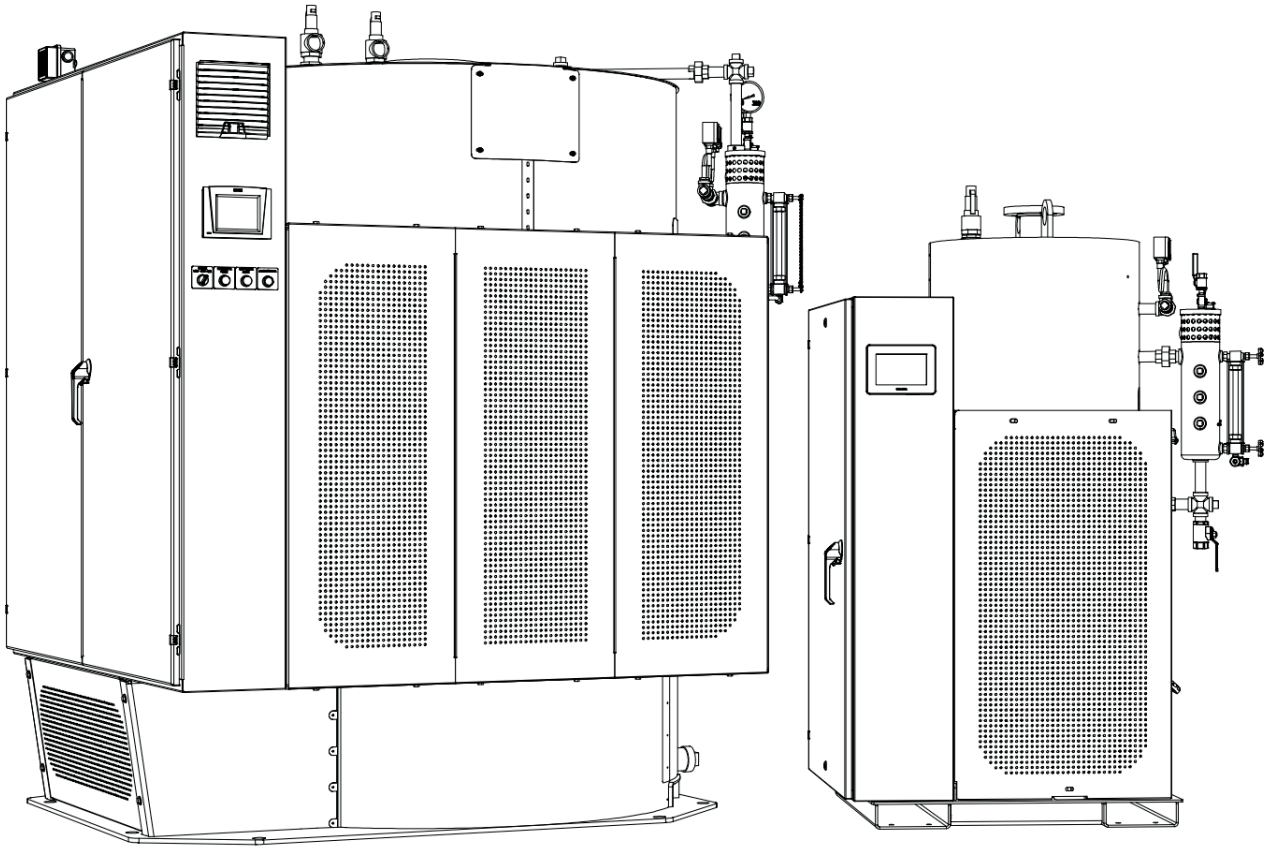
INSTALLATION & OPERATION INSTRUCTIONS

CHSI SERIES
ELECTRIC STEAM BOILER
210KW - 1300KW



CHROMALOX

CHSI-IOM-2024-0927
January 2025

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⚠WARNING

Do not operate, or allow others to operate, service or repair this equipment unless you (they) fully understand all applicable sections of this manual and are qualified to operate/maintain the equipment.

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

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

Operating the equipment beyond its design limits can damage the equipment and can also be dangerous.

Do not operate the equipment outside its limits. Do not try to upgrade the equipment performance by unapproved modifications. Unapproved modifications can cause injury and damage.

Contact your Chromalox Representative before modifying the equipment.

Defective equipment can injure you or others. Do not operate equipment which is defective or has missing parts. Make sure all repairs or maintenance procedures are completed before using the equipment. Do not attempt repairs or any other maintenance work you do not understand.

Never attempt to operate equipment that has failed to pass all the safety checks.

Please read these instructions and save for reference.

INTRODUCTION

OVERVIEW

Prior to shipment, the following inspections and tests are made to ensure the highest standards of manufacturing for our customers:

· Material inspections
· Manufacturing process inspections
· American Society of Mechanical Engineers (ASME) welding inspection
· ASME hydrostatic test inspection
· Electrical components inspection
· Operating test
· Final engineering inspection
· Crating inspection

This manual is provided as a guide to the correct operation and maintenance of your Chromalox equipment, and should be read in its entirety and be made permanently available to the staff responsible for the operation of the boiler. It should not, however, be considered as a complete code of practice, nor should it replace existing codes or standards which may be applicable. Chromalox reserves the right to change any part of this installation, operation and maintenance manual.

Installation, start-up, and maintenance of this equipment can be hazardous and requires trained, qualified installers and service personnel. **Trained personnel are responsible for the installation, operation, and maintenance of this product, and for the safety assurance of installation, operation, and maintenance processes. Do not install, operate, service or repair any component of this equipment unless you are qualified and fully understand all requirements and procedures. Trained personnel refers to those who have completed Chromalox Service School training specific to this product.**

When working on this equipment, observe all warnings, cautions, and notes in literature, on stickers and labels, and any additional safety precautions that apply. Follow all safety codes and wear appropriate safety protection. Follow all jurisdictional codes and consult any jurisdictional authorities prior to installation.

RECEIVING INSPECTION

The customer should examine the equipment for any damage. It is the responsibility of the installer to ensure all parts supplied with the equipment are fitted in a correct and safe manner.

WARNINGS & CAUTIONS

WARNINGS and CAUTIONS appear in various chapters of this manual. It is critical that all personnel read and adhere to all information contained in WARNINGS and CAUTIONS.

· WARNINGS must be observed to prevent serious injury or death to personnel.

· CAUTIONS must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.

All Warnings and Cautions are for reference and guidance purposes, and do not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes or regulations.

In addition, there are bolded **Notes** throughout the manual, which are included as additional information for essential and effective operation and conditions.

DISCLAIMERS & LOCAL CODES

Installation of the equipment shall conform to all the requirements or all national, state and local codes established by the authorities having jurisdiction or, in the absence of such requirements, in the US to the National Electric Code (NEC)/ National Fire Protection Association (NFPA) 70 latest edition, and the specific instructions in this manual. Authorities having jurisdiction should be consulted prior to installation.

When required by local codes, the installation must conform to the ASME Safety Code for Controls and Safety Devices (CSD-1).

The standard boiler is manufactured and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section I for a maximum working pressure of 150 psig.

⚠WARNING

After checking controls by manual adjustment, always ensure they are reset to their proper settings.

Follow proper lockout/tagout procedures for the electrical and water connections.

If any "Manual Reset" limit device trips, DO NOT reset without determining and correcting the cause. (Manual Reset Limits may include high temperature limit and high pressure limit.)

Never tamper with low water (liquid level) cutoff sensors or circuitry.

Check daily that the equipment area is free and clear of any combustible materials, including flammable vapors & liquids.

When stopping the boiler for any extensive repairs, shut off main power switch and pull main disconnect switches on both the boiler side as well as the feedwater side.

Prior to powering the boiler for start-up, all electrical contacts shall be re-torqued to the individual components manufacturers recommendations.

⚠WARNING

Do not store or use gasoline or other flammable vapors and liquids or corrosive materials in the vicinity of this or any other appliances. Cements for plastic pipe should be kept away from all sources of ignition. Proper ventilation should be maintained to reduce the hazard and to minimize breathing of cement vapors.

No shutoff of any kind shall be placed between the safety relief valve and the equipment or in the discharge pipe between such valve and the atmosphere. Doing so can cause an accidental explosion from overpressure.

The discharge from the safety relief valve shall be so arranged that there will be no danger of scalding personnel or damage to equipment. Provisions should be made to properly drain safety relief valve discharge piping.

Fluids under pressure may cause injury to personnel or damage to equipment when released. Be sure to shut off all incoming and outgoing fluid shutoff valves and carefully decrease all trapped pressures to zero before performing any maintenance.

When opening any drains on the equipment or piping system, steps should be taken to avoid scalding/burning of personnel due to hot fluids. Whenever possible, the system should be cooled prior to opening any drains.

Post these instructions in an appropriate place near the equipment and maintain in good legible condition.

Hot surfaces (over 120 F [49 C]) should be insulated or shielded for safety. See Installation section.

Use only your hand to turn valve handles. Never use tools. If the handle will not turn by hand, don't try to repair. Forced or attempted repair may result in fire or explosion.

⚠WARNING

Check daily that the boiler area is free and clear of any combustible materials, including flammable vapors and liquids.

These instructions must not be considered as a complete code of practice nor should they replace existing codes or standards which may be applicable.

Commissioning/Start up by a non-Chromalox authorized person will void the product warranty.

To ensure that your Chromalox equipment is operating safely and efficiently, follow the maintenance procedures set forth in this manual.

SAFETY COMPONENTS: The end user of the boiler must maintain all labels on the boiler in clean, legible condition. All connections and safety devices, both mechanical and electrical, must be kept clean, with ease of access for inspection, use and maintenance.

