cannot be over-emphasized. Make sure that the control and the piping is plumb.

- The settings of controls relating to fuel, either oil or gas, are covered in subsequent sections.
- In the event the boiler is equipped with optional control devices not listed here, be certain to ascertain that their settings are correct. If additional information is required, see your local Fulton representative or contact Fulton.
- On initial start-up or whenever the boiler is placed into operation from a

"cold" start, the manual–automatic selector switch should be set at "manual" and the manual control set at "minimum". After boiler is in operation and thoroughly warmed the selector switch should be turned to "automatic", so that the burner firing rate may be controlled by the modulating control in accordance with load demands.

- Close all power entrance switches (supplied by others).

Gas Pilots

- The gas pilot should be checked for satisfactory performance prior to initial firing. Follow the pilot flame adjustment instructions in the burner manual.
- On initial starting attempts, several efforts might be required to accomplish bleeding time of time pilot line. While checking pilot adjustment observe whether pilot flame is extinguished promptly when burner switch is open. Lingering flame is indicative of a leaking gas pilot valve and a condition requiring correction before proceeding.

Atomizing Air

- The supply and pressure of the atomizing air on an oil fired burner should be checked. Before starting, inspect the oil pump lube oil level. Add oil if necessary.

Startup, Operating and Shutdown – All Fuels

- Set the manual-automatic switch to "manual" and turn manual flame control to "minimum".
- Turn burner switch to "on". Load demand light should glow. Low water level light should remain out indicating safe water level in boiler.
- The programmer is now sequencing.

NOTE: On an initial starting attempt, several efforts might be required to accomplish "bleeding" of fuel lines, main or pilot. If ignition does not then occur, do not repeat unsuccessful attempts without rechecking burner and pilot adjustment.

- On ignition failure the flame light will glow and the blower will purge the boiler of unburned fuel vapors before stopping. After ignition failure wait a few moments before re-setting the lockout switch.

Caution: Do not re-light the pilot or attempt to start the main burner, either oil or gas, if combustion chamber is hot and/or gas or oil vapor combustion gases are present in the furnace or flue passages. The burner and control system is

designed to provide a "pre-purge" period of fan operation prior to establishing ignition spark and pilot flame. Do not attempt to alter the system or take any action that might circumvent this feature.

- After main flame ignition the burner should be left on manual control at its low fire setting (that is, with manual flame control at "close") for about 30 minutes or until boiler is properly warmed, unless it reaches its normal operating pressure or temperature sooner.
- In the case of a steam boiler, CLOSE THE TEST VALVE when steam begins to appear.
- A hot water boiler must have a continuous flow of system water through the vessel during warm-up period. The entire water content of the system and boiler must be warmed prior to increasing fuel input.
- If flame at low fire setting is insufficient to reach normal operation pressure or temperature after 30 minutes, gradually increase the firing rate by turning the manual flame control in one point increments to no higher than the midpoint between close and open. Operate at this increased fuel input rate for a period of time until an increase is noted in pressure or temperature. Sustained operation of the boiler should never be maintained when the manual control is set beyond midpoint.
- After unit is thoroughly warmed, turn the manual flame control to high fire. At this point a combustion analysis should be made, with instruments, and fuel flow regulated as required. After making the high-fire adjustment manually position the burner over the range from high to low fire stopping at intermediate points, analyzing combustion gases and adjusting as required.
- To properly perform this testing and adjusting, it is necessary that the burner be allowed to fire at maximum rate sufficiently long enough to achieve desired results.

Operating

- Normal operation should be with the manual-automatic switch set at “auto” and under the control of the modulating or temperature control.

Caution: If the firing rate controller is operated in the manual position at other than low fire, the pressure vessel steel and refractory are subjected to undesirable conditions. If the manually selected firing rate generates more steam than the system is demanding the boiler will be subject to overheating or over-pressurization potentially damaging the boiler and lifting safety relief valves.

