SUPERIOR BOILER

3524 East 4th Avenue Hutchinson, KS 67501
PH: (620) 662-6693
FAX: (620) 662-7586
www.superiorboiler.com

LIMITED WARRANTY

Superior warrants all equipment manufactured by it and bearing its nameplate to be free from defects in workmanship and material, under normal use and service within one year from the date the equipment is first placed in use for any purpose, temporary or otherwise, or eighteen (18) months from the date of shipment, whichever shall be less. Except where a different expressed written warranty has been issued, no warranty of any kind, express or implied, is extended by Superior to any person or persons other than its direct buyer.

Superior shall have no responsibility for the performance of any product sold by it under conditions varying materially from those under which such product is usually tested under existing industry standards, nor for any damage to the product from abrasion, erosion, corrosion, deterioration or the like due to abnormal temperatures or the influences of foreign matter or energy, nor for the design or operation of any system of which any such product may be made a part or for the suitability of any such product for any particular application. Superior shall not be liable for any cost or expense, including without limitation, labor expense, in connection with the removal or replacement of alleged defective equipment or any part or portion thereof, nor for incidental or consequential damages of any kind. Any substitution of parts not of Superior's manufacture or not authorized by Superior, or any modification, tampering, or manipulation of Superior's product shall void any and all warranties. Alteration of any parts without express written permission of Superior for a purpose other than that intended shall void any and all warranties. Under no circumstances shall Superior's liability exceed the amount paid to Superior for the original equipment.

It is the owner's responsibility to operate the boiler safely and to follow procedures to ensure proper care and maintenance as per the operations and maintenance manual. This warranty is contingent upon proper evidence that the installation is recorded at the factory; is consistent with Manufacturer's design, operation and maintenance recommendations and meets local codes.

The foregoing warranties shall not apply to products or parts not manufactured by Superior.

THIS LIMITED WARRANTY IS GOVERNED BY AND CONSTRUED UNDER THE LAWS OF THE STATE, COUNTRY, JURISDICTION, OR PROVINCE IN WHICH THE PRODUCT WAS ORIGINALLY PURCHASED. 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 TO THE PURCHASER. OUTSIDE THE UNITED STATES AND TO THE EXTENT SUCH WARRANTIES, TERMS AND CONDITIONS CANNOT BE DISCLAIMED AND ARE PERMITTED BY APPLICABLE LAW, SUPERIOR LIMITS THE DURATION AND REMEDIES OF SUCH WARRANTIES AND CONDITIONS TO EIGHTEEN (18) MONTHS OF SHIPMENT FROM THE FACTORY OR TWELVE (12) MONTHS 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.

There are no express or implied warranties which extend beyond those contained herein.

NOTE: All new boilers must be boiled out or Superior Boiler will void the warranty.

NOTE: WARRANTY VALIDATION: Field start-up report must be completed, dated, signed, and returned within 15 days of field start-up to Superior Boiler ATTN: Sales Department to validate warranty.

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BOILER INSTALLATION INSTRUCTIONS

RECEIVING THE BOILER

During the construction of your new boiler, over one hundred (100) separate inspections were made of the unit. These inspections started with the engineering drawing, which your unit was built to, and ended with the signing of the bill of lading by the freight carrier. These inspections were made by our Quality Control Department and our insurance inspection agency. At the time the freight carrier signed the bill of lading at our factory, he acknowledged that the unit was received by him in an undamaged condition. It is good practice for you, prior to signing the freight carrier's delivery receipt to examine your boiler in detail to be sure that the unit has not been damaged in transit. If damage is evident, make a notation on the freight bill of the damage and file a claim against the carrier for the cost of replacement or repair. In the event your boiler-burner unit should have sustained concealed damage (damage which is not outwardly evident), you have up to fifteen (15) days after receipt of the unit to file a claim covering repair or replacement of the concealed damage. Most of our units are shipped with certain fragile and easily damaged parts packaged in a separate box. The freight bill will describe the number of pieces shipped. Be sure that all pieces noted on the freight bill are received.

UNLOADING THE BOILER-BURNER UNIT

Your new boiler-burner unit is equipped with lifting eyes, located on the top center line. These are to be used for unloading. A crane is the best means of unloading and setting the new unit in place. DO NOT USE A LIFTING CABLE AROUND THE UNIT. DO NOT USE A FORK LIFT UNDER THE DRUM OF THE BOILER.

EXTENDED OUTDOOR STORAGE

If a newly delivered boiler is to be placed outdoors for a long period, the following steps are beneficial:

1) The boiler should be placed on crossties under the legs, preferably on a concrete or asphalt surface.
2) Make certain that all water has drained out of the shell and bottom blowdown piping.
3) Plug all remaining open connections in the boiler shell and close all blowdown valves – bottom, water column, and surface.
4) Remove the manway cover and place trays of silica gel desiccant on the uppermost row of tubes. The condition of the desiccant should be checked weekly, and it should be replaced when it changes color.
5) The electrical enclosures and panels will also require silica gel in cloth bags to protect against condensation. These bags should also be checked weekly.
6) The entire boiler should be covered with a tarp, with emphasis on protection for the gas train, oil pump, air compressor, and low water cutoff junction box.

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PUTTING THE BOILER IN PLACE

See “BOILER UNLOADING INSTRUCTIONS” furnished with your boiler and in the original submittal.

THE BOILER ROOM

Local building codes and insurance requirements usually dictate the type of construction and the material to be used in the boiler room. The boiler room floor should be of adequate strength to support the weight of the boiler full of water. The boiler room floor should include a floor drain. It is advisable to use, when possible, wall and floor surfaces that permit hosing. Room should be provided in the boiler room to accommodate the boiler unit or units, boiler feedwater equipment, boiler water treatment equipment, fuel oil pumps, and any other equipment that may be required in the boiler room. Space should be provided at the rear of the boiler to completely open the rear door. Room must be provided at either the front or rear end of the boiler to permit re-tubing. If possible, re-tubing room should be provided at the burner end of the new boiler, as tube removal is considerably easier at this end.

Adequate space should be provided around each boiler to permit cleaning and inspection of all piping supplied with the boiler and attached to the boiler at the job site. Each boiler room must be provided with a combustion air opening. One square inch of free flow combustion air opening is required for each 14,000 BTU input rating of the boiler.

SETTING THE BOILER

After the boiler has been set in place, it is necessary that each unit be leveled. Once the boiler has been permanently installed and leveled, the skid bracket bolts should be loosened half a turn, but no more than one full turn, to allow for expansion of the boiler during operation.

CONNECTING THE STEAM LINE

Most states and jurisdictional agencies have adopted the A.S.M.E. Code, thus it is good practice to install the steam line as per this Code.

HIGH PRESSURE BOILER

Quoting from the A.S.M.E. Code: “Each discharge outlet, except safety valve, shall be fitted with a stop valve located at an accessible point in the steam delivery line, and as near the boiler nozzle as is convenient and practicable. When such outlets are over two inch (2”) pipe size, the valve or valves used in the connections shall be of the outside screw and yoke, rising spindle type so as to indicate from a distance by the position of its spindle whether it is closed or open, and the wheel may be carried either on the yoke or attached to the spindle. A plug cock type valve may be used, provided the plug is held in place by a guard or gland, the valve is equipped to indicate from a distance whether it is closed or open, and the valve is equipped with a slow opening mechanism.”

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TWO OR MORE HIGH PRESSURE BOILERS

"When boilers are connected to a common steam header, the connection from each boiler having a manhole opening shall be fitted with two (2) stop valves having an ample free flow drain between them. The discharge of this drain shall be visible to the operator while manipulating the valve. The stop valve shall consist preferably of one automatic valve of outside screw and yoke type or two (2) valves of the outside and screw and yoke type shall be used."

LOW PRESSURE HOT WATER BOILERS

Stop valve shall be placed in the supply and return pipe connections of a single hot water heating boiler installation to permit draining the boiler without emptying the system. When stop valves over two inches (2") are used, they shall be of the outside and screw yoke rising spindle type, or of such other type as to indicate at a distance by the position of its spindle or other operating mechanism whether it is closed or open. The wheel may be carried either on the yoke or attached to the spindle. If the valve is of the plug cock type, it shall be fitted with a slow opening mechanism and an indicating device, and the plug shall be held in place by a guard or gland. The steam design pressure of all valves used in water headers should equal or exceed the design pressure of the boilers they are attached to.

