CleaverBrooks®

Models WB & IWH

Electric Boilers

Hot Water

Operation and Maintenance Manual

750-136
11/2012

CLEAVER-BROOKS
Models WB & IWH
Electric Boilers - Hot Water

Operation and Maintenance Manual

Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative

Manual Part No. 750-136
11/2012

Printed in U.S.A.

⚠ WARNING

DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

This instruction and maintenance 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.

Cleaver-Brooks boilers are designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied were chosen because of their known ability to perform, however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of the equipment is not to be considered free from the hazards inherent in handling electricity, pressurized hot water, and steam.

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 and this manual is not intended to relieve the operating personnel of the responsibility for proper operation or the application of timely preventive maintenance.

It is recommended that a boiler room log or other permanent record be maintained. Recordings of daily, weekly, monthly, and yearly maintenance activities and recording of may unusual operation will serve as a valuable guide to any necessary investigation.

It is customary to engage the services of a qualified water treatment company or a water consultant to recommend the proper water treating practices. Contact your local Cleaver-Brooks authorized representative for details about Cleaver-Brooks water treatment services.

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

Models WB & IWH Electric Boilers

Table of Contents

CHAPTER 1

General Description

1.1 — Introduction

1.1.1 — Safety Precautions

A complete understanding of this manual is required before attempting to operate or maintain the equipment.

It is essential to read and understand all safety precautions before attempting to operate the equipment.

Failure to follow these precautions may result in damage to equipment, serious personal injury, or death.

The equipment should be operated and maintained only by personnel who have read this manual and who have a working knowledge and understanding of the equipment.

⚠ Warning

Warning indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.

⚠ Caution

Caution indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.

NOTE: "NOTE:" indicates information that is vital to the operation of the equipment.

1.1.2 — Abbreviations

Following is an explanation of the abbreviations, acronyms, and symbols used in this manual.

Abbreviation	Explanation
ASME	American Society of Mechanical Engineers
AR	Automatic Reset
BHP	Boiler Horsepower
BTU	British Thermal Unit
C	Degree Celsius
F	Degree Fahrenheit
Ft	Feet
GPM	Gallons Per Minute
Ht	Height
Hz	Hertz
KW	Kilowatt
Lb	Pound

Abbreviation	Explanation
LWCO	Low Water Cut Off
MR	Manual Reset
pH	Measure of the degree of acidity or basicity of a solution
P/N	Part Number
PPB	Parts Per Billion
PPM	Parts Per Million
PSI	Pounds Per Square Inch
T	Temperature
TC	Temperature Control
TI	Temperature Gauge
wsi	Watts Per Square Inch

1.2 — Application

The Cleaver-Brooks Models WB and IWH boilers come equipped with 75 wsi Incoloy elements. The boilers are designed to operate in hot water heating systems, and to deliver maximum kilowatts in minimum space requirements. Each is ideal for new boiler applications or as a replacement unit to upgrade existing installations.

The Model IWH is ideal for applications where a continuous flow of water is required for basic heating systems or for adding heat to storage tanks, reservoirs, or cooling systems.

These boilers are also designed for use as supplemental heat for heat pump systems operating between 55° F and 175° F, or standard hot water systems up to 250° F. (Higher temperature boilers are available on special order.)

1.3 — Description

A typical Model WB or IWH hot water boiler system includes operating controls, elements, fuses, contactors, relief valve, drain valve, etc.; wired, tested, and ready for installation.

The vessel construction complies with the ASME Boiler & Pressure Vessel Code, Section IV, and is suitable for operation at pressures to 160 psig and temperatures to 250° F. All WB and IWH boilers carry the “H” stamp.

An 11” x 15” manhole is provided on the WB models 361 through 422, smaller boilers are supplied with handholes as required by ASME Code, Section IV.

The following items are standard on all Cleaver-Brooks Electric Hot Water Boilers:.

Component	Description
1. Main Lugs for Supply Circuit	Standard boilers are designed for top entry to main power terminals and are supplied with solderless wire connectors suitable for copper supply wires. These main lugs are mounted on distribution buses which provide individual connections for each heating element circuit.
2. Supplemental Internal Protection Fuses	Boilers are provided with supplemental internal protection fuses rated at approximately 125% of the element circuit load. These current-limiting cartridge fuses have a minimum 200,000 ampere interrupting capacity to provide protection for the element circuit wiring.
3. Built-In Magnetic Contactors	All boilers use definite purpose magnetic contactors designed for use with resistance heating loads. Minimum contactor rating is 50 amps resistive duty rated for 500,000 duty cycles.
4. Heating Elements	Standard heating elements are Incoloy sheathed and rated at 75 watts per square inch (model WB). These elements are individually replaceable hairpin type.
5. 120 Volt Control Circuit	All boilers have 120 volt control circuits. Control circuit transformers with primary fusing and grounded secondary are provided on all models.
6. Customer Control Interlock Connection	A terminal strip is provided on all boilers for connection of the customer's external control devices, interlocks, and switches to enable/disable the boiler, from remote locations.
7. High Temperature Cutoff	All standard boilers are supplied with one automatic-resetting, and manual-resetting high temperature cutoff. These are normally set at 235º F and 240º F respectively, unless otherwise specified. On smaller boilers, one auto-resetting temperature cutoff is standard as a backup to the limit duty rated temperature control.
8. Low Water Cutoff (Model WB only)	Each boiler is equipped with an automatic resetting electrical low water cutoff of the probe type.
9. Temperature Control and Temperature Sensor	Boilers with 1 to 4 stages of control are standardly provided with on-off controls. Larger boilers are provided with a solid state, proportional, modulating, step-type temperature control system. The temperature control system controls the input power to the boiler by increasing (or decreasing) the number of heating element groups (steps) in use as the temperature of the water returning from the system varies due to system load. The controller switches on or off banks of elements in order to maintain a constant outlet temperature. Both control systems (on-off and proportional) have adjustable temperature ranges. The on-off control has a fixed differential of approximately 5º F. The proportioning control has an adjustable differential or proportioning range from 3º F to 30º F. The proportional solid state electronic sequencers also have adjustable time delay between steps varying from 5 seconds up to 10 minutes. These adjustable controls enable the boiler to be tuned to the system it regulates in order to optimize boiler responsiveness and system operation. The proportional controller also prevents serious electrical damage in the event of a power interruption. As power is restored to a cool system, the controller turns on each step in timed sequence until full load is achieved. This avoids the high current surges that would result if the steps were all energized at once.