Boiler blowdown water must be cooled to <140˚F (60˚C) prior to discharge to a drain, or as required per local jurisdictional codes. Failure to use an approved blowdown vessel with adequate cooling could cause personnel/equipment damage.

Improper installation or maintenance of gauge glass and connections can cause immediate or delayed breakage resulting in bodily injury and/or property damage. Only properly trained personnel should install and maintain gauge glass connections. Wear safety glasses during installation. Be sure all parts are free of chips and debris.

⚠CAUTION

Maintenance procedures for this equipment should be completed by trained personnel. Appropriate training and instruction are available from the Chromalox Service Department at or your local Chromalox Representative.

A competent rigger experienced in handling heavy equipment should handle rigging your equipment into position.

Competent personnel in accordance with all applicable local codes should carry out the installation of the Chromalox equipment.

“Factory-Trained Personnel” refers to someone who has attended a Chromalox Service School specifically for the equipment covered in this manual.

All state and jurisdictional codes beyond the scope of the applicable ASME Boiler and Pressure Vessel Codes, for its corresponding classification, should be followed in all cases.

Jurisdictional authorities must be consulted prior to installation.

The equipment must be installed on a non-combustible surface.

A temperature exceeding 120°F (49°C)* in the boiler room may cause premature failure of electrical components. Provisions should be made to maintain an ambient temperature of 120°F (49°C)* or less (the panel box interior should not exceed 125°F [52°C]*).
***Pumps, Programmable Logic Controllers (PLC) or ModSync panels may require lower ambient temperatures or additional cooling.**

⚠CAUTION

Never leave an opened manual air vent unattended. In the event an opened vent is left unattended, water or fluid damage could occur. The exception to this warning is a feedwater deaerator manual vent cracked open may be left unattended.

Do not use this equipment if any part has been under water (or subjected to heavy rains/water if the equipment does not have National Electrical Manufacturers Association (NEMA) 4 wiring, controls and instrumentation). Immediately call a qualified service technician to inspect the equipment and to replace any part of the control system that has been under water.

For all systems containing boilers or unfired steam generators, the water chemistry in the boiler must be kept within the limits outlined in this manual. Failure to do so may cause premature pressure vessel failure and poor steam quality and will void the warranty.

Do not run the pump dry. Irreparable damage to the seal can result. Prime the pump in accordance with the manufacturer’s instructions. Never operate the pump with a closed discharge valve.

⚠WARNING

Competent personnel in accordance with all applicable local codes should carry out the placement and rigging of the Chromalox equipment. All state and jurisdictional codes beyond the scope of the applicable ASME Boiler and Pressure Vessel Codes, for its corresponding classification, should be followed in all cases. Jurisdictional authorities must be consulted prior to installation.

⚠WARNING

Failure to provide required and safe access to the equipment could impede commissioning and maintenance. Service technicians are instructed not to commence commissioning if hazardous conditions exist.

SAFETY COMPONENTS: The end user of the boiler must maintain all labels on the boiler in clean, legible condition. All connections and safety devices, both mechanical and electrical, must be kept clean, with ease of access for inspection, use and maintenance.

After the appropriate system tests have been satisfactorily completed, all hot pipework and vessels must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

⚠CAUTION

The boiler must be inspected before installation to ensure no damage has occurred during shipment, handling, or storage.

Unless specifically designed otherwise, the air surrounding the panel box shall not exceed the maximum design temperature of 104°F.

INSTALLATION

PRODUCT OVERVIEW

Prior to the installation, operation, or maintenance procedures, personnel should become familiar with the equipment and its components. Please read this entire manual before beginning any installation, operation or maintenance procedures.

If any questions arise, contact Chromalox before proceeding. The information contained in this installation, operation and maintenance manual is subject to change due to continuous product improvement. Additionally, these instructions should be regarded as a general guide and must not be considered as a complete code of practice. This manual does not replace existing codes or standards which may be applicable.

PLACEMENT & RIGGING

Adhere to the following for placement and rigging:

1. Verify boiler electrical classification and rating is suitable for installation environment.
2. Check building specifications for permissible floor loading.
3. Place equipment on a non-combustible level base with adequate clearances from combustible materials. See Clearances & Serviceability section of this manual.
4. Place equipment in a well-ventilated room.
5. Ensure there is adequate clearance around the unit to provide access for operators and maintenance personnel to access all parts of the equipment per local jurisdictional requirements. Ensure also that clearance provides for component removal for maintenance. The service engineer or the operator should not have to pass exposed, hot pipework to make adjustments to the boiler. See Clearances & Serviceability section of this manual.
6. Boiler will be shipped crated for forklift transport. Once uncrated, transport unit by forklift or lifting lugs at the top of the boiler. If means of lifting are not available, rollers should be placed beneath the frame of the equipment and it should be guided to the installation location. All units can be moved with forklifts.
7. Never allow weight to bear on the jacket, control panel, trim, burner, fuel train or fan housing of any Chromalox boiler. Use only lifting eyes or fork holes for movement.

CLEARANCES & SERVICEABILITY

All local and national codes (NFPA, ANSI, UL, CSA, ASME) must be followed for proper clearances and serviceability of your boiler. Authorities having jurisdiction should be consulted before installations are made.

Appropriate front, back, side and top clearances must be maintained (Table 1) to allow access around the equipment to facilitate maintenance and a safe work environment.

Table 1 - Minimum Clearances Around the Boiler

UNIT SIZE (kW)	PANEL inch (mm)	REAR/ SIDES inch (mm)	ELEMENT REMOVAL inch (mm)
210	36 (915)	24 (610)	36 (915)
270	36 (915)	24 (610)	36 (915)
400	36 (915)	24 (610)	47 (1194)
500	36 (915)	24 (610)	47 (1194)
600	36 (915)	24 (610)	46 (1168)
700	36 (915)	24 (610)	46 (1168)
800	36 (915)	24 (610)	46 (1168)
1000	36 (915)	24 (610)	42 3/8 (1077)
1300	36 (915)	24 (610)	42 3/8 (1077)
1300	36 (915)	24 (610)	47.4 (1204)

ELECTRICAL CONSIDERATIONS

· Three-phase supply voltage should match the boiler name plate. If supply voltage exceeds the nameplate, contact your utility

· Operating an electric boiler above the nameplate voltage may shorten the life of components.

· Electric elements will have a higher output of watt density when the voltage is increased above design and will have a lower output when the voltage is below design.

· Electric element bundles output is as follows:

$$KW_{ACTUAL} = KW_{DESIGN} \times \left(\frac{Voltage_{ACTUAL}}{Voltage_{DESIGN}}\right)^2$$

⚠WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

Prior to powering up the boiler, all electrical contacts require re-torquing to the individual components manufacturers recommendations.

⚠WARNING

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

Prior to powering up the boiler, all electrical contacts require re-torquing to the individual components manufacturers recommendations.

ELECTRICAL REQUIREMENTS

Adhere to the following:

1. Connect wiring as shown in the specific wiring diagram which is furnished inside the cover of the electrical control box. Be sure to install a separate fused disconnect for the boiler. All wiring must conform to NEC Code.

2. A correctly sized fused disconnect switch should be fitted as close to the boiler as possible and connections made to the boiler control panel in compliance with NFPA (National Fire Protection Association), NEC Code, and local codes. The appropriate number of terminals are provided inside the control panel box to take these connections, but the panel box must be drilled to accept the type of conduit used.

Table 2 - Electrical Requirements (FLA)

MODEL	CHSI-0210	CHSI-0270	CHSI-0400	CHSI-0500	CHSI-0600	CHSI-0700	CHSI-0800	CHSI-1000	CHSI-1300
480/60/3	254	326	483	603	723	844	964	1,204	1565
400/60/3	203	261	386	482	579	675	771	964	1,252

WATER CHEMISTRY

RECOMMENDED WATER CONDITIONS FOR BOILERS/UNFIRED STEAM GENERATORS

Table 3 lists recommendations for feedwater and boiler water. Contact your local water treatment professional for testing and treatment recommendations. It is very important that a strict water treatment program is followed.

It is critical that the boiler water chemistry follow Table 3 whenever water is in the boiler. Solids that enter with the feedwater will concentrate in the boiler. A regular schedule of boiler blowdown (see **Maintenance** section of this manual) must be maintained to prevent high solid concentrations from corroding the vessel or forming deposits.

WATER SUPPLY

The quality of the water used in the boiler will affect the life of the pressure vessel (PV). It is strongly recommended that a competent water treatment company is consulted prior to the operation of the boiler. Elements/PV damaged due to adverse water conditions will not be replaced or repaired under warranty.

Natural feedwater supplies contain hardness, solids and dissolved gases. These may promote scale, foaming, corrosion, and/or poor steam quality. To prevent this, feedwater must be analyzed and treated accordingly. The treatment should provide quality feedwater to the boiler such that corrosion and deposition in the boiler will be minimized.

Thermal cycling, dissolved oxygen, high or low pH can all be major causes of corrosion. Untreated hardness is the major cause of scale deposits. Poor quality feedwater requires increased blowdown and increased chemical treatment costs to prevent boiler corrosion and scaling.

One way to lower the amount of dissolved gases in the boiler feedwater is to preheat the feedwater. This option injects live steam into the feedwater to increase the water temperature to 180 F (82 C) or higher which removes oxygen and carbon dioxide from the water. It is ideal to have the water temperature above 200°F (93°C) for atmospheric vented tanks as long as the feedwater pumps and other associated components are rated for the temperature.

Be sure that the supplied feedwater pump will operate at elevated feedwater tank temperatures.

Reverse Osmosis / Deionized (RO/DI) water is water from which all dissolved solids have been removed. (Consult factory for recommended controls and equipment for operating on RO/DI water.)