BLOWDOWN PIPING

Your new boiler is located with blowdown tappings on the bottom center line of the drum, a surface blowdown tapping approximately two o'clock on the drum, and the water column (if supplied) is equipped with a blowdown valve. Normally, the water column blowdown valve, the manual blowdown valve, and the surface blowdown valve are piped into a common header for discharge to a safe place. It is good practice to discharge blowdown to be exhausted through the roof of the boiler room, and the liquid of the blowdown to be discharged into a drain. In some instances, the blowdown prior to discharging into the separator is piped through a preheater located in the feedwater.

BLOWDOWN VALVES

The A.S.M.E. Code dictates the type of valve to be used on blowdown lines.

LOW PRESSURE BLOWDOWN AND DRAIN VALVES

Each boiler shall have a bottom blowoff or drainpipe connection fitted with a valve or cock connected to the lowest water space practicable.

HIGH PRESSURE BOILERS

"Straight run blow valves of the ordinary type, and valves of such type that dams or pockets can exist for the collection of sediment shall not be used for boiler blowdown service. Straight way "Y" type globe

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valves or angle valves may be used in vertical pipes, or they may be used in horizontal runs of piping provided they are so constructed or installed that the lowest edge of the opening through the seat is at least twenty-five percent (25%) of the inside diameter below the center line of the valve. Blowoff valves and pipe between them and the boiler shall be of the same size except where a larger pipe for return of condensation is used. If a blowoff cock is used, the plug shall be held in place by a guard or gland. The plug shall be distinctly marked in the line with the passage. On all boilers having working pressures exceeding 100 PSI, each bottom blowoff pipe shall have two (2) slow opening valves, or one (1) slow opening valve and a quick opening valve or cock." All blowoff valves must have a design pressure to or exceeding the design pressure of the boiler on which they are installed.

VENT CONNECTION

Your new boiler-burner unit is supplied with a forced draft burner which is capable of supplying all the air for combustion as well as draft. It is, therefore, necessary to supply only a simple stack through the boiler roof to convey the products of combustion to a point of safe discharge. For a boiler installation in a one-story building, the best and most economical stack is one of the same diameter as the stack outlet on the boiler directly through the boiler room roof.

WATER TREATMENT

Maximum trouble free boiler life is in most cases tied directly to proper boiler water treatment. Water treatment is a science of its own. The make up of water varies so much from one area to another, that there is no such thing as one treatment being effective in all areas. Treatment must be provided to prevent scale formation, oxygen corrosion, excess acidity, control of total dissolved solids, prevent caustic embrittlement, and so forth. We, therefore, recommend that you contact a reputable boiler treatment company operating in your area for advice in this field.

CALLING FOR INITIAL START-UP

The cost of start-up on your new unit has, in most cases, been included in the purchase price. In some instances, start-up has been quoted as a separate item. In either event, to prohibit you having to pay for this service twice, it is strongly recommended that you fill out the Superior Boiler Works, Inc. "Prestart-Up Inspection" (attached Form PSI-73) and mail it to your local Superior Boiler Works representative before asking for start-up service. This will eliminate the start-up man arriving at the job site before the unit is completely installed.

INITIAL START-UP

It is strongly recommended that only qualified personnel be allowed to work on your boiler. The design, manufacture, and assembly of your new unit is the result of years of engineering work and field testing. It is a sophisticated piece of equipment and can be properly serviced only by qualified people. We recommend that you contact your Superior Boiler Works representative for the name of experienced service personnel in your area.

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In initiating start-up, it is necessary that the boiler be filled with water to the proper water level, be supplied with the proper electrical voltage with the motors turning in the proper direction, have the proper fuels at the proper pressures piped to the burner to the unit, and have the boiler properly vented. All water lines must be connected and have the people trained in the operation of the unit present.

BOILER-BURNER MAINTENANCE

Periodically, the waterside surfaces of the boiler should be visually checked for scale formation, pitting, and corrosion. Scale collection should not be thicker than an eggshell, as scale is a good insulator and can considerably lower your boiler's overall efficiency. When lowering the water level or draining the boiler for inspection, caution must be used. DO NOT DRAIN A HOT BOILER QUICKLY. Good practice would dictate draining the boiler only after it has been out of service at least twenty-four (24) hours. IN NO CASE EVER FILL A WARM BOILER WITH COLD WATER. THIS WILL CAUSE TUBE LEAKAGE.

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PRESTART-UP INSPECTION

Send to:_____

Address:_____

_____

Date:_____

Owner's Name_____ Location:_____

Boiler Model:_____ National Board No._____

1. Voltage of _____ connected to boiler_____
2. Make-up water connected to unit _____
3. Gas connected to burner Gas Pressure_____ _____
4. Fuel oil suction line tested and installed _____
5. Fuel oil tank filled with #_____ grade oil _____
6. Stack erected or connected to breeching _____
7. Steam or water lines connected to boiler _____
8. Condensate return tank vented _____

The above have been checked by:_____

as of the above date.

Requested Start-Up Date_____

Signed:_____

FORM PSI-73

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OPERATION AND MAINTENANCE INSTRUCTIONS

DAILY PROCEDURE

1. Blow primary LWCO down while burner is firing. Verify that feedwater pump cycles normally and that burner shuts off.
2. Observe burner starting sequence and flame characteristics to verify normal behavior. Check furnace for debris and sooting, also inspect refractory through flame.
3. If operating log is kept, enter reading; otherwise, conduct visual check of all pressure and temperature gauge readings.
4. Check safety valves, handholes and manway for signs of leakage.
5. If boiler is firing oil, check level in oil storage tank. If burner has an atomizing air compressor, check its lubricating oil level.
6. Check stack temperature. If temperature is higher than normal, check burner operation for over-firing or improper combustion.
7. Check temperature of water supplied to unit and if below 140 °F preheat return to about 165 °F.
8. Check water sample readings for proper chemical treatment.
9. Perform bottom blowdown at an interval set by Chemical Representative.

WEEKLY PROCEDURE

1. Check combustion control operation as outlined in check list section of service manual. Investigate and correct at once any failure.
2. Check the pressure limit shutdown. During this check, observe the operation of the programming control to make sure that the operation is as described in the sequence of operation section of the service manual.
3. Wipe the entire unit, particularly the operating parts, so that oil and dust do not accumulate.
4. If firing heavy oil, clean oil nozzle as detailed in burner manufacturer's instructions. Nozzle and electrode setting must be returned to original adjustments
5. Check chemical feed equipment against check list supplied by water treatment. company. Treatment should be introduced directly into the boiler or device located on discharge side of the feedwater pump.
6. Check auxiliary LWCO to verify that it shuts burner off.

MONTHLY PROCEDURE

1. Clean feedwater strainer between the pump and the condensate return tank.
2. Clean the air intake filter on the atomizing air, if air compressor is present. Replace filter oil with clean compressor lubricating oil.
3. Clean combustion air fan and air inlet assembly.
4. Check rear door for flue gas leaks and tighten bolts as required. Tighten bolts evenly - uneven tightening could cause leakage.
5. Check air flow and fuel pressure switches.
6. Manually blow boiler safety valves.
7. Clean scanner lens.

IF BURNER DOES NOT START CHECK FOR CONTROLLER FAULT CODE

1. Check all electric fuses.
2. Check water level in boiler.
3. Check limit controls to make sure they are making circuit.
4. Push motor or starter reset button.
5. Push reset button on the programming control.
6. Push reset on high and low gas pressure switches.
7. Push reset button(s) on LWCO and temperature devices.
8. If burner then fails to start, call a qualified service technician.

TO STOP BURNER

1. Switch off burner control switch or push emergency door switch.
2. Do not pull feedwater pump switch until boiler is cooled.

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SEMI-ANNUAL PROCEDURE

1. Cool boiler slowly to room temperature. (110°F minimum) **NOTE:** Failure to cool boiler slowly will possibly cause tubes to leak. This is very important! To assist cool down, use the Test/Run or Check/Run switch located on the programmer to run the blower.
2. Remove all the nuts and clamps around the front door flange, pry the door loose from the boiler and swing it away on the davits.
3. Using the flue brush and vacuum cleaner, brush through the tubes to the rear end of the boiler.
4. Soot and scale may be removed from the rear end of the boiler by removing the cleanout plug located at the bottom of the rear door and inserting vacuum cleaner hose. (Does not require large door to be opened.)
5. Check the rear door refractory and patch any cracks or spalled areas with high temperature cement. Refractory may be obtained from the factory.
6. Always replace the 1" ceramic fiber seal around the edge of the rear refractory with a new seal when rear door is opened and gasket is damaged.
7. Tighten front and rear door nuts evenly to take up any slack created through drying out.
8. Clean the peep sight glass or replace if required.
9. Flush air compressor as directed in service manual.
10. If boiler is used for a steam process with a high percentage of feedwater makeup, follow the Annual Procedure Items 2 & 3.
11. Clean & Adjust pilot Assy.