- With the switch set at “auto”, burner will operate on a modulating basis according to the load demand.
- The burner will continue to operate with modulated firing until operating limit pressure or temperature is reached, unless:
  a) Burner is manually turned “off”.
  b) Low water condition is detected by low water level control.
  c) Current or fuel supply is interrupted.
  d) Pressure of combustion (or atomizing) air drops below minimum level.
  e) There can be many other reasons for a burner shutdown such as but not limited to motor overheat, flame outages, tripped circuit breakers, blown fuses, or through other interlock devices in the circuitry.
- When the burner is shut down normally, by either the operating limit control or by manually switching burner off, the load demand light no longer glows.
- Shutdown through conditions causing safety or interlock controls to open will actuate the flame failure light (and alarm if so equipped) and the load demand light will remain lit. The cause of this type of shutdown will have to be located, investigated and corrected before operation can be resumed. Refer to the “trouble-shooting” section of your burner manual.

CAUTION: If the safety relief valve has discharged there is a significant problem. Immediately remove the boiler from service and consult a trained service technician.

Shutdown

When the operating limit control setting is reached to open the circuit or if the burner switch is turned “off”, the following sequence occurs:

1. The fuel valve(s) is de-energized and flame extinguished.
2. The blower motor continues running to force air through the furnace in the post-purged period.
3. The air or oil pump motor of an oil-fired burner is de-energized
4. At the end of the programmed post-purge period the blower motor is de-energized.
5. The fuel linkages are returned to low fire position
6. The unit is ready to re-start

CAUTION: It is advisable to check for tight shutoff of fuel valves. Despite precautions and strainers, foreign material in either new or renovated fuel lines may lodge under a valve seat preventing tight closure. This is especially true in new installation. Promptly correct any conditions causing leakage.

Control Operational Test and Checks

Proper operation of the various controls should be verified and tested when the boiler is initially placed into service or whenever a control is replaced. Periodic checks should be made thereafter in accordance with a planned maintenance program as performed by a qualified technician.

- Operating Limit Test: The operating limit control may be checked by allowing steam pressure or water temperature to increase until the burner shuts down.
    - Hot Water Boiler: On a hot water boiler that may be operating at less than full load supply water temperature may be raised by manually increasing the firing rate until the burner shuts down through the action of the operating limit control. Observe the thermometer to verify the desired settings at the point of cutout and again when burner restarts. Return the manual automatic switch to “automatic” and check the modulating control for the desired temperature range

- Steam Boiler: Depending upon the load, it may be necessary to manually increase the firing rate to raise steam pressure to the burner shut off point. If load is heavy, the header valve can be closed or throttled until the pressure increases. Observe the steam gauge to check the cutoff pressure as the pressure or vent steam and check the cut-in setting as the burner restarts. Check the modulating control for desired operating pressure range.

- Observe the ignition and programming control operations to make sure that they are correct. Check the proper operation and setting of the low water cut-off (and pump control, if used).

- Proper operation of the flame failure device should be checked at time of starting and at least once a week thereafter.

- Check for tight shut-off of all fuel valves. Despite precautions and strainers, foreign material may lodge under a valve seat preventing tight closure. Promptly correct any conditions causing leakage.

Care and Maintenance

Boiler Water Treatment - Heating Boilers: Water treatment is required for satisfactory operation of a boiler to prevent depositing of scale and to prevent corrosion from acids, oxygen and other harmful elements that may be in the water supply. A qualified water treatment specialist should be consulted and the water treated.

The basic aims and objectives of boiler water conditioning are:

I. Prevent the accumulation of scale and deposits in the boiler.
II. Remove dissolved gases from the water.
III. Protect the boiler against corrosion.
IV. Eliminate carryover and/or priming (steam only).
V. Maintain the highest possible boiler efficiency.
VI. Decrease the amount of boiler down time for cleaning.

Water treatment should be checked and maintained on a regular basis. The end user should be sure that the boiler is not operated for long periods for approval tests or any other operation of firing without water treatment. It should also be noted that water boilers may well need chemical treatment for the first filling of water and additional periodic chemical treatment, depending on the system losses and the make-up requirements. Water treatment may vary from season to season or over a period of time; therefore, there should be a requirement that a water treatment procedure is checked no less than four times a year and possibly more frequently as the local water conditions may require. When the system is drained and then refilled, chemical treatment is required, in as much as raw water has been put into the boiler and system.

Weekly Maintenance

- Although the Fulton FB-X boiler is fully automatic, it must not be put into operation and forgotten.
- At least once a week, all controls and burner operation should be checked for proper, automatic operation.
- The fire must be observed, noting whether it is clean and normal.