If RO/DI water is used as a water source in a carbon steel boiler, it must be neutralized to pH >7.5 prior to entering the boiler. Failure to neutralize the RO/DI will void the PV warranty and cause high general corrosion rates.

The Chromalox Warranty does not cover damage or failure that can be attributed to excessive corrosion, scale or fouling.

Table 3 - Water Chemistry Requirements for Chromalox Boilers

	CARBON STEEL	
Parameter	Feedwater	Boiler Water
PH	7.5-9.2	8.5-10.5
Feedwater Temp.	140 F (60 C)*	---
Hardness as CaCO3	< 2ppm	<4 ppm
Chlorides	---	***
Total Alkalinity	---	<300 ppm
OH Alkalinity	---	200-300 ppm
Total Dissolved Solids	---	< 2000 ppm
Suspended Solids	No visual turbidity**	No visual turbidity**
Total Organic Carbon	No sheen, No foam +	No sheen, No foam +
Iron	0.1 ppm and colorless liquid++	0.1 ppm and colorless liquid++
Dissolved Oxygen	<1 ppm*	ND
Visual Oil	ND	ND
Conductivity (mS/cm)	---	<2985

* This is a minimum temp. Feedwater temperatures below 200 F (93 C) will require an oxygen scavenger.

**Suspended solids: Take a water sample. After the sample sits for 10 minutes, no solids should be visible.

• Stainless steel electric steam boilers must be fed with de-ionized water with a min. conductance of 1µS/cm; Due to this requirement, units do NOT meet the intent of CSD-1; Please consult factory for more information

+Total Organic Carbon: Take a water sample. Shake vigorously for 30 seconds. No sheen or foam should be visible.

++ Iron: Take a water sample. The upper limit is 0.1 ppm. Hold the sample against a white background. The water should have no visible yellow, red or orange tinge.

ND: None Detected
ppm: parts per million

⚠CAUTION

A temperature exceeding 120 F (49 C) in the boiler room may cause premature failure of electrical components. Provisions should be made to maintain an ambient temperature of 120 F (49 C) or less (the panel box interior should not exceed 125 F [52 C]).

⚠WARNING

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

⚠WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

GLOSSARY OF WATER SUPPLY TERMS

Dissolved Oxygen: Oxygen that is dissolved in the feedwater will cause the steel in the boiler and the feedwater system to be attacked by the water in a manner described as “pitting”. The pits that are produced can vary from tiny depressions to holes large enough to penetrate the boiler metal and are usually covered with tubercles of iron oxide. Once pitting starts, it may be extremely hard to arrest. Pitting can proceed at a surprisingly rapid rate and can occur not only in the boiler proper, but also in pre-boiler equipment such as economizers, feedwater tanks, and feedwater lines.

Suspended Solids: Suspended solids are the undissolved matter in water, including dirt, silt, vegetation, iron oxides, and any other insoluble matter. Normally suspended solids are expressed in terms of turbidity. Suspended solids may also deposit in low velocity areas and create fouling. In line filters, or various types of pretreatment can be used to lower the suspended solids level. Periodic blowdowns will eliminate suspended solids.

Alkalinity: Alkalinity is the capacity of a water to neutralize acids. Common water alkalinities consist of bicarbonate, carbonates, hydroxide, phosphate, and silicate. These alkalinities, especially bicarbonates and carbonates, break down to form carbon dioxide in steam, which is a major factor in the corrosion on condensate lines. High alkalinity also causes foaming and carry over in boilers. Both foaming and carry over cause erratic boiler operation. The reason for the high alkalinity should be determined. It may result from lack of sufficient blowdown. The source of alkalinity may be due to an overdose of alkaline internal water treatment chemical.

pH: pH is a measure of the degree of acid or base of solution. A pH range of 8.5-10.5 will have little influence on the corrosion rate of carbon steel. A low pH can result in corrosion of metals, while a high pH can result in scale formation or caustic embrittlement. In order to control boilers and equipment used for the external treatment of make-up water, it is essential that reliable pH measurements be made. RO/DI water will have a low pH and will require neutralization if used in a carbon steel vessel. It is critical that the boiler pH be alkaline (8.5-10.5) whenever water is in the boiler.

Chlorides: If chloride levels are high enough to cause severe corrosion, they can be controlled by limiting the cycles of concentration and increasing boiler blowdowns. Corrosion from chlorides can also be controlled by increasing the amount of corrosion inhibitor, or changing to a more effective inhibitor.

Oil: Oil is not a natural constituent of boiler water; still it can frequently enter a system through leaks in a condenser or other heat exchanger. Oil can also enter a system through the lubrication of steam driven reciprocating equipment. Whatever the source, the presence of oil in boiler water is undesirable. Oil can act as a binder to form scale. In high heat-transfer areas oil can carbonize and further contribute to the formation of scale and low pH. Foaming is one indication of oil in boiler water. Its presence can also be confirmed by first shaking a bottle containing boiler water. If oil is present foam will result. Often oil in boiler water will originate in the condensate. This contaminated condensate should be directed to the sewer until the source of the oil is determined and corrective steps taken.

Iron (oxides): Iron in any of its oxide or complex forms is undesirable in boiler water. Iron in its various forms can originate in the raw water makeup, condensate return water, or form directly in the boiler as a result of corrosion. It can concentrate in the boiler and it tends to collect in stagnant areas.

Water Hardness: Water hardness is the measure of calcium and magnesium content as calcium carbonate equivalents. Water hardness is a primary source of scale in boiler equipment. Hardness is removed by softening

Periodically, the ion exchange resin bed requires regeneration by flushing through with a brine solution followed by rising with fresh water. The interval between regeneration is dependent upon the raw water hardness and flow rate.

In all cases the water hardness should be tested periodically and prior to starting the boiler or generator to ensure efficient operation of the softener. Unsoftened water should not be allowed to enter the steam boiler or generator unless sufficient scale inhibitor chemical is used.

Feedwater: Feedwater is the combination of fresh makeup and returning condensate that is pumped to the boiler.

Condensate: Condensate is condensed steam that is normally low in dissolved solids. Hence, it does not contribute to the dissolved solid content of the feedwater. In addition, condensate is very expensive to waste. It's been chemically treated, heated, pumped, converted to steam, and condensed.

Dissolved Solids: Dissolved solids are salts in the water that stay in solution. They are invisible to the naked eye. As the boiler generates steam, dissolved solids will concentrate. If the concentration becomes too high, they will precipitate, form a suspended solid, and concentrate in the vessel. Daily boiler blowdown is recommended to help prevent the formation of deposits. Consult Blowdown procedure in the **Daily Maintenance Schedule** section of this manual.

Chemical Dosing: In addition to softening the feedwater, it is also important to consider other factors such as dissolved oxygen and acidity. Depending on the results of an analysis, it may be necessary to inject appropriate amounts of corrective chemical into the feedwater system. This is usually achieved by means of a chemical compound solution and variable output metering pump mounted at the storage vessel. It is important that the chemicals and quantities are correct and it is advisable to contact a water treatment company to arrange a feedwater analysis.

PIPING SPECIFICATIONS

For piping, the basic considerations are the design temperature, the pressure retained by the pipe, the fluid in the pipe, the load resulting from thermal expansion or contraction and, impact or shock loads imparted (such as water hammer, external loads, wind loads, and vibration from equipment).

While referencing **Table 4** and **Figure 1**, adhere to the following:

1. The arrangement of the piping and its appurtenances must take into consideration the location of other structures and equipment adjacent to the piping. The potential for freezing interference and/or damage as a result of expansion, contraction, vibration, or other movements must be factored.

2. Valves are used in piping systems to stop and start the flow of fluid and gasses, to regulate flow, to prevent back flow, and to relieve excessive pressure buildup in the piping. Consideration should be given to the appropriate location and orientation of valves necessary for safe operation and isolation of the piping.

3. All piping and piping components used should be suitable for the design temperatures, pressure and fluid used in the system.

4. During the installation, ensure that no dirt, water, or residue from welding is left in the system.

5. Expansion joints or properly designed and sited loops should be provided to accommodate thermal expansion. Thermal expansion should be calculated using the maximum possible utilization fluid temperature, regardless of whether the pipe considered is in the feed or return circuit. Steel pipe will expand approximately 1“ per 100’ over a 100°F temperature rise (1 mm per meter over 100°C rise).

6. Supports and anchors must be provided for all pipes, as necessary, to prevent undue stresses from being placed on equipment, including pumps, valves, and the heater. Supports and anchors which will not interfere with thermal expansion should be chosen. The equipment should never be used or considered as an anchor. No additional loads should be applied to any factory connection.

7. Gaskets must be used to make all flanged connections. Gasketing material must be suitable for use with the pressure, temperatures and fluids in the system. Ensure that all bolts are tightened evenly and to the torque recommended values provided by the gasket manufacturer.

8. High point bleeds/air vents are to be installed at all high points in the system piping.

9. All pipes should be installed with a pitch to facilitate draining and in the direction of steam flow.

STEAM OUTLET

It is recommended to have 30 inch or five pipe diameters (whichever is greater) of vertical rise out of the steam outlet. This is considered a good piping practice and will allow for proper operation.

Steam outlet sizes should not be reduced until after the steam outlet and at the end of the near boiler piping. Steam piping should be sized for appropriate velocities for the application and pressure. Steam piping is to be sized for 4,500 ft./min. This piping includes the steam outlet piping through the outlet of the main steam header. After the main steam header, distribution piping may be sized for velocities of 4,000 – 6,000 ft./min. for low pressure steam (0-30 PSIG), 6,000 – 8,000 ft./min. for medium pressure steam (30 -75 PSIG), and 8,000 –12,000 ft./min. for high pressure steam (75 PSIG and above).