Component	Description
10. Pilot Switch and Pilot Lights	Pilot lights are standardly provided to indicate “power on,” “high temperature,” and “low water.”
11. Pressure/Temperature Combination Gauge	**NOTE:** Model WB 121 is supplied with individual pressure and temperature gauges. Larger models include a separate pressure gauge and digital temperature read-out.
12. Pressure Relief Valve	This valve is sized according to the boiler’s electrical rating (3500 Btu/KW) per the ASME Code and National Board.
13. Flow Switch (Model IWH only)	Shipped loose.

The following optional equipment may be added and supplemental descriptive information (suppliers’ literature) may be included with your manual for these options:

1. Manual reset low water cutoff
2. Auxiliary low water cutoff (manual or auto reset)
3. High or low pressure cutoff
4. Pilot lights for individual steps
5. Toggle switches to enable/disable individual steps
6. Solid state progressive sequencing step control
7. Outdoor reset controls
8. Proportional outdoor load limiter
9. Demand limiting controls or interface
10. Door interlock
11. Boiler disconnect switch or circuit breaker (with or without shunt trip)
12. Ground fault detection
13. Metering (ammeter, voltmeter or KWH meter)
14. Alarm circuit (with or without horn/silencer push button)
15. Flow switch (with or without time delay)
16. Preheat switch
17. Local/remote modulation switch
18. SCR controller
19. Feedwater valve
20. Other misc. options

Your Dimension Drawings (DD) and Wiring Diagrams (WD) will show the optional equipment on your boiler.

1.4 — Principles of Operation

An electric hot water boiler is a simple device. Water passes through a steel drum (vessel) containing resistance type heating elements. As the water circulates, it absorbs heat from the heating elements. The heated water is then circulated through the external system to heat buildings, to provide heat for manufacturing processes, or for use wherever it is required.

Cleaver-Brooks boilers are designed to keep water volume as low as possible to provide close control and rapid response to the heating needs. Close temperature control of the water is maintained by turning off or on, groups of resistance elements. Controls in the boiler automatically select the number of heating element groups (or steps) needed to maintain the water temperature, while supplying the system's heat demands.

NOTE: Although circulation pumps are not supplied with these boilers, they should, however, be sized to provide a flow rate adequate to deliver the boiler's full output to the system, without high boiler temperature rise (100° F). Pumps should operate continuously and, for the best control, the flow through the boiler should be constant.

CHAPTER 2

Installation Instructions

⚠ Warning

Installation should be performed only by qualified personnel who are familiar with this equipment. Failure to heed this warning may result in serious personal injury or death.

Before proceeding, make sure you read and understand the contents of this manual. Failure to do so may result in serious personal injury or death.

2.1 — Receiving Inspection

Every Model WB or IWH boiler is completely inspected at the factory and carefully crated for shipment. Inspect the packing for signs of exterior damage. After placing the unit as close as possible to the point of actual installation, uncrate carefully and check all boxes and cartons against the packing slip. In case of damage or shortage, notify the carrier immediately.

2.2 — Location

Consult local codes for specific requirements. Refer to the Dimensional Drawings (DD) and Wiring Diagrams (WD) prepared by Cleaver-Brooks for your specific installation. Position the boiler to provide adequate clearance on all sides for necessary access when operating and servicing the boiler.

⚠ Caution

To avoid damage to the equipment, be sure to:

1. Check your local electrical code for minimum clearances required around electrical equipment.
2. For installation in a closet, provide ventilation openings of 200 square inches per 100KW of boiler rating.
3. Observe local codes, which may specify greater clearances over top of boiler and must take precedent.
4. Install indoors only.

2.3 — Piping

This boiler is intended for use on forced circulation systems with a pump of adequate capacity to overcome the system head loss (pressure drop at required flow rate), and to provide a flow rate adequate to permit the boiler to generate its full heat output. Radiators and convectors in the system must have adequate capacity to dissipate the boiler output at system design operating water temperature.

The pressure drop through the boiler is equivalent to the pressure drop through 30 feet of pipe equal to the diameter of the inlet and outlet fittings.

Failure to provide adequate radiator capacity may create a low flow rate through the boiler, raising the temperature too high, and will result in "short cycling" of the boiler due to operation at the limiting or maximum temperature. This also will prevent the boiler from supplying its rated output to the system.

Tight-closing valves should be installed on the inlet and outlet piping to facilitate isolating the boiler from the system for annual boiler internal inspection and/or repair that requires the boiler to be drained.

An expansion tank should be provided with a volume equal to 1/16 of the total water volume of the system, inclusive of the boiler vessel, radiators, coils, and all piping. The expansion tank may be connected to the fitting provided on top of the boiler vessel. If another location for the expansion tank connection is used, the boiler opening must be plugged.