Annual Maintenance

1) Open access to furnace (hinged door or rear manway depending on boiler size);
2) Inspect for signs of soot formation or gas side condensing on tube surfaces;
3) Inspect for signs of flame impingement (discoloration of metal surfaces);
4) Inspect tubes for signs of sagging tubes. This is evidence of water side scaling or tube plugging;
5) Remove jacket panels on left hand side. Panels are vertical;
6) Remove housing panel and exposed pass cover plate on left hand side. For model sizes up to and including 700 housing panels are horizontal. Remove only upper panel for inspection. For larger sizes housing panels are vertical. Remove panel towards rear of boiler (jacket panel removed in (5) above must coincide with location of housing panel to be removed);
7) Inspect 4th pass for signs of soot formation or gas side condensing on tube surfaces;
8) If soot or rust is present, remove all side jacket panels and all side housing panels (both sides) and perform items 9-12 below. Otherwise, proceed to item 13;
9) Remove pass cover plates;
10) Remove upper front and rear wall jacket and housing panels;
11) Perform thorough cleaning of all exposed tube surfaces, 2nd and 4th passes from the sides and 3rd and 5th passes from the ends;

12) Remove loose soot or rust by blowing or by vacuum;
13) Replace pass cover plates as needed;
14) Replace side housing insulation as needed;
15) Replace housing gaskets as needed;
16) Reassemble housing and seal with silicone sealant;
17) Reassemble jacket panels;
18) Remove hand holes on upper and lower drums;
19) Inspect drums for presence of any solids or foreign materials;
20) If present remove materials from drums;
21) If item 4 above showed signs of sagging tubes, remove tubes for replacement;
22) Replace hand holes using new hand hole gaskets;
23) Contact factory at any point during process with questions or for clarifications;

- As carbon (soot) is an insulator, as well as corrosive, the heating surfaces of the boiler must be kept free from any soot accumulations to keep the boiler operating at its highest efficiency, note the stack temperature regularly.

- If the yearly inspection of the boiler tube surfaces reveals a build-up of soot (carbon) or rust (due to condensation), the tube surfaces should be thoroughly brushed. The flue gas venting system should also be thoroughly inspected internally and cleaned as necessary.

- IMPORTANT: If either soot or condensation are apparent, a reputable service agency should be consulted. The presence of soot indicates poor combustion, and a combustion test and readjustment should be undertaken at once. Rust on the tubes indicates operating temperatures are too low.

- A minimum boiler water temperature must be maintained to prevent corrosion or scaling of the fireside heating surface.

- The product of combustion from the burning of all types of fuels contain water vapor (H_2O) resulting from the chemical union of hydrogen in the fuel with oxygen in the air. Therefore, there is a boiler tube temperature at which the water vapor will condense on the tube surfaces. Since such condensation will result in rusting, scaling and early failure of boiler metals, a minimum boiler temperature must be maintained which is above that temperature at which condensation will take place.

- The average dew point temperature for natural gas combustion products is 127°F. Most boiler manufacturers

recommend a minimum boiler water temperature of 150°F, but due to the modern design of the Fulton boiler we generally recommend that the minimum water temperature for our boiler be maintained between 140°F - 145°F.

- Normally, fuel gas condensation problems occur under any one or a combination of:

  I. An outside reset temperature control is used to vary boiler water temperature according to outside temperature.
  II. The system design involves a combination hot and chilled water system in which a portion of the chilled water is returned to the boiler.
  III. The boiler is greatly oversized for the actual load, resulting in intermittent operation at low firing rates.
  IV. The boiler installation is located near a body of water where the atmosphere is highly humid.
  V. The low fire setting is set to low. A boiler naturally extracts all of the possible heat it can from the flue gases. Even if the boiler water temperature is maintained at a reasonable level to prevent condensation within the boiler, it is still possible (by setting the low fire too low) to incur condensation, and subsequent deterioration in metal breechings and stacks.

Replacement Boiler Installations

Protection Against Corrosion & Sediment

The number of boilers being sold for replacement (retrofit) applications is on the rise. This is due, in part, to energy costs of old, inefficient boilers; to conversion from municipal or central steam to on-site boilers; and to replacement of damaged or worn out boilers. Fulton is very active in this market. And the Fulton boiler line lends itself well because of the small package size and the capability of being shipped as field erect *"FE"* construction.