⚠WARNING

Assure all electrical connections are powered down prior to attempting replacement or service of electrical components or connections of the equipment.

Table 4 - Sample Piping Specification

Skid Packaged Steam System Piping Specification
(Boilers with a maximum operating pressure of
125 psig, 150 psig max. trim pressure)

SERVICE	PIPE	FITTINGS	JOINTS
Blowdown	Sch 80 SA 53A or B or SA 106B	≤ 2.5" Forged Steel CL3000 ≥3" SA 234/SA 105	≤ 2.5" Threaded ≥3" welded/flanged 300#
Water bottle nipples Note: downstream of the water bottle drain valve to follow surface blowdown piping requirements	Sch. 40 SA 53A or B or SA 106B	malleable iron CL 150	Threaded
Surface Blowdown Piping	Sch 80 SA 53A or B or SA 106B	Forged Steel CL 3000	Threaded
Condensate (i.e., any piping that may come in contact with the condensate that is not deaerated – water piping).	Sch 80 SA 53A or B or SA 106B	≤ 2.5" Forged Steel CL3000 ≥3" SA 234/SA 105	≤ 2.5" Threaded ≥3" welded/flanged 150#
Feedwater – between the pump and the boiler/steampac++	Sch 80 SA 53A or B or SA 106B	≤ 2.5" malleable iron CL150 ≥3" SA 234/SA 105	≤ 2.5" Threaded ≥3" welded/flanged 150#
Pump Recirculation orifice piping	A length of straight pipe a minimum of 20 pipe diameters directly downstream of the orifice shall be sch. 80 Stainless Steel pipe and the first elbow shall be an extra heavy Stainless Steel elbow. Remaining piping to follow the requirements for Deaerator heated piping above.		
Steam Headers/Deaerator steam piping to 125 psig incoming steam pressure+++	Sch 80 SA 53A or B or SA 106B	≤ 2.5" malleable iron CL 150 ≥3" SA 234/SA 105	≤ 2.5" Threaded ≥3" welded/flanged 150#
Overflow/Drain piping (water) including DA liquid drainer piping	Sch 80 SA 53A or B or SA 106B	≤ 2.5" malleable iron CL 150 ≥3" SA 234/SA 105	≤ 2.5" Threaded ≥3" welded/flanged 150#
Blowdown tank drain and outlet piping	Sch 80 SA 53A or B or SA 106B	malleable iron CL 150	Threaded
100% fresh cold water make up (including: DA tanks, water softener, etc)	Type L copper		

Note: Piping within the boiler's ASME code piping boundary supersedes the information in this table.

++ If there is no preheat in the feedwater tank, feedwater piping between the feedwater tank and the boiler should be sch 80, SA 106B.

+++ Welded/flanged pipe (3" and greater) may be sch. 40.

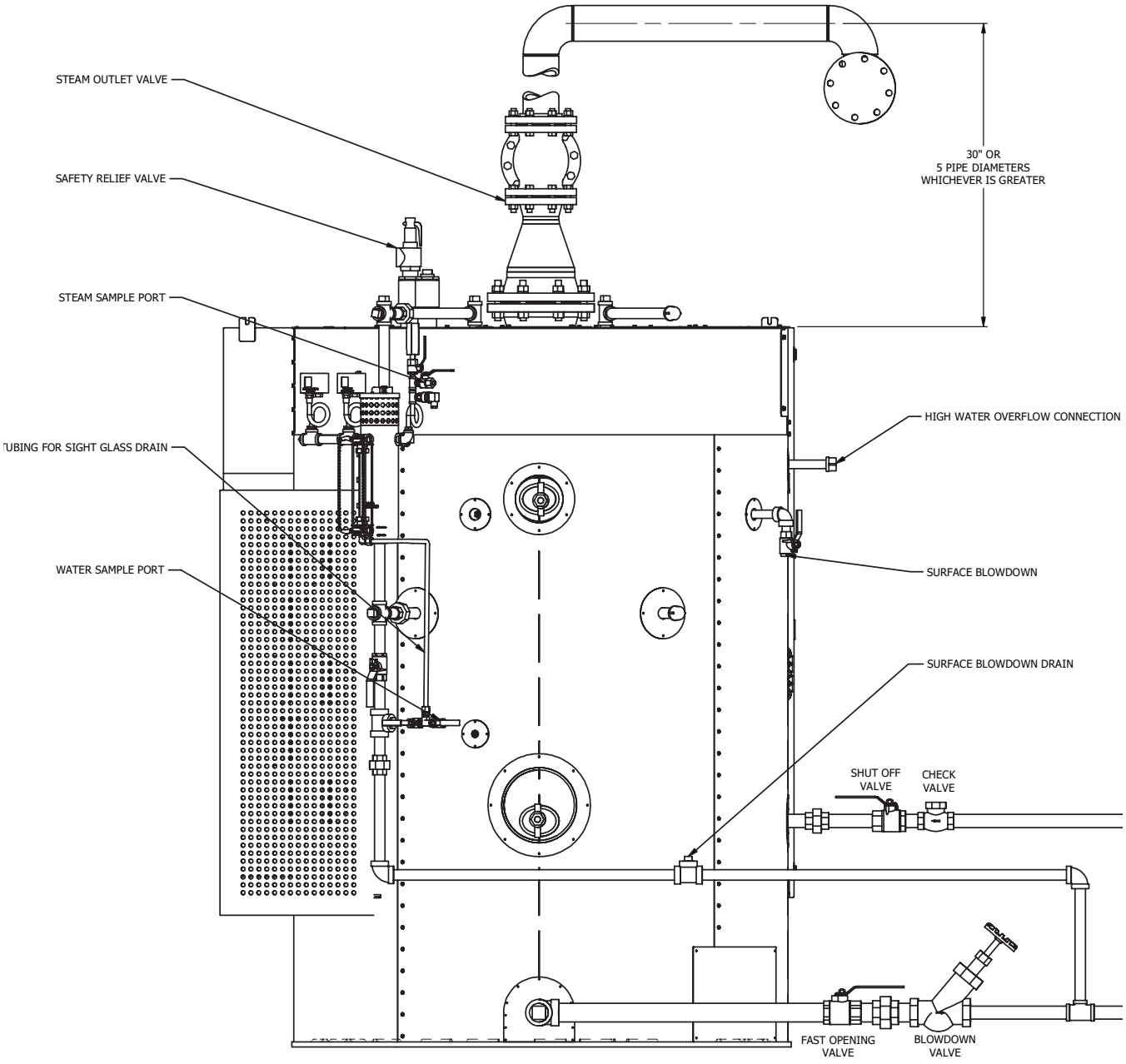

FIGURE 1 - NEAR BOILER PIPING (CONTINUED ON NEXT PAGE)

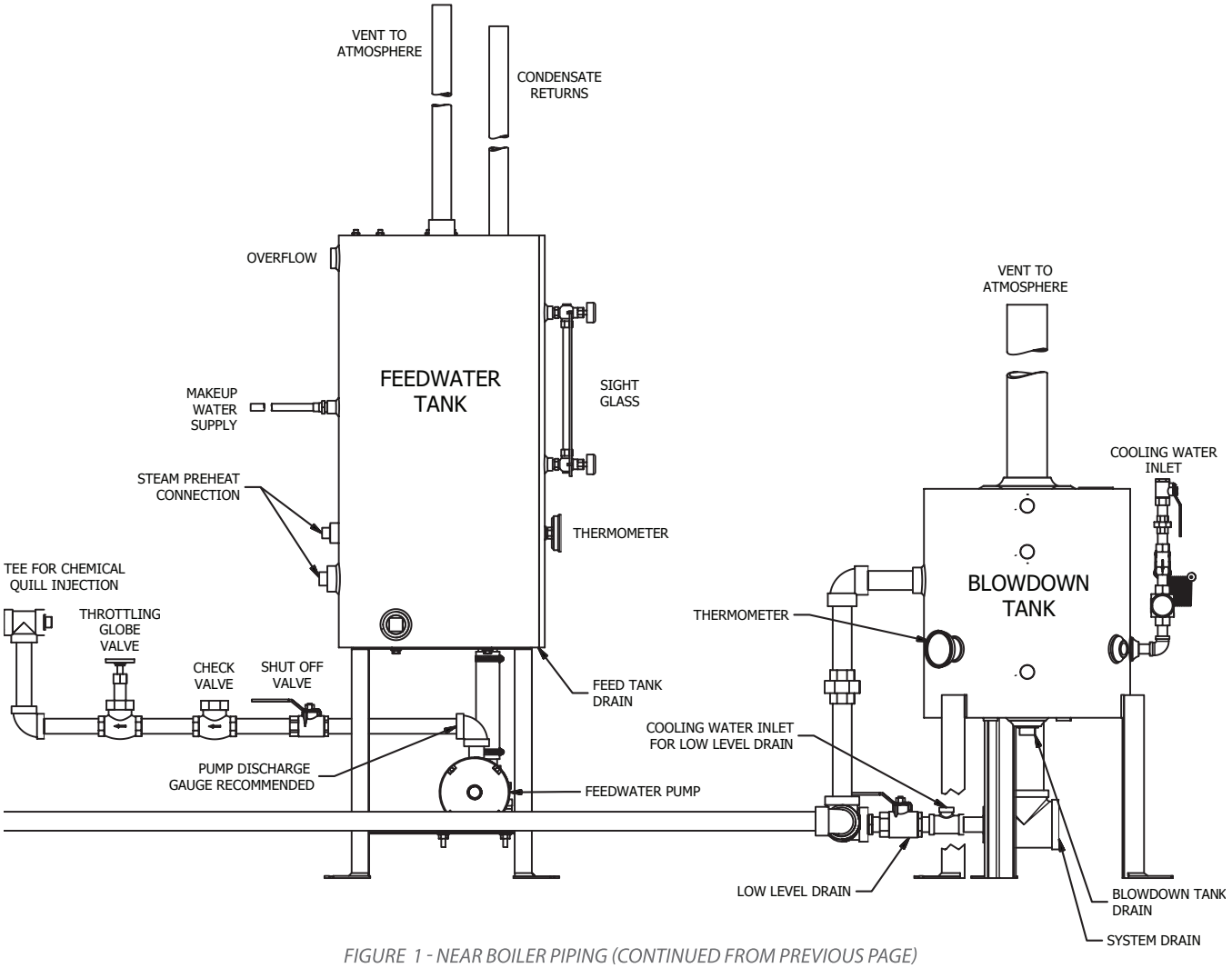

FIGURE 1 - NEAR BOILER PIPING (CONTINUED FROM PREVIOUS PAGE)

⚠WARNING

After the appropriate system tests have been satisfactorily completed, all hot pipework and vessels must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

INSULATION

NOTE: It is recommended that for inspection and maintenance, pumps, flanges, valves and fittings are left uninsulated but suitably shielded for safety.