ANNUAL PROCEDURE

1. Follow steps 1 through 10 listed under Semi-Annual Procedure.
2. Clean water side of boiler as follows:
   - Open upper tri-cocks and any other available vent valves to prove that the boiler contains no steam.
   - Drain the boiler through the blow down valve. Start washing down tubes ASAP.
   - Wash down the inside (water side) of the boiler with a hose, making sure to get all sludge and scale out of bottom of boiler.
   - Remove all handhole covers and the manhole cover.
   - Inspect shell and tube surfaces for signs of corrosion or scale formation. If scale is forming (to any degree) on internal surfaces, chemical treatment is not correct. Consult chemical supplier.
   - Remove plugs from low water cutoff equalizer crosses and rod piping if scale is present. Remove low water cutoff head and clean float chamber. Reassemble with new gasket.
   - Using new gaskets, install the handhole covers and manhole cover.
   - Disconnect the piping on the discharge side of the feedwater pump and inspect for scale build up. Check stop and check valves for proper operation and replace if necessary.
   - Install new safety valves of proper pressure and capacity rating. If the safety valves have not been tested. Old valves may be refurbished by a reputable valve repair company in possession of a VR stamp and kept as spares.
   - Fill the boiler by means of the feedwater pump and reset the low water cutoff.
3. At the time of this yearly inspection and cleaning, it is recommended that the local State or insurance inspector, in addition to the SUPERIOR distributor, or agent, be called in to check the condition of the equipment. Chemical supplier should also be present.

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BOIL-OUT PROCEDURE

The following procedure is from "boiler water quality requirements and associated steam quality for industrial/commercial and institutional boilers" published by ABMA.

Boil Out of New Unit

The internal surfaces of a newly installed boiler will have oil, grease or other protective coatings used in manufacturing. Such coatings must be removed since these coatings lower the heat transfer rate and could lead to overheating of a tube and reduce unit operating efficiency. However, before boiling out procedures may begin, the burner should be ready for firing. The operator must be familiar with the procedure outlined in the boiler operating instruction manual.

Suggested procedure for boil out prior to initial operation:

1. *Trisodium phosphate and caustic soda* are the suggested chemicals for cleaning of newly installed boilers. The quantities will vary according to conditions, but an amount of one pound of each chemical per 50 gallons of water is suggested. Refer to boiler's manual for boiler water capacity.

2. When dissolving chemicals, the following should be observed:

(a) Use of suitable face mask, goggles, protective gloves and garments is required when handling or mixing caustic chemicals.
(b) Do not permit the dry chemical or solution to come in contact with skin or clothing.
(c) Always follow the safety precautions on the container's labeling, and be familiar with the contents of the Material Safety Data Sheets.
(d) Warm (80 to 100 ^{o}F) water should be put into a suitable container
(e) Slowly introduce the chemical into the water, stirring at all times until the chemical is completely dissolved.
(f) The chemical must be added slowly and in small amounts to prevent excessive heat and turbulence.

3. Before introducing the solution into the boiler, an overflow pipe should be attached to one of the top boiler openings and routed to a safe point of discharge.

CAUTION: Boiling out under pressure is not recommended for this class of boiler.
4. Water relief valves and steam safety valves must be removed before adding the boil out solution so that neither the solution nor surface contaminants will settle upon the valve seats. Use care in removing and reinstalling the valves.

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5. All valves in the piping to or from the system must be closed to prevent the boil out solution from getting into the system.

6. Gage glasses must be protected from contact with the boil out chemicals during procedure.

7. Fill pressure vessel with clean water until top of the tubes in a firetube/firebox boiler are covered. Add the cleaning solution and then fill to the top of the vessel. The temperature of the water used in this initial fill should be at ambient temperature and softened.

8. After filling, 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.**

9. After the five hour boil, begin to add a small amount of fresh water to create a slight overflow to carry off surface impurities. Continue boil and overflow until water clears. When water clears, shut burner off.

10. Let the boiler cool to 120°F, drain using caution that the water is discharged with safety.

11. Remove hand-hole covers and/or wash out opening and wash the waterside surfaces thoroughly using a high pressure water stream.

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

13. After boil out, close all openings and reinstall safety or relief valves, gage glasses and other components. Fill the boiler with ambient treated water and fire unit at low fire until water temperature of at least 180°F is reached to drive off any dissolved gases.

14. Boiler is now ready for operation.

CAUTION: If boiler is not to be operated within 24 hours see section on lay-up.

<u>System Clean Out</u>
Many clean boilers have been ruined with system contaminants such as pipe dope, cutting oil, metal shavings or chips and other debris associated with installation. If these contaminants are not removed from the system, the debris will find its way back to the boiler.

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MAINTENANCE SCHEDULE

DAILY PROCEDURES

Blow primary LWCO down while burner is firing. Verify that feedwater pump cycles normally and that burner shuts off.

Observe burner starting sequence and flame characteristics to verify normal behavior.

If operating log is kept, enter readings; otherwise, conduct visual check of all pressure and temperature gauge readings.

Check safety valves, handholes and manway for signs of leakage.

WEEKLY PROCEDURES

Check function of auxiliary LWCO while burner is firing, verify proper response of alarms.

Check flame safety control's response to lack of flame with main gas off.

Standing Pilot – Shut pilot gas off, time relay response.

Intermittent Pilot – Start burner with pilot gas off, verify lockout.

Interrupted Pilot – Start burner with pilot gas on, verify lockout.

Determine that alarms are reacting to lockout.

During and after flame failure test, observe ignition spark and pilot flame for abnormalities.

Record pilot and main flame signals if proper meter is available.

If boiler is equipped with modulating burner, verify that adequate differential exists between operating and modulating controls to prevent short cycling.

Verify that main fuel valves are closing within specified timings; check valve position indicators.

MONTHLY PROCEDURES

Check air flow switches mechanically and electrically. Sail switches can remain stuck in closed position if shaft is dirty. Disconnect wire, start burner, verify that pilot does not light.

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.

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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.

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 position.

Test main gas valves for leakage. Close checking cock, connect hoses to open leak test valves, submerge hose ends in water, and watch for bubbling.

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.

After returning to normal setpoints, burner must not restart until switches have been manually reset.

Test oil atomizing medium interlock by interrupting flow of compressed air or steam to burner. Oil valves must close, with subsequent flame safeguard lockout.

Manually lift safety valve with test lever while boiler is at normal operating pressure.

ANNUAL PROCEDURES

Since the LWCO 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.

Disassemble and clean all safety control related piping – LWCO equalizers, pressure control manifolds, and air flow switch tubes.

Check boiler pressure gauge against calibrated master gauge or with dead weight tester. New gauges are built to one percent (1%) accuracy.

Jumper operating control and run boiler under manual control at reduced load to determine if high limit control functions correctly.

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

Remove gas line strainer basket and clean.

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THE FOLLOWING TWO PAGES ARE COPIES

OF THE

"MAINTENANCE, TESTING AND INSPECTION LOG"

FOR YOUR BOILER.

PLEASE REMOVE ONE TO MAKE

COPIES FOR YOUR USE.

Maintenance, Testing, and Inspection Log High/Low Pressure Steam Boilers	Building:	Month:	Year:
	Address:	Fuel Type:	
Person(s) to be notified in Emergency (Name and Telephone Number)		Boiler Number: Model Number:	

DAILY CHECKS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
(1) Observe Water Level																															
(2) Record Pressure																															
(3) Record Flue Gas Temp.																															