Water for make-up during operation should be added manually or automatically directly to the expansion tank.

⚠ Warning

The relief valve outlet should be piped to a safe point of discharge where no serious personal injury or death to persons, or impaired access to the boiler controls, would result from unexpected discharge of hot water from the relief valve.

The boiler drain valve should be piped to the drain.

2.4 — Heat Pump Systems with High Flow Rates

The Model WB will accept flow rates that will give a minimum temperature rise across the boiler as low as 3° F when supplied with optional inlet baffle or oversized connections. Minimum temperature rise can also be obtained by installing a bypass piping arrangement to adjust the flow through the boiler.

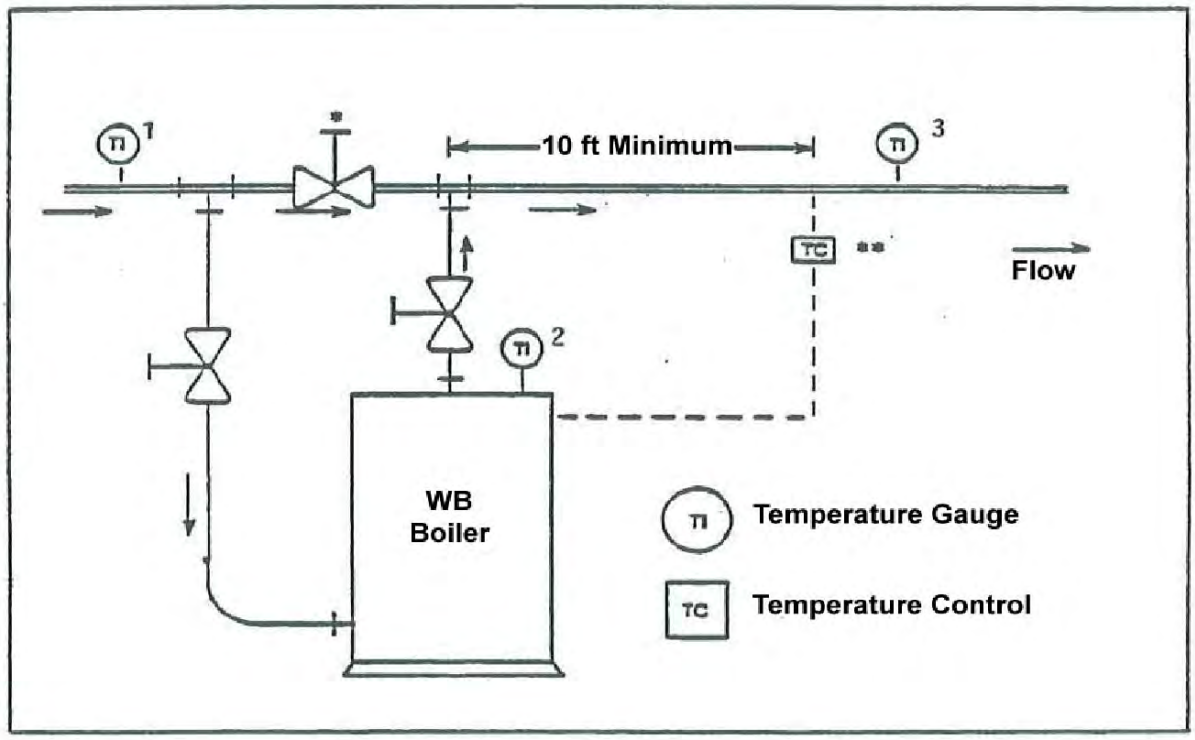
Use the following formula to determine the maximum and minimum flow rates of a given boiler:

$$\text{FLOW (GPM)} = \frac{\text{KW} \times 6.816}{\text{T}}$$

where T is equal to any temperature rise between 3° F and 30° F, as indicated by TI1 and TI2 in Figure 2-1.

Maximum flow rate for IWH is based on a maximum velocity of 1.5 feet/second through the header.

If the system flow rate is greater, a bypass around the boiler with a balancing cock or globe valve will be required to bypass the appropriate portion of the system flow.



* If the hot water boiler cannot handle the full system GPM, substitute the balancing valve, which will be partially opened, to bypass the appropriate portion of flow. The flow must be constant.

** The boiler temperature control is to be located so as to sense temperature of the system water after the boiler water and bypassed water have blended (TI3).

FIGURE 2-1. Typical Piping Arrangement for Bypass System

For optimum temperature control without cycling, the flow rate through the boiler must be kept constant.

2.5 — Electrical

⚠ Warning

Disconnect and lock out the main power before proceeding with the electrical installation in order to avoid the hazard of electrical shock, which can cause serious personal injury or death.

The following procedures are based on requirements of the National Electrical Code. Local electrical codes and/or boiler codes may require slightly different procedures, and it is therefore recommended that the electrical installation be performed under the supervision of a qualified and licensed electrical contractor familiar with local codes and inspection procedures.

Electric hot water boilers are typically designed for top connection to the main supply lugs and are supplied with solderless wire connectors suitable for copper supply wires.

If aluminum supply wires are selected by the customer, Cleaver-Brooks strongly recommends that the installing electrical contractor splice a short length of copper wire to the aluminum supply conductors and terminate this copper wire in the main supply lugs on the heater. If copper splices are not used and the customer chooses to terminate the aluminum supply wires directly in the main supply lugs, an oxide inhibitor paste should be applied liberally to the conductors.

⚠ Warning

Before tightening the main supply lugs, disconnect and lockout main power to avoid the hazard of electrical shock, which can cause serious personal injury or death.