Adhere to the following:

1. The boiler is insulated at the factory. No additional insulation on the boiler pressure vessel is required. Adding insulation may damage the boiler and its components.
2. Feedwater tanks, surge tanks and deaerators should be insulated. Insulation should be chosen with care such that the fluid in the tanks does not exceed the maximum operating temperature of the pump.
3. Blowdown vessels should not be insulated. They should be guarded to prevent accidental contact with hot surfaces or exposure to steam/hot water discharge.
4. Equipment should be insulated with material suitable for the application and temperatures expected prior to attempting replacement or service of electrical components or connections of the equipment.

FEEDWATER TANK

Where an atmospheric feedwater tank is to be fitted, adhere to the following:

1. Vent to a safe location.
2. Boiler feed tank shall have a capacity sufficient to satisfy boiler consumption as well as maintain proper feedwater tank temperature. Capacity should provide a minimum of 10 minutes of storage. Boiler pump is to provide a capacity of 2.5 times the evaporation rate for on/off pumps and 1.5 times the evaporation rate for continuous running pumps. The discharge pressure of the pump must be 3% over the boiler safety valve setting and include the necessary additional pressure to overcome piping losses.
3. See Feedwater Instruction Manuals for detailed instructions.

FEEDWATER PIPING

Where the feedwater piping is to be fitted, adhere to the following:

1. Size makeup water piping adequately to provide proper water supply. Do not reduce feedwater piping smaller than supplied line size. Depending on installation, feedwater piping may need to be larger to minimize pressure drop of feedwater piping.
2. Do not use the feedwater pump as a support for the feedwater piping. This could add undue strain to the pump head. Use proper piping supports as necessary to support feedwater piping.
3. Do not use stainless steel within the Boiler External Piping (BEP) boundary.
4. Ensure all piping is done in compliance with all applicable codes.
5. See Feedwater Instruction Manuals for detailed instructions.

BLOWDOWN TANK

Where a blowdown tank is to be fitted, adhere to the following:

1. Vent to a safe location.
2. Have a capacity sufficient to satisfy boiler blowdown, as well as maintain proper drain temperature.
3. Ensure compliance with all applicable codes when determining connection piping between the boiler and the blowdown tank.
4. Do not downsize vent pipe (this may cause pressure build up in the blowdown tank).
5. Ensure means to control discharge drain temperature below 140°F or maximum allowable temperatures allowed by local jurisdiction.
6. Do not insulate the blowdown tank.

THE BLOWDOWN VALVES

Where the boiler blowdown valves are to be fitted, adhere to the following:

1. Ensure pipes and connections are clean and free of any foreign material.
2. Pipe blowdown pipes to a blowdown tank of approved design.
3. Ensure that for each blowdown line there is a slow opening and a fast opening valve.
4. Ensure compliance with all applicable codes.

STEAM SAFETY VALVE

1. Use only the safety valve provided with the boiler as noted on the ASME data report.
2. Ensure pipes and connections are clean and free of any foreign material.
3. Do not install using a pipe wrench. Use the appropriately sized wrench on the bonnet nut.
4. Install the valve vertically with no unnecessary intervening piping between the boiler and the valve.
5. Do not cap or plug the weep hole on the side of the safety valve.
6. Ensure that the valve is vented to a safe location.
7. A discharge pipe shall be of a pipe size equal to, or greater than, the outlet of the safety valve.
8. Consult local codes for combined safety valve pipe sizing.
9. Minimize discharge piping fittings and overall piping run to avoid over pressurization of the piping, limiting safety valve discharge volume.
10. Do not support discharge piping with the safety valve. Discharge piping must be supported adequately by appropriate means.
11. Chromalox recommends the use of a drip pan elbow, as this provides the needed drainage and isolation from expansion as required.
12. Terminate the discharge pipe directly to atmosphere. Discharge pipe must not contain a shut off valve of any sort.

⚠WARNING

After the appropriate system tests have been satisfactorily completed, all hot pipework and vessels must be adequately insulated with material suited to the temperature and application to prevent both heat loss and personnel injury.

⚠WARNING

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/professional codes and regulations.

⚠WARNING

Under no circumstances should there be any shut off valve or restriction smaller than the safety valve inlet between the boiler and the safety valve.

STEAM PRESSURE GAUGE ASSEMBLY

Adhere to the following:

1. Ensure pipes and connections are clean and free of any foreign material.
2. Do not install using a pipe wrench. Use the appropriately sized wrench on the connection fitting.
3. Install using a siphon loop flooded with water to act as a water seal to buffer the gauge element.
4. Face the gauge in a direction easily viewable by the operator.
5. Range the gauge to no more than double the pressure at which the safety relief valve is set but in no case less than 1.5 times the safety relief valve set pressure.

THE WATER COLUMN AND WATER GAUGE GLASS

When installing the water column and gauge glass connections (refer to Figure 2), adhere to the following:

1. Inspect the water gauge glass to ensure that the glass is free of cracks or chips. Do not subject the gauge glass to bending or torsional stresses.
2. Install the piping from the water column and gauge glass to a safe blowdown vessel of approved design.
3. Install the top fitting (the fitting without the drain port) into the upper fitting on the water bottle using service rated sealant. Wrench tighten the fitting until it is snug and the glass outlet is pointing at about 5 o'clock (about 1/8 turn from its final downward vertical position).
4. Install the bottom fitting (the fitting with the drain port into the lower fitting on the water bottle. Wrench tighten the fitting until it is snug and the glass outlet is pointing directly upward.
5. Verify that the top and bottom fittings are threaded into the water bottle tappings the same amount (horizontally).
6. Remove the glass packing nut, friction washer and glass packing from the fittings and place them in the same order on either end of the water gauge glass. Push both packings about 1in (25.4 mm) from the end of the water gauge glass.
7. Gently insert one end of the water gauge glass into the top gauge fitting. Keeping the glass inside the fitting, gently rotate the top fitting clockwise until it is vertically aligned with the bottom fitting. It is crucial that the gauge glass valves are aligned both vertically and horizontally. If not aligned, they may leak.
8. Insert the gauge glass into the bottom fitting until it bottoms out, and then gently raise glass about 1/16 in (1.6 mm). Do not allow glass to remain in contact with any metal surface.
9. Carefully slide the bottom glass packing down until the glass packing is touching the lower gauge fitting. Carefully slide the top glass packing up until the glass packing is touching the upper gauge fitting.
10. Hand tighten both glass packing nuts, then tighten ½ turn more by wrench. Do not overtighten. If any leakage occurs, tighten the packing nut slightly, no more than a ¼ turn at a time, until the leak stops.
11. When provided, install the protective guard over the gauge glass assembly.
12. The gauge glass valves are fitted with ball checks. Make sure that the valves are fully open to ensure that the ball check will function properly in the event that the gauge glass breaks.
13. Install drain piping from water bottle and lower water gauge glass fitting to the boiler blowdown piping.