We want to alert you to some of the precautions, which must be exercised when installing a new boiler on any old system. It is imperative that the owner and the installer be made fully aware of the hazards of simply pulling out an old boiler and putting in a new one.

The following guidelines must be stressed to the owner and the installer to assure that the new boiler will perform well, last a useful life, and provide energy efficiency.

- Clean, or Replace, All System Piping and Heating Units
- Arrange for chemical and mechanical cleaning of the entire system.
- A chemical treatment company should be consulted for the proper means of chemical cleaning.
- Replace any piping considered to be deteriorated beyond safe or cleanable condition.
- Flush the system clean, independent of the boiler. DO NOT FLUSH THE SYSTEM THROUGH THE BOILER.

When filling the system, provide chemical treatment as previously outlined. For some older systems, there is a reluctance to chemically clean the piping because of the likelihood of leaks occurring in badly corroded lines. Should the customer decline cleaning; it is good practice and may be necessary to install filtration equipment. Install either a fibrous filter or a centrifugal filter in the boiler return piping. This will collect and remove sediment from the system. A booster pump may be necessary to overcome the additional pressure drop introduced in the line by the filter. Supply of this pump by others.

CAUTION: FAILURE TO PROPERLY CLEAN THE SYSTEM OR INSTALL

MECHANICAL SEDIMENT REMOVAL EQUIPEMENT CAN RESULT IN TUBE STOPPAGE AND CORROSION PLUS DAMAGE TO PUMPS, AIR REMOVAL DEVICES AND CONTROLS. THESE CONDITIONS WILL AFFECT BOILER WARRANTY.

- Inspect the system for proper location and design of air elimination devices.
- Inspect and test all air elimination devices in the system and replace any suspect devices.
- Install gauge glasses on airhead expansion tanks and install a tank fitting in the system connection to the tank.

EXTENDED BOILER LAYUP

If the boiler is to be placed into an extended lay-up the following items need to be accomplished.

- Use the burner controls to safely shut the burner off
- The electric power to the control panel should be disconnected to insure no accidental restart of the boiler
- Once shut-off isolate the boiler from the system and allow the boiler to cool slowly.
    - Water-side: close isolation valves
    - Gas-side: close manual gas cocks
- The flue gas isolation damper (if installed) should be closed to minimize air flow through the boiler
- Once cool, slowly open the vents to allow pressure to be safely bled off
- If the lay-up is to be of a short-term then the unit may be kept in a wet lay-up
    - Ensure that the boiler is not exposed to a freezing condition
    - Once pressure is equalized close all vents to insure no additional fresh air is allowed to enter the system
- If the boiler is to be kept off-line for an extended period of time the unit can be placed into a dry lay-up
    - The boiler should be drained and a desiccant placed into the boiler
    - After installation of the desicant all pressure side openings should be closed to keep fresh air and oxygen out of the boiler
    - It is recommended that blind flanges be installed in the gas and/or fuel oil lines for additional insurance that no fuel is able to leak into the furnace.
    - Upon restarting of the boiler, a complete waterside and fireside inspection should be accomplished
- For either lay-up ensure that the safety relief valve is free of standing water and is dry to avoid corrosion of the assembly

The ability to quickly and easily replace individual tube elements is a key design feature of the Fulton FB-X boiler. This feature requires the utilization of both easily removable outer casing as well as tube elements that do not require code welders. No ASME Code welding is required to execute the repair of a Fulton FB-X boiler. All Fulton FB-X boilers feature a mechanical tapered fitting connection and a bolted base plate to secure the tubes in position. All outer casing panels are connected to the boiler with easily removable and reusable screws. The panels also allow for the quick and easy identification of the location of a potential tube problem. Anyone that has had to repair a membrane boiler will appreciate the ease of repair of the Fulton design.

If you suspect that a tube may be leaking the procedure for identification and repair is as follows:

1. Secure the boiler for the system and insure that the burner cannot be lit. This can be accomplished by closing and tagging the gas cocks or even physically removing a segment of gas line. Insure that the stop and non return valves are closed to isolate the boiler from a common steam header if applicable

2. Once the boiler has cooled down you may remove the outer casing from the area where you suspect the problem to be. Do not drain the boiler yet as the water pressure will help point to he problem area.