⚠ Caution

Main supply lugs should be tightened every 24 hours during the first week of operation. After the first week, the main supply lugs should be tightened once every 30 days. After the first 30 days of operation, all electrical power connections should be tightened (with power off).

Power wiring should be selected for high temperature use (minimum wire rating, 75° C, per National electrical Code) and/or per local electrical codes.

2.5.1 — Electrical Installation Checklist

The following procedures are recommended:

1. Check the boiler nameplate for the boiler kilowatt rating, voltage, amperage, and whether it is single or three phase.
2. Check the electrical supply voltage to verify that it conforms to the boiler requirements, and that sufficient circuit capacity is available for the boiler.
3. Refer to the boiler Wiring Diagram (WD), included with the boiler, for the number and rating of supply circuits required by the boiler.
4. Refer to your local electrical code for proper wire and conduit sizes for these ratings.
5. Install wiring from the feeder switch or circuit breaker to the boiler, and connect to the bus assembly as indicated on the boiler Wiring Diagram (WD).
6. All Cleaver-Brooks Electric Boilers are supplied with factory-mounted magnetic contactors, and all internal circuits are factory installed and tested.
7. Check all electrical connections for tightness. Vibration during transit sometimes loosens connections.

⚠ Warning

To avoid the hazard of electrical shock: On boilers requiring more than one supply circuit, be sure that phasing is correct and circuits are not “mixed” before energizing. *Failure to observe this warning could result in serious personal injury or death.*

2.5.2 — Recommended Torque Settings

The following table notes typical torque settings *only*, as recommended by Cleaver-Brooks. Specific components may differ between boilers. ALWAYS adhere to each component's recommended torque setting for specific wire size and type (often located on component's factory label).

Recommended torque settings **Electric boilers - main control panel**	
Power distribution blocks (6AWG - load side)	45 in lbs
Fuse blocks for contactors (6AWG)	45 in lbs
Contactor, 50A res. (6AWG - line side)	45 in lbs
Contactor, 50A res. (8AWG - load side)	40 in lbs

⚠ Caution

Specific components may differ between boilers. ALWAYS adhere to each component's recommended torque setting for specific wire size and type (often located on component's factory label).

CHAPTER 3

Pre-Start Preparation

Warning

Make certain that you have read and understand Chapters 1 and 2 before proceeding.

Pre-startup should be performed by a qualified technician who is familiar with this equipment.

Failure to heed this warning may result in serious personal injury or death.

3.1 — Inspection

Boilers which have been exposed to dust, wet and/or humid conditions must be thoroughly cleaned and dried out. Otherwise, the buildup of dust and rust on the contactors, or moisture at the terminal end of the elements, may result in severe damage.

Warning

Disconnect and lockout the main power to avoid the hazard of electrical shock, which could cause serious personal injury or death.

The following precautions must be undertaken:

1. Make certain all electrical connections and element terminals are thoroughly cleaned, dried, and checked for loose connections.
2. Inspect all contactors, fuse bases, and wire bundles for stray or loose metal objects (screws, bolts, metal shavings, knockout slugs, etc.) that may lodge there. All such material must be removed before startup.

3. There is a very high probability that, during shipment or storage prior to operation, the elements will accumulate moisture. The moisture will turn to steam when the elements are energized, rupturing the element casing.

⚠ Caution

Moisture in the element may result in damage to the element.

⚠ Warning

Disconnect and lockout the main power to avoid the hazard of electrical shock, which could cause serious personal injury or death.

To check for this condition, take a reading with an ohmmeter between one of the contactor terminals (load side) to ground for each contactor. If the reading is less than 17,000 ohms for standard 3-phase connection, or 50,000 ohms for a single element, remove the fuses going to that contactor so that, during the first day's operation, the low reading elements will not be energized, but will be heated by other dry elements and the moisture driven out at a controlled rate.

There are alternate heating methods. Direct a heat lamp at the offending elements or remove the element assembly, bake it in a 200° F oven for 8 hours, then reinstall and rewire. Following any of these procedures, the support element then may be put in operation by replacing the fuses after the elements have been rechecked with an ohmmeter.

3.2 — Boiler and System Cleaning

One important phase in completing hot water heating installations and boiler startup is cleaning the system.

No matter how carefully a system is constructed, certain extraneous materials could find their way into the boiler. Pipe dope, thread cutting oils, soldering flux, rust preventatives, soldering compounds, core sand, welding slag, and dirt, sand or clays from the jobsite usually are found.

Cleaning a hot water system (either steel or copper piping) is neither difficult nor expensive. The three most common materials used for cleaning are:

a. Trisodium Phosphate (TSP)

b. Sodium Carbonate

c. Sodium Hydroxide (Lye)

Their preference is in the order shown. Prepare the cleaning solutions as follows, do not mix different types of cleaners.

a. Trisodium Phosphate: one lb. for each fifty gallons in the system.

NOTE: Check local codes for restrictions on the use of TSP.

b. Sodium Carbonate: one lb. for each thirty gallons in the system.

c. Sodium Hydroxide: one lb. for each fifty gallons in the system.

NOTE: Do not use Sodium Hydroxide for copper or galvanized systems.

⚠ Warning

Cleaning compounds are hazardous and protective clothing and personal protective equipment must be worn when mixing or handling chemicals and chemical solutions in order to avoid serious personal injury or death.

Fill, vent, and circulate the system with the selected solution, allowing it to reach operating temperatures if possible. After circulating for three hours, drain the system completely and refill it with fresh water. Usually enough of the cleaner will adhere to the piping to give an alkaline solution satisfactory for operation. A pH reading between 8.5 and 9.5 is preferred, and a small amount of cleaner can be added if necessary to raise the pH value.