WEEKLY CHECKS (Enter Date)

	WEEK 1	WEEK 2	WEEK 3	WEEK 4
(1) Test Low Water Cutoff				
(2) Test Gate Glass				
(3) Observe Flame Condition				

MONTHLY CHECKS (Enter Date)

(1) Manual Lift Safety Valve				
(2) Review the Condition or Test Each Item	(A) Linkages		(F) Floor Drains	
	(B) Damper Controls		(G) Flame Detection Devices	
	(C) Stop Valves		(H) Limit Controls	
	(D) Refractory		(I) Operating Controls	
	(E) Flue Chimney Breeching		(J) Other:	
(3) Inspect Fuel Piping				
(4) Combustion Air Adequate/Unobstructed				

General Comments:

HIGH/ LOW PRESSURE STEAM BOILER
24 HOUR LOG

SUPERIOR BOILER, INC.
3524 EAST 4TH AVENUE-HUTCHINSON, KS 67501
1-800-444-6693

BOILER NUMBER ____________________
DATE ________________________________
National Board Number______________

CHECK EVERY ONE HOUR	TIME	WATER LEVEL	PRESSURE		TEMPERATURE			CHECK EVERY FOUR HOURS	FEED PUMP	CONDENSATE TANK	BURNER OPERATOR	FUEL SUPPLY		CHECK EVERY EIGHT HOURS	LWCO	LEVEL CONTROL	WATER COLUMN	GAUGE GLASS		CHECK EVERY SHIFT	WATER TREATMENT	BOILER BLOWDOWN	FEEDWATER MAKEUP	OPERATOR ON DUTY	REMARKS:
			STEAM	FEED PUMP	FEEDWATER	CONDENSATE	FLUE GAS																		

TO TEST	Water column & gauge glass: Open drain valve quickly & flush water from glass & column. When drain valve is closed, water level should recover promptly. LWCO & water level control: Drain float chamber while firing equipment is operating. Proper operation should shut off the firing equipment & start feed pump. If controls are probe or other type that require lowering of water level in boiler to test, DO NOT lower level to point below bottom of gauge glass.
INST.	These checks are designed to determine whether or not the boiler & controls are functioning correctly. Should any test indicate a problem, it should be corrected IMMEDIATELY and noted under "remarks." Safe boiler operation is dependent on the boiler and controls operating properly.

Maintenance, Testing, and Inspection Log High/Low Pressure Steam Boilers	Building:	Month:	Year:
	Address:	Fuel Type:	
Person(s) to be notified in Emergency (Name and Telephone Number)		Boiler Number: Model Number:	

DAILY CHECKS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
(1) Observe Water Level																															
(2) Record Pressure																															
(3) Record Flue Gas Temp.																															

WEEKLY CHECKS (Enter Date)

	WEEK 1	WEEK 2	WEEK 3	WEEK 4
(1) Test Low Water Cutoff				
(2) Test Gate Glass				
(3) Observe Flame Condition				

MONTHLY CHECKS (Enter Date)

(1) Manual Lift Safety Valve				
(2) Review the Condition or Test Each Item	(A) Linkages		(F) Floor Drains	
	(B) Damper Controls		(G) Flame Detection Devices	
	(C) Stop Valves		(H) Limit Controls	
	(D) Refractory		(I) Operating Controls	
	(E) Flue Chimney Breeching		(J) Other:	
(3) Inspect Fuel Piping				
(4) Combustion Air Adequate/Unobstructed				

General Comments:

HIGH/ LOW PRESSURE STEAM BOILER
24 HOUR LOG

SUPERIOR BOILER, INC.
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BOILER NUMBER ____________________
DATE ________________________________
National Board Number______________

			PRESSURE		TEMPERATURE																				
	TIME	WATER LEVEL	STEAM	FEED PUMP	FEEDWATER	CONDENSATE	FLUE GAS		FEED PUMP	CONDENSATE TANK	BURNER OPERATOR	FUEL SUPPLY			LWCO	LEVEL CONTROL	WATER COLUMN	GAUGE GLASS			WATER TREATMENT	BOILER BLOWDOWN	FEEDWATER MAKEUP	OPERATOR ON DUTY	REMARKS:
CHECK EVERY ONE HOUR								CHECK EVERY FOUR HOURS						CHECK EVERY EIGHT HOURS						CHECK EVERY SHIFT					

TO TEST	Water column & gauge glass: Open drain valve quickly & flush water from glass & column. When drain valve is closed, water level should recover promptly. LWCO & water level control: Drain float chamber while firing equipment is operating. Proper operation should shut off the firing equipment & start feed pump. If controls are probe or other type that require lowering of water level in boiler to test, DO NOT lower level to point below bottom of gauge glass.
INST.	These checks are designed to determine whether or not the boiler & controls are functioning correctly. Should any test indicate a problem, it should be corrected IMMEDIATELY and noted under "remarks." Safe boiler operation is dependent on the boiler and controls operating properly.

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BOILER BLOWDOWN PROCEDURE

Proper boiler blowdown is an essential part of firetube boiler operating procedure. It is necessary to control the amount of total dissolved solids in the boiler water. The total dissolved solids should not exceed 3500 parts per million in a scotch marine boiler. If boiler blowdown is not controlled, excessive dissolved solids will have tendency to increase and concentrate to a point that will cause a foaming or a carry over condition which will contaminate the steam. High concentrations of total dissolved solids in firetube boilers have a tendency to collect as scale on the heat transfer surfaces. Scale is an excellent insulator and its collection on the heat transfer surfaces of a boiler considerably lessen the heat transfer capabilities. This results in overheating the boiler tubes and tubesheets which in turn will result in tube leakage. The following chart shows the loss of efficiency of various types and thickness of scale.

Thickness of Scale	Soft Carbonate	Hard Carbonate	Hard Sulphate
1/50”	3.5	5.2	3.0
1/32”	7.0	8.3	6.0
1/25”	8.0	9.9	9.0
1/20”	10.0	11.2	11.0
1/16”	12.5	12.6	12.6
1/11”	15.0	14.3	14.3
1/9”	-----	16.0	16.0

Boiler blowdown can be accomplished either manually or automatically. Manual blowdown involves the operating personnel opening the boiler blowdown valves for a predetermined length of time at regular intervals. Automatic blowdown can be accomplished by many methods. The most common method is the use of a surface blowdown skimmer attached to a calibrated blowdown valve which permits a continuous preset amount of boiler water to be blown down.

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The proper boiler blowdown rate can be easily figured when two things are known. It is necessary to know the total dissolved solids in the feedwater and it is also necessary to know the amount of make up water that the boiler is using. The amount of total dissolved solids in the feedwater can be determined from a water analysis. The amount of make up water being used is normally determined with the use of a water meter installed in the make up feedwater line. The correct amount of boiler blowdown as a percentage of feedwater can be figured with the following formula.

$$\text{Percentage of boiler blowdown} = \frac{\text{Total dissolved solids in the feedwater}}{\text{3500 – total dissolved solids in the feedwater}} \times 100$$

An example of the use of the above formula assuming the total dissolved solids in the feedwater at 200 parts per million is shown below.

Example: $\frac{200}{3500 - 200} \times 100 = 6\%$ of make up

BOILER WATER TREATMENT

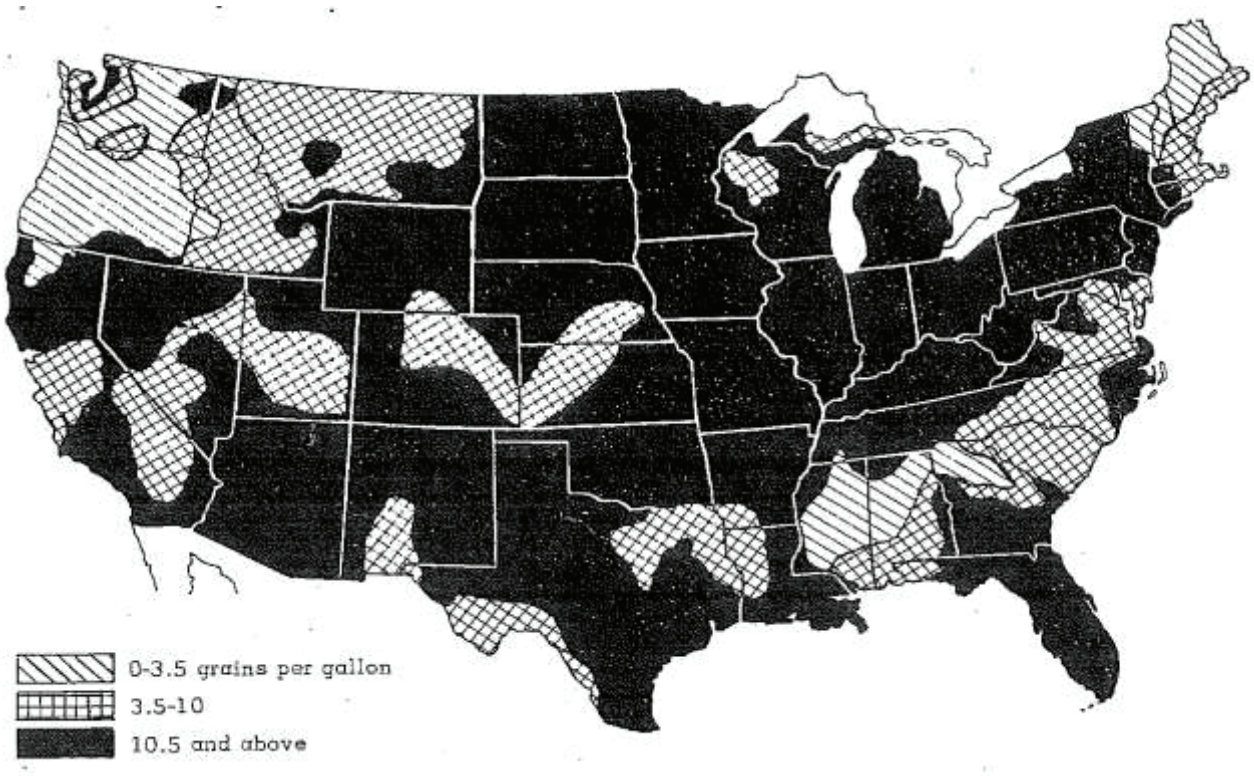
Proper boiler water treatment is the most important factor toward extended trouble-free service from your new boiler. There are no universal treatments, as water can vary drastically from one source to another in the same area.