3. Once the problem has been identified the boiler may be drained.

4. Unbolt the nut that holds the plate over the tube ferrules from the upper and lower drums

5. Remove the damaged tube by utilizing Fulton tube removal tools.

6. Once removed the tube holes on the drums should be inspected to insure proper surface conditions.

7. Install the replacement tube as supplied by Fulton.

Note! Fulton tube end ferrules are machined to extreme tolerances. Fulton does not recommend the use of aftermarket parts not manufactured directly by Fulton

8. With the new tube in position a 10 to 12 pound sledge hammer should be used in conjunction with Fulton drive tool to insure the striking force is directed onto the landing on the ferrule and no other place on the tube. The ferrule may require two to three strong strikes with the sledge to insure proper sealing. Measure insertion depth to recommended setting.

9. Once the tube ferrules have been hammered into both drums the retaining plates can be reinstalled with their bolt.

10. The unit should be refilled with water insuring proper sealing of the repaired area.

11. Once the connection is confirmed as sealed the outer panels can placed replaced and the boiler returned to service using the start-up instructions as provided in this manual.

TROUBLESHOOTING

If you are not a professional trained boiler service technician qualified to work on this equipment then do not attempt any repair on the equipment and contact Fulton or your local agent for support.

Prior to conducting any service insure that all safety precautions are taken including isolating the boiler, electric, and fuel from the boiler system as applicable.

Not all scenarios can be identified in a manual. The suggestions below are the most common. All corrective actions ultimately are the responsibility of the service technician.

Problem: Boiler Will Not Fire

1. Is the boiler on ?

   - Check to insure that the boiler has correct utilities supplied including electricity and fuel.
   - Check fuses, breakers, and disconnects to the control panel.
   - Check the position of shut-off lines from fuel sources. Pressure gages on the fuel lines should verify proper fuel supply.

2. Is there a demand for heat?

   - Is the firing rate control receiving a demand for heat signal, either steam or hot water?
   - If the BMS is receiving a demand for heat signal from either it's local firing rate control or a remote lead-lag system then the BMS should identify the demand signal and begin the start-up process.
   - If no demand signal is received by the BMS then the issue probably lies with the local operating control pressuretrols for steam and aquastats for hot water boilers or the lead-lag sequencer for a multiple boiler installation. Refer to the specific manufacturer's manuals for those components to diagnose the fault further.

3. A demand for heat is established but the boiler is still not firing

   - If the demand signal to the BMS exist and the boiler is not firing check the BMS for a start-up or operational permissive fault. Refer to the manufacturers instructions for the specific BMS or supplied with the burner for fault identification. Examples of BMS limits are as follows but not limited to:
     - High or low fuel supply pressure
     - Failure of automatic fuel supply valves
     - High or low water level inside of the boiler
     - High pressure or high water temperature inside of boiler
     - Insufficient combustion air pressure
     - Failure to light or sustain the flame

   - The BMS has a specific start-up sequence. Refer to the manufacturer's manual for the specific BMS supplied with the burner
     - When the BMS receives a demand for heat signal it will follow a defined sequence of events to start the burner including but not limited :
       - Insure automatic fuel valves are in close position
       - Check low water/high pressure/high temperature cut offs
       - Return the burner to a low fire position
       - Start the FD fan and execute the required purge
       - Light off pilot and prove flame
       - Light off main burner and prove flame at low fire
     - Once flame has been proven at low fire the BMS hands the firing rate control off to the local firing rate controller or lead-lag sequencer.
     - By taking information from the BMS as well as observing the start-up sequence it should be able to diagnose the specific reason for the fault.

4. Boiler starts but immediately shuts off

   - If the boiler shuts off immediately after a successful start-up it is most probable that the boiler is "Short Cycling".
   - This is most probably a problem with the boiler operating controls being configured as not to allow for a normal operating span.
     - Check the manufacturers manual as to proper set points for the pressuretrols or aquastats
   - This may also be a case of a boiler oversized for the demand not allowing the burner to operate at very low turndown range forcing the boiler to shut off.
   - Short cycling can lead to damage to the boiler and steam system and is extremely inefficient