There are definite indications of an unclean system. See the checklist below. If any of these conditions occur when filling the system, the boiler and associated system piping need cleaning.

☑ Obviously discolored, dirty water.

☑ A pH or alkalinity test that gives a pH test reading below 7. (Below 7 indicates water in the system is acidic and corrosive.)

☑ The appearance of dirty foam or scum lines on the surface.

In some cases, there are sufficient quantities of such materials to break down chemically during the operation of the system causing gas formation and acidic system water. All such materials should be removed.

Hot water systems, in most cases, naturally operate with a pH of 8.5 or higher. If a system indicates pH values below 7 on the scale, the following symptoms may occur:

- Gas formation in the system.
- Pump seal and gland problems.
- Air vent sticking and leaking.
- Piping leaks at the joints.

If system deterioration is permitted and leaks develop and water losses increase, it is possible to cause serious damage to the boiler. Therefore, it's important to have a closed system that is clean, neutral, and water tight.

3.3 — Boiler Water Treatment

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. Contact your Cleaver-Brooks local representative for more information on a water treatment program.

Objectives of boiler water conditioning include:

- Prevent the accumulation of scale and deposits in both the boiler and heating system.
- Remove dissolved gases from the water.
- Protect the boiler and system against corrosion.
- Maintain the highest possible heating system efficiency.
- Decrease the amount of boiler downtime for cleaning.

For optimum performance, the following water quality parameters should be maintained:

pH:	8.3 - 9.5
Iron:	0.1 ppm maximum
Alkalinity:	<300 ppm maximum
Chlorides:	30 mg/liter maximum
Oxygen:	0.1 mg/liter maximum
Specific Conductivity:	3500 μmho/cm
Total Hardness	<3 ppm maximum

These recommended guidelines do not include all dissolved minerals. For more information about maintaining water quality, contact your Cleaver-Brooks local representative.

The purchaser should be sure that the boiler is not operated for long periods for approval tests, temporary heat, or any other operations without water treatment. It also should be noted that water boilers will need chemical treatment for the first filling of water and additional periodic chemical treatment.

Water treatment may vary from season to season or over a period of time; therefore, there should be a requirement that the water treatment procedure be checked no less than four times a year, and possibly more frequently, as the local water conditions may require.

CHAPTER 4

Operating Instructions

Warning

Make certain all pre-start procedures listed in Chapter 3 have been completed prior to reading this chapter. Failure to heed this warning may result in serious personal injury or death.

Before opening the cabinet doors to gain access to any electrical wiring or controls, lockout and disconnect the boiler's main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

4.1 — Initial Startup

1. Fill the vessel and the system with water, open the vent at the highest point in the system to allow air evacuation, and close the valve. Start the system circulation pump. Check to see that the system pressure is within the design range for the boiler and associated equipment.
2. Set the high limit temperature control. (Suggested setting - 20º F above operating temperature.) The boiler must not exceed a maximum temperature of 250º F per ASME Code, Section IV.
3. Set the required temperature on the temperature control. The temperature control on boilers up to 4 stages (on/off controls) has a 5º F fixed differential. The temperature control on larger boilers has an adjustable proportioning range from 3º F to 30º F, which should be set at 10º F for the initial start. This proportioning range may require small adjustments later to set the system. The temperature set point is always the center of the proportioning range.

Proportional Temperature Control

Setpoint: This is the center point of the proportional range.

Range adjustment: The proportional temperature control may be adjusted to vary the temperature range within which proportional action is desired.

Example: If the temperature of the controlled medium is to be maintained at 130º F, and a proportional action from 125º F to 135º F (a range of 10º) is desired, adjust the setpoint to 130º F and the proportional range to 10.

On-Off Temperature Control

The differential value is adjusted using the internal potentiometers (see Figure 4-3).

NOTE: Boiler controls may vary depending on boiler model. Consult the appropriate literature for information specific to your application.

Proportional Control

On/Off Control

FIGURE 4-1. Temperature Controls

4. Close the main power switch. Turn the pilot switch on to energize the boiler control circuit. The white pilot light will light. If both temperature and water level are within limits, the red pilot light or lights will not light and you will hear the contactors begin to close.
5. To assure all limit circuits are operational, individually test each high temperature limit control by lowering its setting momentarily. All contactors should drop out and the red “high temp” light should light. Then return the setting to the desired limit setting.
6. Monitor the temperature rise through the boiler. If a bypass piping arrangement is used, adjust the flow through the boiler to obtain the desired temperature rise detailed in Chapter 3.
7. Monitor the boiler operation to see that the control functions at the desired temperature setting. If the control cycles on and off on the proportional type controller, widen the proportional range (about 5º at a time) until the system is stable.
8. If the contactors cycle too rapidly even after increasing the proportional band, the step control may have to be adjusted to increase span, proportional band, or time delay, depending on the step control supplied.