The most common cause of boiler tube failure is calcium and magnesium hardness which forms scale on the boiler, reducing heat transfer and causing overheating of the tubes. This eventually causes tube leakage. This can occur in a boiler using a high percentage of makeup water in a matter of days. For example, a 30 day period without treatment in some areas has resulted in the necessity of completely retubing a new boiler. The ultimate in boiler water treatment is completely de-mineralized water; however, the expense of de-mineralizing prohibits its use except in the larger boilers such as power plants, etc. The method of softening water most generally used for commercial boilers is with the Zeolite type water softeners. These softeners come in a variety of sizes and operating characteristics. The required softener size depends upon the hardness of the water being used, the size of your boiler, and the frequency of regeneration you desire. To give you some idea of the hardness in our water nationally, a map of the United States is below indicating hardness by area.

Lack of boiler blowdown closely follows hard water as a major cause of boiler tube failure. Most water contains minerals of several types, and when this water is heated to the point of making steam, these minerals are left behind in the boiler. It follows that in time the minerals have to be removed or soon they build up to the point (depending on the amount of minerals in your water) where the water in the boiler becomes thick and syrupy causing the boiler to foam, prime and pull water out with the steam. It is also factual that an overabundance of these minerals can keep the heat of the fire from transferring into the water, thus causing overheating and tube failure. Lack of boiler blowdown required the retubing of a new boiler in service only 4 months. Lack of boiler blowdown is also the cause of furnace tube replacements. The removal of these minerals is very simply achieved by a regular blowdown procedure, which can be accomplished either manually or automatically. The rate and frequency of blowdown again depends upon the size of your boiler, the amount of makeup water used, and the pressure at which your boiler is operated. Proper blowdown practice will maintain the total dissolved solids in your boiler below 3,5OO parts per million.

Hardness removal and proper blowdown are, in most cases, not sufficient for total treatment. The water in your boiler should be neither acid nor alkaline, sulfates, or Gyp water, when present, are a major cause of tube leakage, and oxygen, when present, must be removed to prevent internal corrosion.

We earnestly urge you to contact a reputable local water treatment firm to advise you on the proper treatment for your boiler. Water treatment is a science in itself and when properly applied to your boiler will save you many dollars that may otherwise be required for maintenance.



PROBLEM: Boiler blowdown removes a portion of the water from the boiler to lower the suspended and dissolved solids content of the system. Solids introduced with the boiler feedwater will tend to increase in concentration with time. How can you easily estimate the amount of blowdown required to keep boiler water solids concentration within recommended limits?

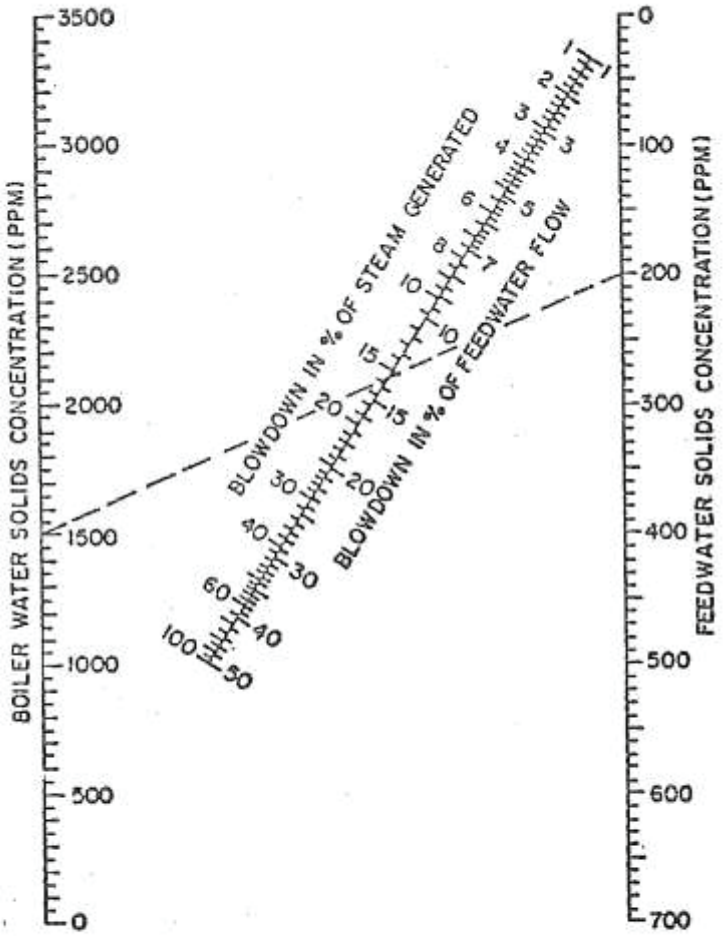
SOLUTION: First find allowable boiler water solids concentration from the table on page 3. Using the nomograph, place a straightedge connecting the allowable boiler water solids concentration on the left scale with feedwater solids concentration on the right scale, the answer in percentage of steam generated or feedwater flow is read directly from the center scale.

EXAMPLE: With a boiler operating at 800 psig, what would be the necessary blowdown, both as a percentage of steam generated and boiler feedwater flow, if there are 200 ppm total solids in the feedwater? (Note: From the chart, allowable solids concentration for a boiler operating at 800 psig is 1500 ppm.)

Ans.: 15.3% of steam generated; 13.2% of feedwater flow.

NOMOGRAPH

Boiler Blowdown



Boiler Outlet Pressure (psig)	Total Solids Concentration (ppm)
0-300	3500
301-450	3000
451-600	2500
601-750	2000
751-900	1500
901-1000	1250
1001-1500	1000

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FIRETUBE BOILERS WATER QUALITY ABMA RECOMMENDATIONS

BOILER WATER CONCENTRATION

Boiler Pressure psig	Total Dissolved Solids ppm	Total Alkalinity ppm as $CaCO_3$	Suspended Solids[2] Max. ppm	Silica[1] ppm	Total Iron[1] max. (FE) ppm
0-250	5000-3500	1200-900	100	150-100	10
251-350	4000-3000	900-700	25	120-100	8
351-450	3000-2500	800-600	10	80-50	5

NOTES:
1. Maximum values may not be achievable due to plant operating conditions or feedwater characteristics
2. Critically affected by operating conditions and year of boiler manufacturer

FEEDWATER LIMITS

Drum Pressure psi	Dissolved Oxygen (ppm)	Total Iron ppm	Total Copper ppm	Total Hardness ppm	pH	Nonvolatile TOC ppm	Oily Matter ppm
0 – 15	< 0.03	≤ 0.1	≤ 0.05	≤ 1.0	8.3 - 10.5	< 10	< 1
18 – 300	< 0.007	≤ 0.1	≤ 0.05	≤ 1.0	8.3 - 10.5	< 10	< 1
301 - 450	< 0.007	≤ 0.05	≤ 0.025	≤ 0.3	8.3 - 10.5	< 1	< 1

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MAINTENANCE AND CARE RECOMMENDATIONS FOR YOUR NEW SCOTCH MARINE BOILER

With proper operation and maintenance you can expect years of trouble-free service from your new boiler. The procedure for correct operation and care of your unit is not complicated, nor is it time consuming; thus, we are outlining in this bulletin the function of each component of your unit and recommendations for its care.

PREPARATIONS PRIOR TO USE

It is necessary to clean the inside of the new boiler of oil and grease used as tube rolling lubricants. Failure to remove these materials will result in your unit foaming, priming, and pulling over. This cleaning operation is easily accomplished by following the practices as outlined below.