5. The boiler shuts off during normal operation when there is a demand for heat.

   - Check the BMS for the reason for the shutdown. There are many reason that a boiler would shut off during normal operation including the following but not limited to:
     - Aggressive load swings or improper water level control can lead to low water trip
     - Aggressive load swings could lead to a system over pressurization leading to a shutdown due to apparent system load satisfied
     - Water in the fuel could lead sputtering combustion and a flame scanner safety shutdown
     - Fuel pressure fluctuations could lead to the BMS safety shutdown
     - If firing oil check for a clogged tip and proper atomizing media
     - Electric utility issues could lead to a safety trip
     - Any electrical component in the system could be faulty

6. The boiler makes excessive noise when firing

   - There are many different sources of noise inside of a boiler in service. The source of the noise must first be identified:
     - Combustion Rumbling:
       - A burner that is not properly tuned can rumble. Varied atmospheric conditions, high operating hours without tuning, and changes to the boiler system in general could lead to burner rumbling. This could be a dangerous situation and a qualified combustion technician should immediately be consulted. If there is any question about the safety of the unit the boiler should immediately be shut off.
       - **Danger: Improper fuel-air ratios can lead to an explosive situation**.
       - The vibration can lead to damage of the boiler and trim
     - Leaks
       - A boiler suffering leaks can emit a water or steam spray as well as making a noise.
       - **Danger: Be careful not to allow the spray to come in contact with unprotected body parts**
     - Failing Components
       - Failing fan bearings or failing automatic valves can emit a distinctive noise

- Once the reason for the noise has been identified the suspect device should be repaired or replaced as applicable.
- Use the sight opening in either the burner or located in rear of the boiler (if installed) to observe the flame pattern. Viewing the flame pattern is an effective way to diagnose combustion issues.

7. The safety relief valves are lifting

- The safety relief valves should never lift. If they do it is indicative of a major problem within the system. There are many reasons the valves may be lifting. The include but are not limited to:
  - Failure of high-fire limit: if the firing rate control is broken or improperly adjusted the burner may be at a fifing rate that exceeds system demand causing an excessive build-up of pressure within the boiler. This would be excessive pressure for a steam boiler and high temperature for a hot water boiler.
  - Aggressive load change: If the system places aggressive load swings on the boiler it is possible that the boiler controls may not be able to track these load swings. An instantaneous stopping of demand on a boiler already at a high firing rate could allow the pressure to build faster than the burner can ramp down.
  - Damaged safety valves: Safety relief valves can suffer scarring across the seat leading to weeping and improper lifting.
  - Damaged burner: the firing rate control mechanism on the burner may be damaged not allowing the burner to accurately track load

8. The boiler trips because of water level

- Low and high water level trips are an important safety interlocks. The action of the level inside of the steam drum can be observed on the gauge glass. Catastrophic damage can occur if a boiler is dry fired. Damage to the plant can occur from excessive water levels either through poor quality steam or flooding of the steam header. Some common reasons for low water trips is as follows:
  - Excessive demand: if the system is demanding more steam than the boiler can produce the drum pressure will begin to fall ultimately sucking the water out of the boiler leading to a low level trip
  - Insufficient feedwater pump capacity: If the boiler is demanding more water than the feedwater pump is capable of pumping the boiler can trip on low water.

  - Aggressive load swings:

Aggressive load swings can lead to excessive water level fluctuations leading to low or high level trips

- Poor water chemistry or contaminated water: poor water chemistry can lead to excessive solids in the steam drum. This will lead to foaming that can provide false signals to the level controls. Bubbles formed in poor water can mask low water level conditions with float-type water level devices. Improper chemistry can also lead to nuisance trips of probe-type devices.
- Improper control system: The type of drum level control system may not be sufficient to the actual operation of the boiler. Some problems may be as follows:
  - Slow operating feedwater regulating valve: Boilers equipped with a modulating feedwater system may not have a fast enough response time to react to load change
  - Level control scheme: Boilers equipped with only a single element feedwater control system may need to be upgraded to a two element control if the boiler is subjected to aggressive load swings.
  - Adequate feedwater flow rate: The flow rate of a feedwater pump must be suitable to not only meet the demand of the boiler at a given firing rate but provide additional water flow capacity to fill a steam drum that could be rapidly depleted by a high instantaneous demand. Boilers equipped with on-off feedwater system are susceptible to low water trip if the pumps are undersized .