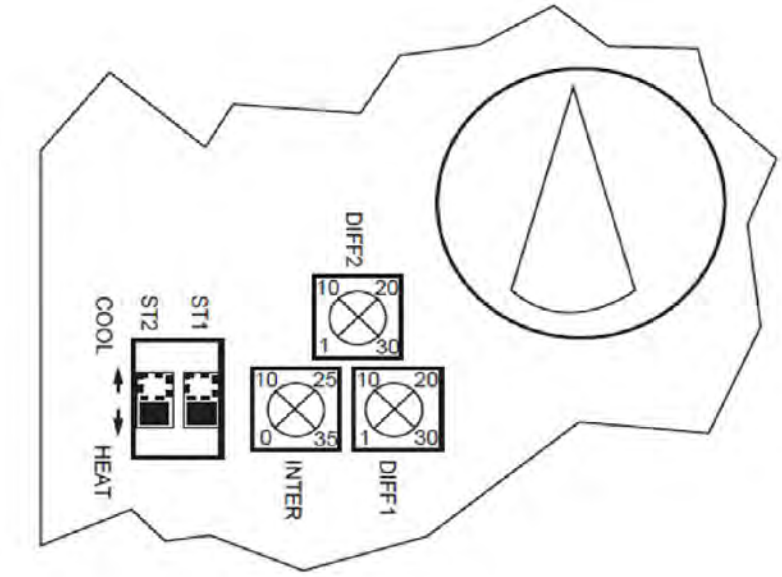


FIGURE 4-2. **Adjustments (On - Off Control)**

Remove On-Off Temperature Control cover to adjust for:

Two-Stage Heat

1. Set ST1 and ST2 switches to HEAT.
2. Set interstage (INTER) and differential (DIFF1, DIFF2) to desired settings.
3. Position the setpoint knob at the setting for stage 1.

After making adjustments, replace the On-Off Temperature Control cover.

4.2 — Maintenance Schedule

NOTE: Only personnel who have a working knowledge and understanding of this equipment should have access to the control cabinet.

4.2.1 — Weekly Procedure

⚠ Warning

Lockout and disconnect the boiler's main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

Tighten the main supply lugs every 24 hours during the first week of operation.

4.2.2 — Quarterly Procedures

While the boiler is operating, lower the temperature setting drastically on the temperature control and listen for the magnetic contactors to open. Then return the setting to normal and again listen for the magnetic contactors to operate.

Turn off the control pilot switch and the main power supply switch. This is done as a safety measure to prevent accidental turn-on of power.

Tighten all the electrical connections that could have loosened due to heat expansion and contraction. Pay particular attention to the main lugs that receive the power circuit. Examine all the relays and the magnetic contactors for pitting, corrosion, burned or welded contacts, or inoperative 120 volt coils. Inspect for blown fuses or discoloration of fuse clips, which would indicate a loose fit. Correct malfunctions as required.

⚠ Caution

When checking the element terminal connections, use wrenches on both nuts to avoid twisting the terminal stud and damage to the equipment.

If all the elements have been operating normally and each element bank draws its rated current or amperage, where:

$$\text{AMPS (3-phase)} = \frac{\text{Watts}}{\text{Volts} \times 1.73}$$

or

$$\text{AMPS (single phase)} = \frac{\text{Watts}}{\text{Volts}}$$

no further element tests are necessary. However, if there is a low or unbalanced amp reading, further tests with an ohmmeter may be necessary to detect the open or shorted element(s) in the group. To test individual elements for continuity with an ohmmeter, the jumpers between elements must first be removed.

4.2.3 — Annual Procedure

The boiler should be drained and cleaned to remove any accumulated scale or sludge. This normally can be done concurrently with an annual inspection. More frequent cleaning may be required if the boiler supply water contains sediment or if a considerable amount of make-up water is used to replace system losses. The annual checkout and start-up procedure is otherwise identical with the aforementioned monthly and quarterly procedure.

4.3 — Element Replacement Procedure

4.3.1 — Heating Elements

The smaller, individually replaceable Cleaver-Brooks electric heating elements are readily accessible for fast, easy, on-the-job maintenance. They can be removed and replaced with standard tools. The small physical size of each element means the element bundle is lighter and simpler to remove.

4.3.2 — Element Replacement

⚠ Warning

Before element replacement, make certain the boiler is drained below the element opening and lock out and disconnect the boiler's main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

1. Make a sketch or a drawing of the element bussing and tag the wires to simplify re-connection later. Refer to the wiring diagram supplied by Cleaver-Brooks for your installation.
2. Disconnect the wires and remove the element assembly flange bolts.

NOTE: To assist in breaking free the gasket, insert one of the flange bolts into the tapped hole provided.

3. Remove the element assembly by pulling it straight out.
4. Remove the jumper wires and remove the brass ferrule nuts.
5. Slide the element toward the dry side (about 2") to expose the brass ferrules on the element. Cut off the ferrules with a hacksaw. Slide the element out of the steel flange toward the wet side.
6. Inspect and clean the thread and the seat of the steel flange where the new ferrules will seal. If seats are pitted or rusted, it may not be possible to seal the new elements; therefore, a new flange may be required.
7. Screw the new ferrule nuts (furnished with a replacement element) into the cleaned or new flange plate (finger tight).
8. Slide the element into position. Make sure the element protrudes beyond the ferrule nut approximately 1/4", or to match original assembly. Some boiler models require the element sheath to extend out further than 1/4", so duplicate the original assembly as closely as possible.

NOTE: Since the elements often differ in length, check to assure that there is an adequate clearance (3/4" min.) between the end of the element and the opposite side vessel wall. Check by measuring both the element extension (from flange to tip) and the distance from the tank flange face to the vessel wall.

9. Hold the element to prevent twisting while tightening the ferrule nuts. Tighten the nuts to approximately 45 ft. lbs. (35 ft. lbs. for 208 and 240 volt elements). You will feel the ferrule separate from the nut while tightening. A properly tightened ferrule nut will have separated from its ferrule and the ferrule will be squeezed or compressed onto the element sheath, thus providing a tight seal.