(a) Fill boiler to normal water line.
(b) Close valve in steam line.
(c) Remove safety relief valve(s).
(d) See “Boil-Out of a New Unit”.
(e) Connect a vent pipe to the safety relief valve port on the boiler and run this vent to a convenient drain.
(f) Fire the boiler at a low rate for three (3) to four (4) hours allowing the steam to discharge through the vent pipe installed in place of the safety relief valve.
(g) Drain the boiler while still warm. Remove top inspection plate, wash out handhole, and two (2) handhole plates in front of boiler. Wash interior of boiler with tap water at full pressure through a nozzle. Wash until all evidence of dirt, mud, and impurities are removed through the bottom handhole opening.

The boiler will be ready for service after replacing the safety valve and opening the steam valve.

The above cleaning operation also serves to dry the insulating refractory in your boiler.

BURNER CONTROLS AND OPERATION are found in the burner manufacturer’s instruction book.

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PRESSURE AND TEMPERATURE CONTROLS

Your boiler is operated automatically by a pressuretrol if a steam boiler, or aquastat if a water boiler. These operators serve two (2) functions; to shut the burner off when the desired pressure or temperature is reached and turn the burner on when the pressure or temperature drops below the desired level. The adjustment of the pressuretrol is made by rotating the larger of two (2) adjustment screws located on the top of the pressuretrol. Turn this screw until the indicator located on the side of the pressuretrol directly under the adjustment screw shows the desired pressure. This adjustment should be checked against the steam pressure gauge at the time the burner turns on. If the pressure gauge and the scale on the side of the pressuretrol do not agree, the scale on the pressuretrol should be moved up or down to agree with the pressure gauge. This is accomplished by loosening the four screws holding the scale to the pressuretrol. The second adjustment necessary for automatic operation is the adjustment of pressure at which the burner is to turn off. This is accomplished by rotating the smaller of the two (2) screws located on top of the unit and is read on the scale directly under this screw. This scale is calibrated as difference and indicates the pounds per square inch above the burner turn on point at which you want the burner to turn off.

On a water boiler, it is necessary only to adjust the aquastat to the desired operating temperature. This is indicated on the scale on the front of the aquastat. The unit then automatically maintains this preset temperature to within ten (10) degrees.

In all cases, the operating controls should be set at the lowest levels possible that will allow the boiler to do its assigned job. To set the operators higher than necessary wastes fuel.

LOW WATER CUTOFF

The function of this unit is to control the pump or solenoid supplying water to the boiler and to eliminate the possibility of firing the boiler without sufficient water.

Steam Boiler:
The low water cutoff is enclosed in the water column and is a float-operated mechanism. If the water level in the boiler drops, the float also drops. When the water level in the boiler drops three quarters of an inch (¾") below normal, the float operated mechanism turns on the device supplying water to the boiler. If for some reason water is not supplied (pump or solenoid inoperative, water not available, etc.), the low water cutoff breaks the electrical circuit to the burner and turns it off. The burner cannot be turned on until the water in the boiler is returned to the normal operating level. To insure proper operation of this unit, periodic blowdown of the water column is recommended. Blowdown is performed by rapidly opening the water column blowdown valve two (2) full turns and quickly closing the valve. The burner should be on when the blowdown is begun and should turn off during the blowdown. Should the burner continue to burn through the blowing down operation, the low water cutoff is not functioning properly,

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indicating that the float chamber should be cleaned. With a boiler supplying steam for processing, the water column should be blown down daily. With a heating boiler, blowdown should be performed weekly during the heating season.

Water Boiler:
The low water cutoff on a water boiler is a probe unit located on the top of the boiler. It has a probe extending down into the water in the boiler to within three inches of the top row of tubes. If the water level in the boiler drops below the probe, the burner electrical circuit is broken and the burner shuts off. The burner cannot light until the proper water level in the boiler is restored and a reset button on the low water cutoff is pushed.

BLOWDOWN

Heating Boilers:
Under your boiler near the back is a blowdown line and valve. The purpose of blowdown is to remove precipitates that collect in the boiler. With the average heating system, very little water has to be added to the boiler; thus, the same water is used over and over. The recommended boiler blowdown with a leak free heating system is the withdrawal of 2 gallons of water monthly from the boiler. In heating systems which require the addition of fresh water to the boiler frequently, it is good practice to blow the boiler down more frequently. This valve has a replaceable seat to facilitate repair in the event leakage appears.

Boilers Supplying Steam for Process:
The boiler blowdown operation is performed by opening the blowdown valve adjacent to the boiler all of the way, then rapidly opening and closing the second valve two (2) full turns. Blowdown should be performed while the boiler is under a light load. Daily blowdown is recommended for this type of service.

SAFETY VALVE

The purpose of this valve is to relieve any pressure in the boiler above its design limit. These valves are sized to relieve the BTU capacity of your boiler. It is good practice to manually open the safety relief valves on your boiler monthly if a heating boiler, or weekly if steam is used for processing. This is done by rapidly lifting and releasing the handle provided on the valve three (3) of four (4) times.

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INSPECTION AND WASHOUT PLATES

These openings are placed in the boiler to facilitate visual inspection, cleaning and re-tubing your boiler. Upon evidence of leakage, the plate should be tightened by taking up the nut holding it in place. It is not uncommon for a new unit or a newly gasketed plate to start seeping after being in use a short time inasmuch as the gasket softens a bit upon exposure to moisture and heat. This seepage can be stopped as pointed out above. It is good practice to always use new gaskets on these plates after they have been removed. Be sure there are no foreign particles on the seating surface of the plate or boiler before installing new gaskets. The use of oil, graphite paste or pipe dope on both sides of a new gasket aids in getting a leak proof seal. Do not tighten nuts with pressure on the boiler.

WATER TREATMENT

Heating Boilers:
Water treatment in a heating boiler is usually not a problem inasmuch as the same water is used over and over. Treatment is primarily to eliminate corrosion and pitting cause by alkalinity and oxygen. It is usually necessary to treat the water in a heating boiler once a year at the beginning of the heating season. Asking the advice of a competent water consultant about the treatment is recommended. The appearance of scale, corrosion or pitting is definite evidence that water treatment is needed.

Process Steam Boilers:
When the boiler supplies steam for processing, it is necessary to replace steam used with makeup water. Water treatment for boilers supplying process steam varies with analysis of water available. It is, therefore, strongly recommended that the owner secure the services of a reputable water chemist to run water analysis and recommend treatment.

PIPING

The piping on a boiler (water column – blowdown – safety relief valve vent) should be kept leak proof. A small leak, if allowed to continue, soon becomes a major problem. All vent and blowdown piping running vertically up should have means for draining the vertical run.

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BOILER LAY-UP PROCEDURE

FROM NBIC PUBLICATIONS

The primary purpose of laying up a boiler is to extend its life. A boiler should be shut down when not required to provide heat. We "lay-up" the boiler to prevent further corrosion on both the waterside and fireside, which enhances longevity. A secondary purpose of laying up a boiler – and an economic savings opportunity – is to perform an inspection of its condition during shutdown. This aids in evaluating the water treatment requirements on the waterside and the combustion efficiency on the fireside.

The recommended method of boiler lay-up is dictated by a boiler's type and size and by economic safety-oriented advantages achieved performing the lay-up.

There are different types of lay-up to be aware of. This article focuses dry lay-up and wet lay-up. Some factors in the selection of lay-up include length of shutdown time, size and type of boiler, and the amount of effort to refill and monitor the boiler with treated water.

Before beginning lay-up and cleaning of a boiler, be sure that the combustion system is performing efficiently. This will minimize creation of soot in a clean boiler when started in the fall.

Dry Lay-up:

Dry lay-up should be used when the boiler will be shut down for an extended period or when there is no urgency to restart (as with a standby boiler). This method also works in areas where the boiler may be exposed to subfreezing temperatures. Unlike the wet lay-up method, it requires a minimal amount of monitoring.

After performing a lock-out and tag-out of the system, the steps for dry lay-up can be as simple as:

1 – Draining the boiler

Perform a bottom blow-off on the boiler before and then after shutdown to remove sediment and scale and to drop the unit's pressure and temperature. Once the unit is at zero psi gage pressure and water temperature is under 140°F, open an air vent and boiler drain to empty the boiler. Do not use the safety valves for vents. If a vent is not installed, remove the plug or cap on the top cross-fitting of the water column and install one on the side of a tee. This will also allow venting of air during the refill of the boiler.