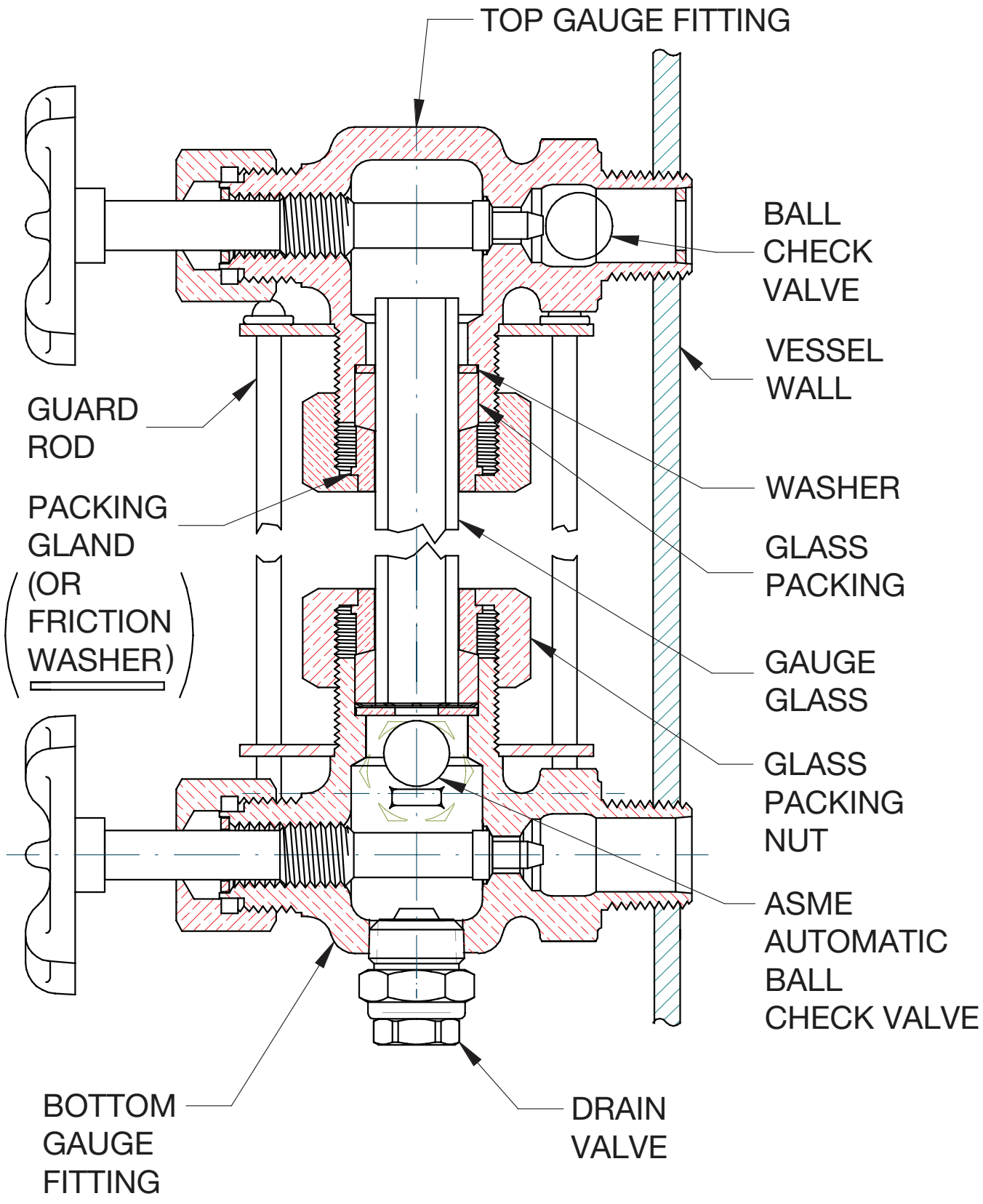

FIGURE 2 - SIGHT GAUGE GLASS

⚠WARNING

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WARNING: High Voltage Equipment Testing --- Risk of Electric Shock or Electrocution.

⚠CAUTION

Verify panel box is free of metal chips and shavings if drilling or punching is necessary.

Equipment damage can occur if proper precautions are not taken.

⚠CAUTION

All bolting should be re-checked during start-up to avoid leakage during operation.

INSTALLING ELECTRONIC ELEMENTS

WARNING: HIGH VOLTAGE EQUIPMENT TESTING --- RISK OF ELECTRIC SHOCK OR ELECTROCUTION.

All procedures described below shall only be performed by qualified personnel. Failure to observe proper safety procedures could cause injury or death. All power must be disconnected prior to attempting any work on equipment. Test equipment described creates high voltages. Proper safety equipment must be worn during tests.

CAUTION: EQUIPMENT DAMAGE CAN OCCUR IF PROPER PRECAUTIONS ARE NOT TAKEN.

The following is general description of testing of electric heating equipment. It is not intended to be a complete guide to trouble shooting. This information is believed to be accurate but does not completely identify all limitations and equipment impacts. No warranty is implied or given by Chromalox related to the use of this information. This information is to be used at the equipment owner's risk. Material can be returned to Chromalox for inspection if there is any concern regarding use of this information.

INTRODUCTION

One of the more common field problems is an electric heater that is reported to have low insulation resistance (Megohm values) after it has been shipped from the factory, removed from storage, or installed in the application. This is particularly common with large assemblies such as flanged immersion heaters, circulation heaters, or duct heaters. The following discussion and recommendations while directed toward multiple element assemblies are appropriate for all field installed electric heaters including individual elements.

CHARACTERISTICS

Magnesium oxide (MgO), used in electric heating elements, absorbs moisture easily. This can happen during transit, storage, or when exposed to humid environments. Even if heater terminals aren't sprayed or submerged in water, moisture can enter through open terminal housings during installation, especially if water or rain gets into the enclosure. Humidity in the air enters the open ends of the element (terminals) and permeates through the MgO. This process usually occurs gradually, with moisture initially gathering near the terminal end of the element.

PROBLEMS ASSOCIATED WITH MOISTURE ABSORPTION

As the MgO absorbs moisture, the insulation resistance (Megohm value) decreases proportionately. In most heating elements, the amount of moisture absorbed by the MgO is negligible and is quickly driven off when the heater is energized. However, if moisture absorption process continues for an extended period of time, the MgO in the entire element may eventually become saturated with moisture. The end result is an element or heater with abnormally low insulation resistance. If the insulation resistance is low enough, it may result in a high leakage current to ground that can cause nuisance trips of ground fault protection equipment (GFI) when the heater is energized. In some instances the presence of moisture in the MgO may actually cause a dielectric breakdown (short circuit) and element failure during the initial heater start up.

DETERMINING A LOW MEGOHM CONDITION

Before commissioning or after long term storage, it is advisable that the heater assembly be checked to ensure the insulation readings are adequate. Insulation resistance is usually measured using a voltage potential between live circuits (heater terminals) and the chassis (ground).

Insulation resistance shall be measured utilizing 500 volts direct current (VDC). Individual circuits shall be greater than 5 megaohm. If measuring individual elements, insulation resistance shall be greater than 20 megaohm.

If the electric heating element has a low megaohm reading, contact Chromalox for factory repair.

⚠WARNING

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WARNING: High Voltage Equipment Testing --- Risk of Electric Shock or Electrocution.

⚠CAUTION

Equipment damage can occur if proper precautions are not taken.

SYSTEM PIPING TESTING

Upon completion of the installation, adhere to the following for system piping testing:

1. Perform a pressure test.
2. Perform soap tests at all welds and joints to ensure that the system is free from leaks.

ASSEMBLY OF CHROMALOX MULTI-SKID SYSTEMS

Adhere to the following for multi-skid engineered systems:

1. Refer to the Chromalox mechanical/electrical drawings during assembly.
2. Ensure that equipment orientation allows for operation interface and maintenance.
3. Align the skids as shown on the drawings ensuring that skid fasteners (skid joint angles) are matched. The skid joint angles are a matched set and the edges of the fasteners should be exactly aligned.

NOTE: Do not bolt the skids to the housekeeping pad/floor until all of the piping has been reassembled and tightened.

4. Ensure the skids are level and flat before fastening the skids together with the supplied bolts. The skids should be leveled front to back, side to side and corner to corner. Failure to properly level the skids will result in piping misalignment. A level or laser level should be used to verify skid alignment (when a standard level is used, the length should be appropriate for the skid). If assembling multi component support stands, attach sections using the supplied bolts through the tank frame mounting plates. These should be hand tight until all of the piping is assembled.

NOTE: Skids are leveled at the factory using a laser level.

5. Connect the piping between the skids by matching the union connections and/or flange stamps and tightening. Refer to the mechanical drawing as necessary to confirm location of spool pieces etc. as the flange stamps are shown on the drawing in hexagonal callouts. The flange stamps should be matched and aligned (the flange stamps should be directly across from one another. Rotating a flange will result in piping misalignment). Bolts should be hand tight until all of the piping is assembled. Refer to the appropriate instructions to tighten the flanges to the required torque specifications. Support pipe runs as required.

6. Ensure that a low point drain is installed in the piping.

7. Connect the conduit runs between the skids and tighten conduit connectors.

8. Locate the supplied wiring for the equipment and pull wiring through the appropriate conduit runs. Electrical wires are labeled for easy landing. Connect all wiring per the Chromalox supplied electrical drawings.

9. If a header is supplied, mount the header as shown in the mechanical drawing.

NOTE: For piping supplied in sections, make up and connect hand tight until all sections are in place to ensure sections align properly. Sections are match marked for reassembly.

10. Tighten all connections, including threaded and flanged factory connections which may loosen during shipment.

11. Pneumatically test the piping (at 15 psig [103 kPa] maximum) prior to filling the systems.

12. Check bolts and connections for tightness after the first heat up cycle. Retorquing may be required.

BEFORE LEAVING THE INSTALLATION

Before leaving the installation, adhere to the following:

1. Check all controls to ensure they are operating properly.

2. Cycle the boiler several times.

3. Make sure the installation complies with all applicable codes.

⚠WARNING

Do not attempt to start the boiler for any testing prior to filling and purging the boiler. A dry fire will seriously damage the equipment and may result in property damage or personnel injury and is not covered by warranty.

All information in this manual is for reference and guidance purposes, and does not substitute for required professional training, conduct, and strict adherence to applicable jurisdictional/ professional codes and regulations.

OPERATION

START-UP PREPARATION & INSTALLATION REVIEW

Check with local authorities where approval for start-up is required. In some localities, final inspection of services may be required.

Review the installation section of this manual carefully. Confirm accordance with installation guidelines, including:

1. You have read and followed all safety information.
2. The equipment area is in conformance with established boiler room requirements. Review national and local codes.
3. There are no obstructions left in the piping from pressure leak testing such as blanking plates in flanged joints or unions.
4. Pipework is free to expand naturally when hot.
5. Equipment is located with the proper clearances.
6. Relief valves have been properly piped as described in the **Installation** section of this manual.
7. There are no flammable liquids, materials or hazardous fumes present in the environment.
8. Nothing was damaged or knocked loose during installation.
9. Moisture removal has been complete. For detailed instructions, refer to the Installation section of this manual.
10. **Installation Checklist** (provided with equipment) is complete.