10. Replace the element assembly into the boiler, using a new gasket and anti-seize compound on gaskets and bolts. Torque the element flange bolts to 90 to 100 ft. lbs.
11. When the boiler is filled and pressurized, inspect for leaks. If leaks are detected around the brass ferrules, tighten the nuts in 5 ft lb increments up to a maximum of 70 ft lb (60 ft lb for 208 and 240 Volt elements) until leaks are no longer detected.
12. Rewire the element ends. Torque element stud nuts to 35 in lb.

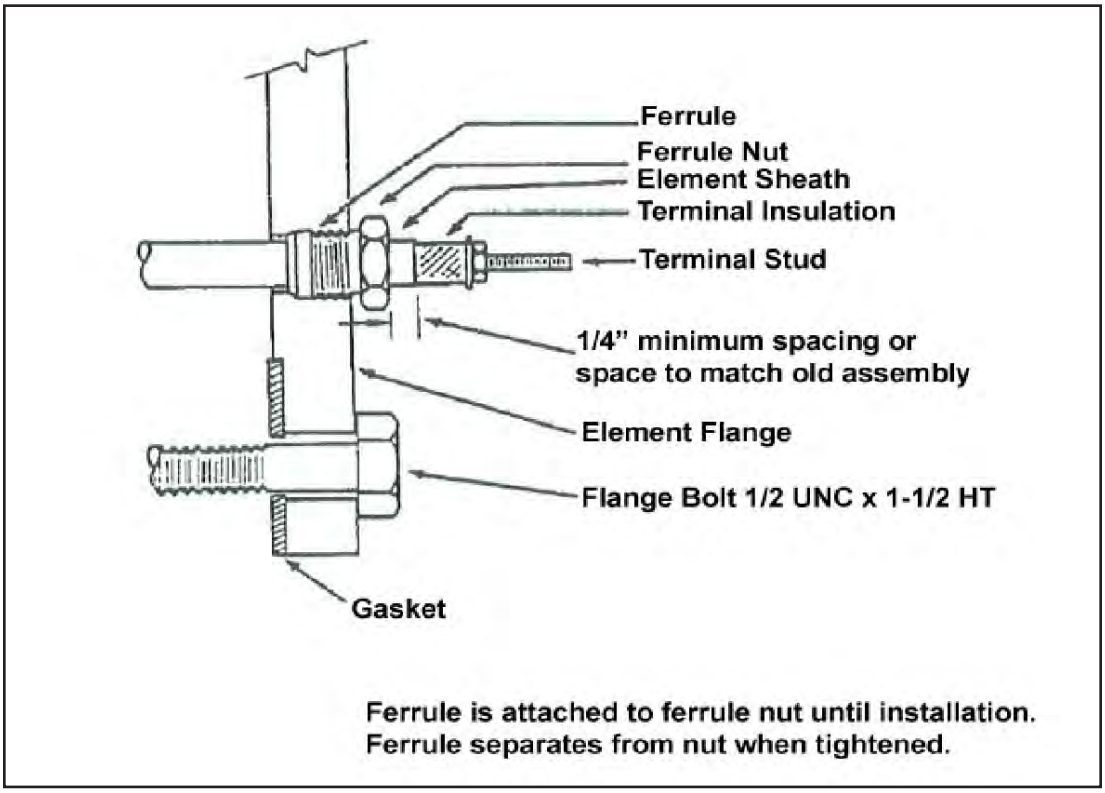


FIGURE 4-3. **Element Installation Details**

CHAPTER 5

Troubleshooting

5.1 — Problems, Causes, and Actions

⚠ Warning

Troubleshooting should be performed only by a qualified technician who is familiar with the equipment and who has read and understands this manual. Failure to heed this warning could result in serious personal injury or death.

During troubleshooting, when possible, disconnect and lockout the main power to avoid the hazard of electrical shock, which could result in serious personal injury or death.

Problem	Possible Cause	Action
Pilot switch set to "power on," pilot light off.	• Main power supply not on. • Control transformer fuse is blown. • Control transformer inoperative. • Pilot light burned out.	• Energize power supply. • Check for loose connections, then replace fuse. • Check for proper wiring/loose connections, replace transformer. • Check for loose connections, replace light.
High pressure/temperature alarm pilot light on.	• Pressure/temperature has exceeded setpoint on auto reset limit control. • Pressure/temperature has exceeded setpoint on manual reset limit control.	• Allow pressure/temperature to fall below setpoint less control differential. Raise setting if necessary, but not above design limit or manual reset setting. • Allow pressure/temperature to fall below setpoint less control differential. Depress reset button. Raise setting if necessary, but not above design limit.

Problem	Possible Cause	Action
Low water alarm pilot light on.	• Float-type LWCO: Water below cutoff line on float cage. • Float-type LWCO: Float stuck/ switch mechanism jammed. • Probe-type LWCO: Probe circuit open/water below cutoff level. • Probe-type LWCO: Probe or relay faulty.	• Assure unit has proper water level. Check that LWCO line is at proper level. • Check that float blocking plug has been removed. Perform blow-down of float cage. Assure switch plate operates freely. • Check for loose connections/ improper wiring. Assure unit has proper water level. • Replace probe or relay.
Control power pilot light on, alarm pilot lights off, contactors not energized.	• Alarm pilot light(s) burned out. • Step control fuse blown. • Pressure/temperature control improperly wired to step control.	• Replace pilot light(s). • Replace fuse. • Check that wiring is per control literature and per unit wiring diagram.
Steps do not all energize.	• Step control faulty. • Contactor coil inoperative. • Step control relay(s) faulty.	• Replace step control. • Check for loose coil connection. Replace contactor. • Check that relay is tight in socket. Replace relay.
Steps do not draw rated current	• Branch circuit fuse(s) blown. • Element bussing improper.	• Check element(s) for proper ohms and resistance to ground then replace fuse(s). • Check that element bussing is per wiring diagram.
Contactors noisy (chatter).	• Element(s) open. • Contactors damp/dirty.	• Replace faulty element(s). • Blow out contactors with compressed air. Remove contactor, disassemble and clean, and replace contactor.