2 – Opening the fireside

When cleaning the boiler, remember that soot is easier to remove when it is warm and dry. Some technicians fire the boiler to the water and soot warm before cleaning. The method of removing the soot on the tubes must take into account tubes using extended heating surfaces or dimpled tubes. Manufacturer's instruction should be followed to the minimize removal on the tubes.

While cleaning the boiler's fireside, look for rust (orange) or scale (grayish-white) trails the pressure boundary wall. Mark those areas for further evaluation of leakage. Look for soot trails on fireside gaskets to evaluate possible short-circuiting of combustion gases, corrosion of the gasket seating surface, and overheating of air-cooled surfaces. Discolored or chalky paint is an indication of possible overheating.

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Inspect refractory and insulation on the fireside. Small cracks in refractory are normal due to expansion and contraction, especially where openings such as observation ports pass through the refractory.

3 – Opening the waterside
With the outlet, feed, and make-up valves locked and tagged closed, and air vent valve locked and tagged open, remove all inspection opening closures.

Look for signs of gasket leakage and potential corrosion of the gasket seating surface (which could prevent a good seal). Inspect all handhole and manway yoke bolts and nuts for deterioration (which could prevent uniform tightening of the gasket). Using a battery -operated light, inspect the waterside (in accordance with all applicable confined space entry procedures) and evaluate the scale and corrosion condition. Wash down the boiler and attempt to move all scale and sediment out of the washout openings at the bottom of the boiler. Any scale and sediment not removed will trap moisture and oxygen and corrode the boiler.

4 – Drying all surfaces
Depending on ambient air temperature, a fan can be used to blow dry the waterside. Electric air heaters can be used on the fireside to warm and dry out the waterside. It is not recommended to use fuel-fired air heaters because of the potential of adding moisture or getting petroleum products on the waterside or soot on the fireside.

5 – Performing examination
Closely examine all surfaces showing potential leakage. Dye-penetrant examination is an inexpensive method to check leaks for potential cracking. A pressure test may be required before startup. Refer to the *National Board Inspection Code,* Part RB-1000 through 5000, and the National Board Website for guidance.

6 – Determining if any repairs are required
Make repairs using an organization meeting jurisdictional requirements. In most cases, the jurisdiction will require an "R" stamp. A listing of "R" organizations can be found in the Manufacturer/Repair Directory.

After examinations and repairs are completed, fireside surfaces can be swabbed with neutral mineral oil to prevent further corrosion. It is important to remember that the initial light-off may be a little smoky until the oil is burn off or the boiler water is hot enough to evaporate the oil.

7 – Closing the dry boiler
If the ambient air is always dry, the boiler can remain open. However, if humidity and dew points get high, then the boiler should be closed. Before closing the boiler, place moisture absorbing material such as silica gel or lime (also called unslaked lime, quick lime, calcium oxide, burnt lime, calx, and caustic lime) in the waterside and fireside. (This is not required on the fireside if it is swabbed with mineral oil). Use a flat tray or pan to contain the material. Set it inside boiler and close all openings. This material should be renewed or re-dried every three months.

The stack should also be covered to eliminate moisture accumulating near the boiler stack connection. A sign or tag should be placed on the boiler power disconnect to warn of the stack cover. A stack damper does not provide sufficient seal from the main stack. If the main stack cannot be sealed, slip a piece of sheet metal between the boiler exhaust flange and stack flange.

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For smaller boilers, incandescent lights have been used to keep the boiler and/or control panel warm to prevent the collection of moisture. Electrical safety should be considered before placing light fixtures in a boiler.

Wet Lay-up

(Recommended for steel water boilers and cast-iron boilers, both steam and water). The steps of preparing a boiler for wet lay-up are essentially the same for dry lay-up. The exception is when a boiler is closed and prepared to be filled with water and water treatment chemicals. Perform dry lay-up steps 1-6 (except do not swab the fireside with mineral oil) and then follow the step 7 below.

7 – Filling the boiler with water and treatment chemicals

The alkalinity should be adjusted to greater than 400 ppm. This prevents acidic corrosion of the waterside. Tri-sodium phosphate or caustic soda has been used in the past to accomplish this (about 3 pounds/1000 gallons). Also add an oxygen-scavenging chemical such as sodium sulfite to a concentration greater than 200 ppm (about 5 pounds/1000 gallons) or sodium chromate (100 ppm steam, 300 ppm water boilers) or hydrazine (consult a water treatment company for concentration information).

Fill the boiler to its normal operating level with water hotter than 180°F. This temperature helps drive off dissolved gases. If hot water is not available, heat the water using the boiler's burner after the water level reaches the lowest permissible level as marked on the boiler. Vent the air and gases as needed. Since there no feed or condensate tank to introduce the treatment chemicals on water boilers, it is recommended the chemicals be premixed with water before being placed in the boiler. Fill the boiler, allowing air to continue to vent until the water boiler is full or until the steam boiler is at its normal operating level and warm.

When Wet Lay-up is Complete

It is strongly recommended boiler water be circulated periodically to prevent stratification of chemicals. The burner can be used to warm the water and induce natural circulation. A water boiler can use it's system circulator, but will change the concentration of chemicals when diluted by system water.
Monitor the chemical concentrations routinely while in lay-up. System leaks will cause make-up water to be introduced and with it more oxygen and carbon dioxide.
Before starting a steam boiler in wet lay-up, perform a bottom blow-off of the boiler to reduce the alkalinity (thus minimizing the chance of carryover). For all boilers, ensure all tags and locks are removed, and witness the system cycles for a minimum of three (3) cycles. This will help ensure proper operation of the boiler before leaving it in automatic mode.

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MODULATING CONTROL ADJUSTMENT PROCEDURE

STEAM BOILERS

Given the fact that the approximate desired plant operating steam pressure is known, review the factory firetest pressure control settings (shown on the Firetest Report) and make the indicated adjustment change on each control. In the initial phase of adjustment, the original factory set spread between control settings should be maintained. Typical factory set points are stated below.

Boiler Type	Limit	Operator	Modulator
Low Pressure	12#	10#	8#
150 PSIG MAWP	110#	100#	75#
200 PSIG MAWP	180#	170#	140#
250 PSIG MAWP	225#	215#	180#
300 PSIG MAWP	270#	260#	225#

Turning the larger main scale adjusting screw CW will raise the pressure, while CCV rotation will decrease it. The same convention also pertains to the smaller differential adjusting screw. The manual reset high limit control has no differential screw.

After the boiler has been started up, the burner adjusted, and the safety devices checked out, the boiler should be put on line to carry a normal steam load. Note that control adjustment will be difficult to complete accurately if the load is either too high or too low. Control settings are determined by observing the steam pressure gauge at the point of switch function as opposed to relying on the pointer indication on the scale plate.

There is no benefit in adjusting the manual reset high limit and operating control switch set points too close to each other. In fact, this practice can lead to nuisance tripping and lockout of the high limit. A 10 PSIG spread is practical. The manual reset high pressure limit should not, if at all possible, be set any higher than safety valve set pressure minus ten percent (10%), while the automatic reset operating control MUST NOT be set any higher than ninety percent (90%) of the safety valve set pressure.

The minimum proportional band available on the 150 and 300 PSI Honeywell L91B modulating control is 5 and 12 PSI, respectively, while the maximum is 23 and 48 PSI. This means that the spread between operating control set point and modulating control set point must be greater than the proportional band in order to keep the burner in a continuous and modulated firing mode of operation.

The steam pressure control incorporate a subtractive switch differential that will require a minimum decrease in steam pressure of 8 and 15 PSI, respectively, on the 150 and 300 PSI models before the burner can start. The arithmetic difference between the modulator throttling band and the pressure switch

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differential should be added to the throttling band in order to establish the proper spread between control and set points.

If the differential between the operating and modulating controls is too small, the burner will shut down on incremental load reduction before it reaches its minimum input at low fire. This mode of operation will cause wide steam pressure swings in the steam header and poor tracking of load changes. Fuel consumption will increase due to additional standby losses and increased cyclic pre- and post-purging of a hot boiler. Linkage and valve wear will increase due to a higher frequency of operation. Boiler life will also be shortened due to the stressing caused by alternate cold air purge and high fire burner operations, as well as thermal cycling of the vessel structure.

The spread between operating and modulating control set points should be maintained at the highest practical level (two to three times the actual modulating control proportional band). In most applications, it is reasonable to set the operating control differential and the modulating control proportional band near their respective minimums. If the burner firing rate constantly hunts up and down, the proportional band should be widened until the burner responds only to pressure changes visible on the pressure gauge.