START-UP SERVICE

Careful preparation can expedite the commissioning of your boiler. Most delays can be avoided by following the instructions in this manual. Failure to complete required procedures properly can result in the need for further service time, at extra cost to the customer.

Service technicians will not commence start-up if there are obvious system deficiencies. However, start-up service in no way constitutes a system design check or approval of the installation.

In addition to commissioning the boiler, the service technician will also familiarize boiler room personnel with the operation of all Chromalox equipment. Personnel must be qualified to understand the basic operation and function of controls.

PREPARE FOR INITIAL START-UP

These instructions are for use when the unit is being started up for the first time, or after prolonged shutdown. They are to be used in conjunction with the information in **Daily Start-Up** section of this manual.

PERFORM BOIL OUT

Chromalox recommends boil out is accomplished prior to boiler system operation. This procedure ensures that all oils, sealants and other organic compounds that may cause erratic water level control are removed from the boiler and piping. Consequently, if boil out is not accomplished prior to system operation, erratic water level control and surging may occur.
Chromalox strongly recommends that a boiler chemical specialist be consulted for the purchase of chemicals for boiler cleaning.

BOIL OUT PROCEDURE

Chromalox recommends pressure vessel cleaning prior to system operation or after major maintenance.
This boil-out procedure removes oils, greases and other organic compounds that may cause erratic water level control and surging. There are many chemicals on the market that may be used and our recommendations are as follows:

· Chromalox recommends the use of washing soda (sodium carbonate) to wash out boilers. Sodium carbonate (also known as washing soda or soda ash), Na2CO3 is a sodium salt of carbonic acid. Called washing soda, soda crystals, or sal soda in the detergent section of stores, it effectively removes oil and grease.

· Trisodium phosphate (TSP, E339) is an excellent degreaser and alternative to washing soda. It is a white, granular or crystalline solid, highly soluble in water producing an alkaline solution. The item of concern is often partially hydrated and may range from anhydrous trisodium phosphate, Na3PO4, to the dodecahydrate, Na3PO4·12H2O. Most often found in white powder form, it can also be called trisodium orthophosphate or just plain sodium phosphate.

Adhere to the following when performing boil-out:

1. The boil-out shall include “over-the-top” wasting of water. A temporary 2” pipe shall be run from the relief valve tapping to a suitable point of discharge as required by local jurisdiction(s) to assure that grease and oils are floated to the top and out of the unit. Minimum time for the procedure shall be four (4) hours of constant water discharge alternating between bottom and top blowdown. At least two (2) complete bottom blowdown and complete refills shall be done. A suitable manner of chemical waste handling shall be employed to meet local jurisdictional requirements.

2. Do not introduce steam to the system until the boiler has been properly boiled out. A separate line discharged to a safe location is recommended for steam discharge prior to boil out completion.

⚠WARNING

This information is for reference purposes only. Chromalox Companies is not responsible for this product, including (but not limited to) its accuracy, reliability, and safety. No Chromalox document should substitute for full review of documentation available from the product manufacturer.

OPERATING CONTROLS

LOW WATER CUT-OFF

Each cutoff device shall be installed to prevent startup, and to cut off the boiler fuel or energy supply automatically, prior to the fall of the water level below the lowest visible level of the gauge glass. Standard low water cutoff devices are Chromalox level probes. Alternate cutoff devices are MM-150, MM-157, MM-193-7b. Chromalox probe type low water cutoff devices have a built in 3 second time delay feature. Float type low water cutoff controllers have a 30-second delay.
Test as follows:

· PRIMARY LOW WATER CUT-OFF

This is the first low water safety cut-off, typically an automatic reset safety. Some local jurisdictions require this safety control to be a manual reset.

To test this safety:

1. Slowly drain the boiler, open the blowdown valves while boiler is operating, and make sure that when the safety switch trips, the boiler is shut down. Close the blowdown valves.
2. Once water level is above the cut-off point, the electric elements will automatically turn back on.

· SECONDARY LOW WATER CUT-OFF

This is always a manual reset safety.

To test this safety:

1. Slowly drain to the secondary cut-off level. This must be above the bottom of the lowest visible point in the sight glass. Once the secondary level cut-off is tripped, a light on the panel will become illuminated.
2. Do not push the manual reset button for the low water safety cut-off at this time. Refill the boiler first.
3. Once boiler is refilled, turn the boiler ON switch. With the low water cut-off light still illuminated, the electric elements should not turn on.
4. Push the low water reset button. Once this button is reset, the electric elements should turn on as long as all other safety interlock devices are satisfied and there is a demand for steam.

HIGH LIMIT PRESSURE SWITCH

Perform the following to test:

1. With electrical elements on and the boiler under pressure, lower the set pressure on the switch until it trips and shuts down the electrical elements. Be sure that the pressure is the same as the boiler operating pressure.
2. To test the manual reset button, wait until the boiler has fully completed the post purge phase. Once the boiler is in standby position, reset the switch to the original set point.
3. Press the manual reset button on the pressure switch. This will ensure that the manual reset switch is functioning correctly. The electric elements should not start until the reset button is pressed.

OPERATING PRESSURE LIMIT SWITCH

Perform the following to test:

1. With the boiler under pressure, lower the set pressure on the switch until it trips and shuts down the electric elements. Be sure that the pressure is the same as the boiler operating pressure.
2. This switch is an auto reset. Reset the switch to the original set point. The electric elements should turn back on automatically.

PRESSURE RELIEF VALVE

Located on the boiler, this valve limits the maximum operating pressure of the equipment.

SIGHT GLASS ISOLATION VALVES

The brass sight glass isolation valves are equipped with an internal ball check. In the event that a sight glass should break, the ball will set, preventing discharge of steam and water. The brass valve stem must be opened fully to enable this feature If the valve is in any other position, the ball will not set.

⚠WARNING

Prior to the commencement of any work requiring the removal of cover plates and the opening of the control panel box, the electrical supply to the boiler must be disconnected.

Proper lockout / tagout procedures must be employed when servicing this unit.

Hazard analysis should be performed by end user to ensure safety of their employees and/or service technicians.

Qualified and knowledgeable personnel should perform all weekly, monthly and annual maintenance checks.

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

⚠CAUTION

Verify proper operation after servicing.

To ensure the continued safety and efficiency of the boiler, you must adhere to the schedule of maintenance outlined in this section.

Installation and service must be performed by a qualified and knowledgeable individual, such as a Chromalox representative, qualified installer, service agency or gas supplier. Any potential warranty issues that arise after an unqualified individual has manipulated boiler parameters will not be considered.

⚠CAUTION

If the feedwater is being treated by chemical compounds, make sure that this treatment is carried out carefully and according to the supplier's instructions.

MAINTENANCE & TROUBLESHOOTING

PROCEDURE FOR CLEANING WATER PROBES

To clean the probe in the boiler shell and probes in water column:

1. Make sure there is no pressure in the boiler during the removal of the probes.
2. Remove one probe (using a 7/8" socket), clean with very fine emory cloth and replace it before removing another to assure no probe mix-ups that would change the control functions.
3. Check water level in sight glass.
4. Check to be sure feedwater pump is working.
5. For float type water level control, blow down the float chamber.
6. Check water chemistry.