9. The boiler may be leaking

- There are many ways to identify a leak inside of the boiler, Should a leak be detected it is important to have your service technician examine the situation.
  - Water leaking from boiler drains
  - Water leak observed through boiler sight glass
  - Excessive plume exiting stack
  - Excessive condensation in ductwork drains
  - Excessive make-up water usage
  - Reduced stack temperatures
- Boilers can remain in service until a time convenient to shut down the boiler and execute a repair
- If a leak is identified contact Fulton for the supply of replacement parts

THE INFORMATION CONTAINED IN THIS MANUAL IS PROVIDED AS A GUIDE ONLY. IF FOLLOWED, A SUCCESSFUL START UP AND OPERATIONAL HISTORY SHOULD RESULT.

Limited Warranty

FBX Steam Boilers

Provided the boiler is installed, commissioned, controlled, operated, and maintained in accordance with Fulton's Installation, Operation and Maintenance Manual, and the Fulton Authorized Representative or Fulton Factory Technician has successfully completed and returned the equipment Installation and Operation Checklists to the Fulton Quality department, Fulton provides the following limited warranty:

PRESSURE VESSEL WARRANTY

The pressure vessel is warrantied for five (5) years from the date of shipment from the factory against failures determined by Fulton to be the result of defective materials or workmanship. If so determined, Fulton will repair, replace, exchange or credit, at Fulton's sole discretion, the pressure vessel, F.C.A. factory. Waterside corrosion or scaling is not covered. Fireside corrosion due to contaminated combustion air or fuel is not covered. Failures outside of the ASME pressure vessel boundary are not covered under this section.

PARTS WARRANTY

Fulton will repair or replace F.C.A. factory any part of the equipment of our manufacture that is found to be defective in workmanship or material within eighteen (18) months of shipment from the factory or one (1) year from startup provided this equipment has been installed, operated, and maintained by the buyer in accordance with requirements in the manuals of Fulton and the component's manufacturer.

CONDITIONS OF WARRANTY

The warranty is valid for the original installation and original owner only. Any modifications, adjustments, repairs, or replacement parts to the equipment not authorized by Fulton will void this warranty.

Fulton shall be notified in writing as soon as any defect or failure becomes apparent. These can be emailed to warranty@fulton.com. Failure to do so may limit Fulton's obligations under this warranty or render the warranty invalid in whole or in part. No agent or representative of Fulton has authority to modify or alter the conditions of warranty. A formal Purchase Order is required prior to shipment of any replacement warranty item. This warranty does not include freight, handling, or labor charges.

To the extent not prohibited by law in the state, province, jurisdiction or country of purchase, this warranty and the remedies set forth are exclusive and in lieu of all other warranties, remedies, and conditions, whether oral, written, statutory, express, or implied, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event or under any circumstances shall Fulton be liable for any consequential, incidental, special, punitive, or other indirect damages arising in any way including, but not limited to, loss of profits or business, even if Fulton has been advised of the possibility of such damages. Under no circumstances shall Fulton's liability exceed the amount paid to Fulton for the original equipment.

THIS LIMITED WARRANTY IS GOVERNED BY AND CONSTRUED UNDER THE LAWS OF THE STATE, COUNTRY, JURISDICTION, OR PROVINCE IN WHICH THE PRODUCT WAS ORIGINALLY SOLD BY FULTON. THE LIMITED WARRANTY TERMS CONTAINED IN THIS STATEMENT, EXCEPT TO THE EXTENT LAWFULLY PERMITTED, DO NOT EXCLUDE, RESTRICT, OR MODIFY BUT ARE IN ADDITION TO THE MANDATORY STATUTORY RIGHTS APPLICABLE TO THE SALE OF THIS PRODUCT. OUTSIDE THE UNITED STATES AND CANADA AND TO THE EXTENT SUCH WARRANTIES, TERMS AND CONDITIONS CANNOT BE DISCLAIMED AND ARE PERMITTED BY APPLICABLE LAW, FULTON LIMITS THE DURATION AND REMEDIES OF SUCH WARRANTIES AND CONDITIONS TO EIGHTEEN (18) MONTHS OF SHIPMENT FROM THE FACTORY OR ONE (1) YEAR FROM STARTUP, WHICHEVER COMES FIRST. THIS LIMITED WARRANTY GIVES THE PURCHASER SPECIFIC LEGAL RIGHTS, AND THE PURCHASER MAY HAVE OTHER LEGAL RIGHTS, WHICH MAY VARY BY STATE, COUNTRY, JURISDICTION, OR PROVINCE.