The final check for proper pressure control adjustments should be to reduce boiler load to zero over a period of two (2) minutes. The burner will rapidly modulate to low fire and hold there until the operating control shuts it off. If the burner shuts off before it reaches low fire, further adjustments will be required.

The maximum practical operating steam pressure that a boiler can be adjusted for and be determined by subtracting the various control and valve differentials from the boiler's design pressure. An example for a 200 PSIG boiler is detailed below.

10% Safety Valve Cushion	20#
Modulator Differential	12#
Total	32#

Subtracting the total above from two hundred (200) gives 168 PSIG as the maximum shell pressure that can be maintained without incurring the risk of cyclic stress damage to the boiler vessel. Please note that these numbers are based on the minimum available differentials for both the modulating and operating controls. If either control is adjusted to a higher differential, the maximum shell pressure will have to be reduced accordingly.

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STACK VELOCITY ESTIMATE PROCEDURE

Standard flue gas flow rate per million BTUH for both gas and oil fired boilers is tabulated below for various excess air levels, along with ACFM at 400 F.
°

TABLE 1

EXCESS AIR	SCFM	ACFM
0	175	285
10	191	310
15	199	323
20	207	336
25	215	349
30	223	362

If the stack temperature differs materially from 400 , the following multipliers may be used to calculate the ACFM for a given stack temperature.
°

TABLE 2

STACK TEMP.	TEMP. CORR.
285	.85
300	.88
325	.91
350	.94
375	.97
400	1.00
425	1.03
450	1.06
475	1.09
500	1.12

Actual stack volumetric flow is then the ACFM for a particular excess air level multiplied by the firing rate in millions of BTUH multiplied by the stack temperature correction factor from Table 2.

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The next step in determining stack velocity is to divide the ADFM figured from Tables 1 and 2 by the time-adjusted stack area factor from Table 3.

TABLE 3

STACK DIA.	FACTOR
6	11.78
7	16.04
8	20.94
8	26.51
10	32.72
12	47.12
14	64.14
16	83.78
18	106.03
20	130.90
22	158.39
24	188.50
26	221.22
28	256.56
30	294.52
32	235.10
34	378.30
36	424.12
38	472.55
40	523.60

The result is stack velocity in FT/SEC. For velocity in FT/MIN., multiply by 60.

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Shutdown and Cool-Down Procedure

When the unit is taken out of service, good care of the boiler during the idle periods is mandatory to prevent unnecessary corrosion damage.

1- Gradually reduce burner load to low fire position. When the unit is at the low fire position, blow down the boiler along with water column gage glass.
2- Follow burner manufacturer's recommendations for normal burner shutdown sequence.
3- Do not shut feed-water pumps.
4- To assist cool-down, use the Test/Run or Check/Run switch located on the programmer to run the blower.

Cooling rate must not exceed 100°F per hour to avoid drum distortion and resulting strains on tubes joints. You can monitor cooling rate by using one thermometer at front tubes-sheet located around the hand-hole and another one at steel surface of clean-out plug at rear of boiler.

5- The steam pressure should be allowed to drop naturally without opening vents or other means of taking steam from the unit to speed-up the lowering of steam pressure.
6- When steam pressure drops to 15 psig, the stop valve on the steam line should be closed and vent valve fully opened **to prevent a vacuum from forming within the boiler.**
7- When pressure gauge reading shows 0 psig, wait for one hour then check boiler water temperature, if it is around 200 deg. F then globe valve of 3-valve by-pass should be opened, make sure feed-water pumps are turned on and drain valves can be opened to maintain a water level in gauge glass at not less than mid level and not higher than 2/3 of visible gauge glass, water level can be maintain by throttling feed-water globe valve and slow-opening blow-down valve.
8- When steel doors and front tube-sheet around hand-holes are less than110 deg. F, then you can open front and rear doors.

WARNING: DO NOT attempt to drain boiler until temperature is less than 110 deg. F.

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CARE OF IDLE BOILERS

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

Boilers Laid Up Dry

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

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

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

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

Boilers Laid Up Wet

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

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 three hundred fifty (350) parts per million of alkalinity and also add enough sodium sulphite to produce a residue of fifty (50) to sixty (60) parts per million of this chemical.

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

While 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 oxidization of the metal. Fuel oil lines should be drained and flushed of residual oil and refilled with distillate fuel. If all boilers are to be laid up, care of oil tanks, lines, pumps and heaters is similarly required.

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EXTENDED OUTDOOR STORAGE

If newly delivered boilers are to be stored for a long period, the following steps are required:

1. The boiler should be placed on cross-ties under the legs, preferably on a concrete or asphalt surface.

2. Make certain that all water has drained out of the shell and all piping (i.e.: water column, surface blowdown, bottom blowdown, etc.)

3. Plug all remaining open connections in the boiler shell and close all blowdown valves – bottom, water column and surface.

4. Remove the manway cover and place trays of silica gel desiccant on the uppermost row of tubes. The condition of the desiccant should be checked weekly and it should be replaced when it changes color.

5. The electrical enclosures and panels will also require silica gel in cloth bags to protect against condensation. These bags should also be checked weekly.

6. The entire boiler should be covered with a tarp with emphasis on protection for the gas train, oil pump, air compressor, low water cut-off and junction box.

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COLD BOILER STARTUP & OPERATION

FIRING THE BOILER - PRELIMINARY STEPS AND WARM-UP

Ensure that an accurate stack thermometer has been installed into stack coupling (50-500°F on Scotch Marine boilers 100 HP or larger and 150-750°F on smaller Scotch Marine and most Firebox boilers). Also an accurate Steam Pressure or Water Temperature gauge should be installed in their appropriate locations.

The fuel train should be checked and lined up for operation. Also check and line up the feedwater system for steam boilers and turn on the circulating pump(s) for water boilers.

On steam boilers check the water sight glass to verify the water level is at the Normal Water Level (NWL), approximately three (3) inches of visible water in the glass.

If the burner is equipped for gas-oil combination firing, move fuel selector switch to the appropriate position.

Move manual-automatic modulation selector switch to manual position and turn the manual potentiometer to the minimum or closed position. Move the burner control switch to the ON position to start the pre-purge cycle.

Once burner fan starts, immediately observe behavior of main gas valves. If valves begin to open during pre-purge, shut burner switch and circuit breaker off until wiring or control error is corrected. Assuming the gas valves remain in their normally closed position let the burner continue its pre-purge cycle. If the burner is of modulated construction, observe the behavior and stroke limits of all linkage, watch for binding or jerking of the linkage.

After the burner has completed its open damper pre-purge, it will return to the low fire position for the pilot ignition trial. Once the pilot trial begins, lock the programmer into its TEST mode, refer to the burner controller specs for location and operation of the TEST/RUN switch, and observe pilot flame characteristics from the furnace sight port. Place the TEST/RUN switch in the RUN position to complete pilot trial and continue to main flame trial.

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Once main flame has been established, visually check the flame and note its appearance. The flame should be relatively small to achieve a slow warm-up. The main issue is stable combustion and slow, even heating of the boiler to minimize structural stresses.

NOTE: On water boilers, you must have the system circulating pump(s) running to evenly warm the boiler and heating loop(s) to avoid thermal shock to the boiler.

FIRING THE BOILER - DETERMINING TEMPERATURE

Water boilers are warm enough for higher firing rates when the water temperature reaches **160°F** and the bottom of the front tubesheet is hot to the fingertips.

Steam boilers may be taken slowly toward high fire after the shell temperature has reached **220°F**, but the bottom of the front tubesheet should be checked before proceeding. A magnetic thermometer can be placed directly on the boiler shell at the cutout in the jacketing material where the data has been stamped into the vessel. On large diameter boilers (94" and up), it will be necessary to wait until the bottom is hot.

NOTE: STEAM BOILER VESSEL TEMP. SHOULD BE 220°F MINIMUM BEFORE SLOWLY INCREASING THE FIRING RATE.

Remain fully aware of water temperature and flow rate or steam pressure and water level while operating the boiler at higher capacities.

Raise the burner firing rate in small increments until the steam pressure or water temperature is at least up to 2/3 of the normal operating pressure or temperature before placing the firing rate MANUAL/AUTO selector switch in AUTO.

Your boiler is now ready for normal operation. Refer to your Maintenance Instructions that came with the boiler for daily, weekly, etc. maintenance procedures. For a new copy of these procedures please contact a Superior representative in your area or the Superior Customer Service Department at (620) 662-6693.