CHAPTER 6 Parts

6.1 — Ordering Parts

Be sure to furnish complete information when ordering parts. Include the boiler serial number (displayed on the boiler name plate) on your order. The order should state:

- Cleaver-Brooks part number
- name and description of the required part
- quantity required
- method of shipment
- date the part(s) is needed by

If repair parts are required for accessory equipment, order these parts from your local authorized Cleaver-Brooks representative.

Elements

Part Number	Description
129-00100-000	Ferrule Nuts, for 208/240V Heating Elements (.315" ID)
129-00104-000	Ferrule Nuts, for 380/415/480/600V Heating Elements (.475" ID)
129-00409-000	Element Flange Gasket, 8"
129-00204-000	Element Flange Gasket, 10"
Consult Factory for P/N	Heating Elements

Contactors

Part Number	Description
833-05099-000	Contactor, 50A, 3 Pole

Fuse Blocks and Fuses

Part Number	Description
848-01044-000	Fuse Block, Class T, 3 Pole, 30A, 600V
848-01019-000	Fuse Block, Class T, 3 Pole, 60A, 600V
884-00155-000	Fuse Block, Front-Mounted, Class T, 3 Pole, 60A, 600V
832-01568-000	Fuse Cartridge, Class T, 30A, 600V
832-01371-000	Fuse Cartridge, Class T, 50A, 600V
832-01376-000	Fuse Cartridge, Class T, 60A, 600V

Operating/Modulating Controls

Part Number	Description
817-05070-000	Operating Temperature Control, 2 SPDT Relay Outputs, -25°F to 105°F
833-03953-000	Operating Temperature Control, 2 SPDT Relay Outputs, 100°F to 240°F
817-05073-000	Operating Temperature Control, 2 SPDT Relay Outputs, Outdoor Reset, -40°F to 248°F
817-05071-000	Operating Temperature Control, 4 SPDT Relay Outputs, -40°F to 248°F
817-05074-000	Operating Temperature Control, 4 SPDT Relay Outputs, Outdoor Reset, -40°F to 248°F
817-05072-000	Modulating Temperature Control, 4-20 mA Analog Output, -40°F to 248°F
817-05075-000	Modulating Temperature Control, 4-20 mA Analog Output, Outdoor Reset, -40°F to 248°F
997-10815-000	UDC2500 w/ RS-485 Modbus Communication

Limit Controls

Part Number	Description
817-04100-000	Operating Limit Control, Automatic Reset, 120°F to 210°F
817-04101-000	Operating Limit Control, Automatic Reset, 175°F to 240°F
817-04099-000	High Limit Control, Manual Reset, 120°F to 210°F
817-04098-000	High Limit Control, Manual Reset, 175°F to 240°F

Step Controllers

Part Number	Description
833-03551-000	3-4 Steps
833-03552-000	4-8 Steps
833-03552-000 and 833-03551-000	8-12 Steps (Master and Slave)
833-03552-000 and 833-03552-000	13-16 Steps (Master and Slave)
833-03553-000 and 833-03554-000	17-18 Steps (Master and Slave)
833-03553-000 and 833-03555-000	19-20 Steps (Master and Slave)
833-03553-000 and 833-03556-000	21-22 Steps (Master and Slave)
833-03553-000 and 833-03557-000	23-24 Steps (Master and Slave)

Control Transformers

Part Number	Description
832-01801-000	Control Transformer, 500VA, 208V Pri, 120V Sec
832-01910-000	Control Transformer, 500VA, 380/415V Pri, 120V Sec
832-01802-000	Control Transformer, 500VA, 240/480V Pri, 120V Sec
832-01911-000	Control Transformer, 500VA, 600V Pri, 120V Sec
832-01912-000	Control Transformer, 1000VA, 208V Pri, 120V Sec
832-01913-000	Control Transformer, 1000VA, 380/415V Pri, 120V Sec
832-01803-000	Control Transformer, 1000VA, 240/480V Pri, 120V Sec
832-01914-000	Control Transformer, 1000VA, 600V Pri, 120V Sec
832-00235-000	Transformer, Damper, 40VA, 120V Pri, 24V Sec

Toggle Switches

Part Number	Description
836-00706-000	Toggle, SPST, On-Off
836-00398-000	Toggle, Momentary, SPST, NC
836-00399-000	Toggle, Momentary, SPST, NO
836-00211-000	Toggle, DPDT

Pilot Lights

Part Number	Description
881-00249-000	White, Neon Type
881-00250-000	Amber, Neon Type
881-00251-000	Red, Neon Type

Miscellaneous

Part Number	Description
997-10943-000	Safety Door Interlock, 115Vac, 60Hz, for single door enclosures
997-00148-000	Safety Door Interlock, 115Vac, 60Hz, for dual door enclosures
817-00239-000	Alarm Bell, 4"
817-00468-000	Alarm Bell, 6"
817-03096-000	Alarm Horn, 4", NEMA 1
836-01461-000	Panel High-Temperature Thermostat Switch

Consult factory for special/custom parts or for parts not shown on this list.

e-mail: info@cleaverbrooks.com
Web Address: http://www.cleaverbrooks.com