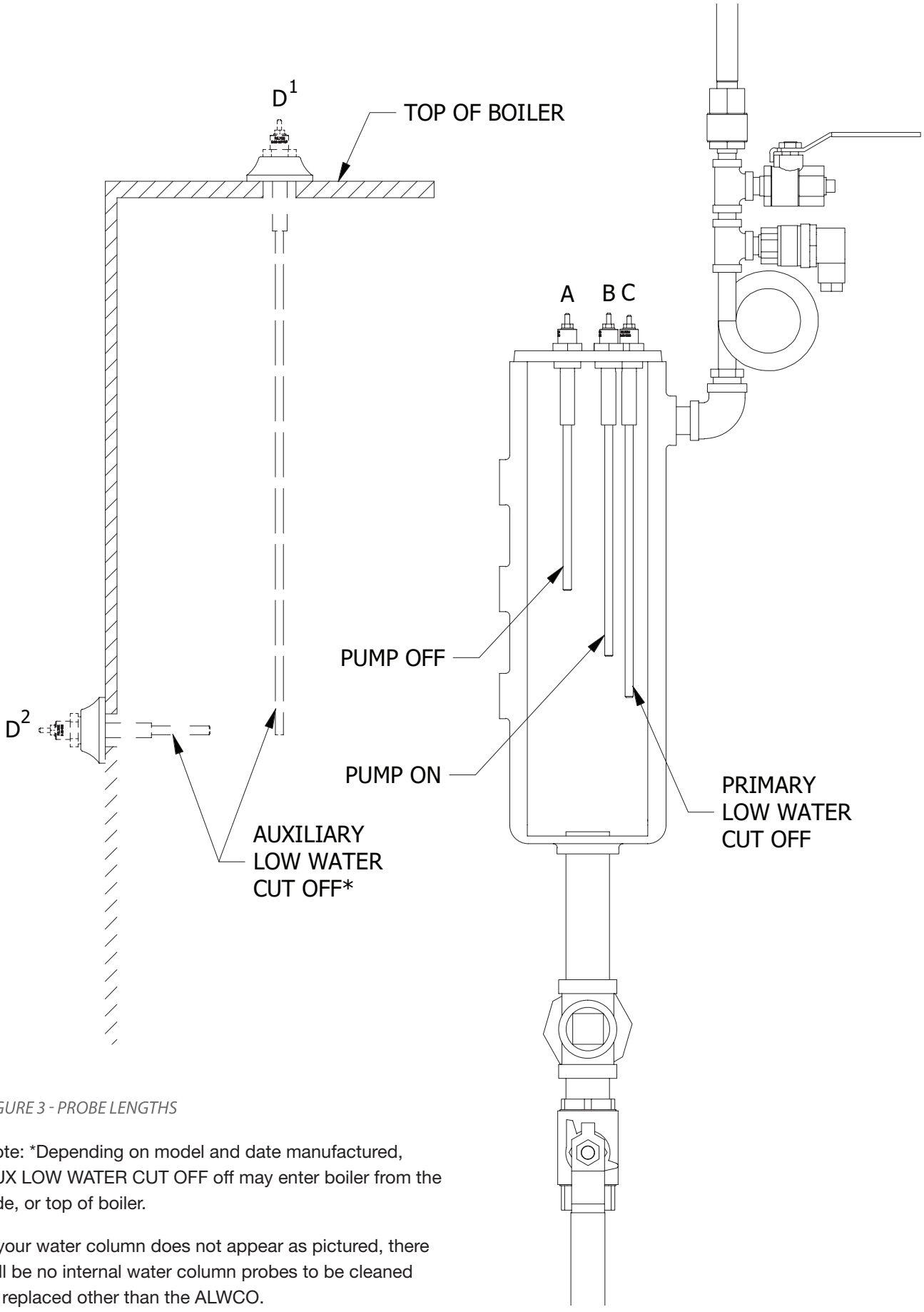


FIGURE 3 - PROBE LENGTHS

Note: *Depending on model and date manufactured, AUX LOW WATER CUT OFF off may enter boiler from the side, or top of boiler.

If your water column does not appear as pictured, there will be no internal water column probes to be cleaned or replaced other than the ALWCO.

⚠WARNING

Only qualified, trained electrical personnel shall perform any activity on energized equipment. Lockout /tagout shall always be performed prior to opening an electrical panel.

Any persons about to perform installation procedures with any electric heater must first satisfy themselves as to the nature and extent of any potential hazards that may be encountered. These hazards should be identified by a risk analysis undertaken by the responsible person within the installation team prior to commencement of the installation process.

ELECTRIC SHOCK HAZARD

Disconnect all power before installing or servicing heater. Heater must be installed or serviced by a qualified person. Heater must be effectively grounded in accordance with the applicable governing standard, such as the IEC (International Electric Code). Failure to do so could result in personal injury or property damage.

ELECTRIC ELEMENT MAINTENANCE

Ensure that any grounding on the heater is properly installed and in satisfactory condition. Perform a ground integrity test if necessary to verify sufficient bonding.

With large amounts of fault current available, there is always the possibility of “arc flash”. Take all necessary precautions and use the appropriate Personnel Protection Equipment (PPE). Never open junction boxes unless the equipment has been de-energized.

All gasket surfaces must be clean and dry before seated to mating equipment. When connecting flanged joints, only nuts, bolts and gaskets in accordance with the applicable piping specification shall be used and tightened to the recommended torque as specified below:

- For units rated 120 to 600 volts, heater terminal to bussing hardware should be tightened to 14-17 inlbs. (1.58-1.92 Nm). Check all remaining bussing to bussing hardware is tightened to 20-25 in-lbs. (2.26-2.82 Nm).

Gaskets are designed for single use only. Once gaskets are seated by torque setting and relieved by bolt removal, they are to be replaced. Gasket replacement will require removal of the bundle from the heater vessel Please refer to the Installation section of this manual for detailed procedures on element testing.

RECOMMENDED DAILY MAINTENANCE SCHEDULE

The following procedures should be carried out daily as recommended maintenance. They are designed to prevent the buildup of scale, silt, or sludge in the bottom of the boiler and in the pipes leading to the water gauge. In addition to these procedures, the advice of a water treatment supplier should be sought and followed. An ASME Section VIII blowdown tank must be provided.

1. Blow down the boiler each morning by starting the boiler and generating not more than 10 PSI (.7 kg/cm2) of steam. Turn on cooling water to blowdown tank, if equipped, then open the boiler blowdown valve for approximately 10 seconds, then close valve. See Figure 4. Be sure that the slow opening valve (Y-Valve) is adjusted properly. The slow opening valve is to be adjusted so that only 1-2” of water empty from the boiler sight glass during the 4-10 second bottom blowdown. If a manual method of cooling water is used, be sure to shut off the cooling water supply. If there are two bottom blowdown connections on the boiler, both should be blown down daily.

2. Blow down water column each morning when boiler is at 10 PSI by opening the water column and the water gauge blowdown valves for approximately five seconds, then close the valves. On boilers with float type level devices, refer to the water column cut sheet for proper blowdown technique. Any water column on the system should be blown down daily following the above procedure.

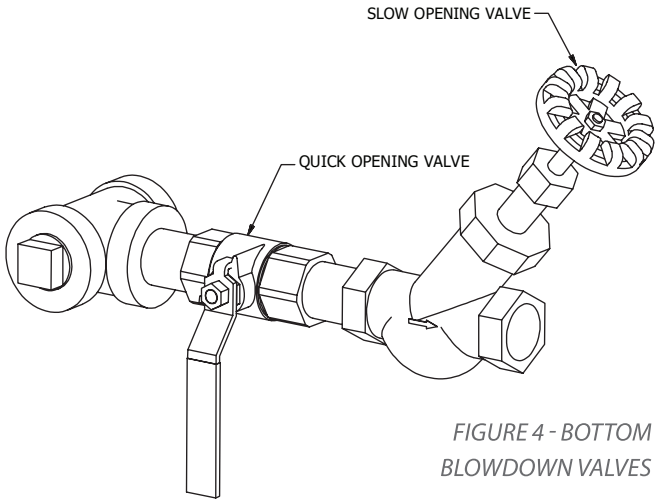


FIGURE 4 - BOTTOM BLOWDOWN VALVES

3. If the feedwater is being treated by chemical compounds, make sure that this treatment is carried out carefully and according to the chemical supplier's instructions.

· **NOTE: Chromalox recommends that the feedwater chemical treatment should be added between the pump and the boiler.**

4. Check water level in sight glass.

5. Check to be sure feedwater pump is working.

RECOMMENDED MONTHLY MAINTENANCE SCHEDULE

The following steps should be carried out monthly:

1. Clean the water gauge glass using a commercial non-abrasive glass cleaner. Use diluted acids such as hydrochloric (muriatic) acid when regular cleaners do not seem to work. Do not use wire brushes or any abrasive materials that could scratch the glass. If leakage is evident, replace the gaskets.

2. Always reinstall the gauge glass protectors, if equipped.

3. Clean feedwater pump strainers.

4. Check starter contacts. Burned or pitted contacts must be replaced. Do not use sand paper to file or clean.

5. Clean all system strainers for steam and water.

RECOMMENDED SEMI-ANNUAL MAINTENANCE SCHEDULE

The following steps should be carried out semi-annually:

1. Check for proper operation of steam traps in your system.

2. Check feedwater pumps for correct operation.

3. Clean water safety and level probes.

4. Check operation of steam safety valve at no more than 15 PSIG.

5. Drain and clean feedwater tank.

6. Check electrical controls and motors for correct operation.

7. Shut off the boiler completely and drain.

8. Remove brass pipe plug at the cross connection below the water column and inspect and clean the nipple into the boiler. The boiler must be cold and the water level must below the pipe connection.

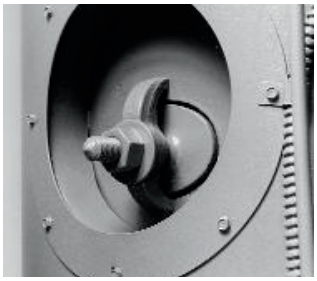


FIGURE 5 - INSPECT HAND HOLES FOR SCALE OR SLUDGE BUILDUP

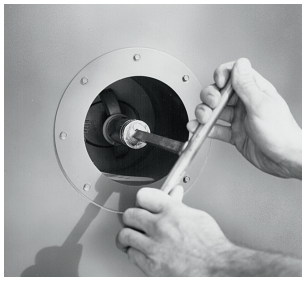


FIGURE 6 - REMOVING HAND ASSEMBLY WITH TEE HANDLE WRENCH

9. Remove the hand holes and inspect the interior of the vessel for scale or sludge deposits. See Figure 5. The amount of deposits will indicate the efficiency of the water treatment being used. The frequency of the inspection will depend on the condition of the water side of the boiler.

10. Replace hand hole gaskets as follows:

» Remove the hand hole assembly using a 1-1/4" tee handle wrench or 1-1/4" 1/2" drive socket wrench. See **Figure 6**.

» Remove the old gasket and thoroughly clean the surface on the boiler and the plate.

· **NOTE: Do not reuse old gasket(s).**

11. Fit the hand hole assembly as follows:

» Place the gasket on the hand hole plate and ensure that it is seating correctly. Do not use any grease, lubricant, or adhesive

» Position the plate in the boiler. Set the yoke and tighten the securing nut sufficiently enough to provide a snug fit. Verify the position of the plate in the boiler, then make it hand tight and then snug with wrench about 1/4 turn. Do not compress excessively. See Figures 7-8.

» Refill the boiler with fresh water.

⚠CAUTION

If the gasket leaks while pressure is being built up, tighten only enough to stop leakage. Never tighten more than necessary to prevent leakage. Excessive tightening may shorten the life of the gasket.

BOILER LAY-UP PROCEDURE

The following information includes suggested protocol and guidelines for boiler and ancillary equipment lay-up. When working on this equipment, it is critical to follow all product warning and caution information available in the product installation and operation manual. All content herein is subject to change without prior notice. A water treatment professional must be consulted for procedures/requirements, and actual site conditions must be factored. Guidelines below are for the vessel only. For additional information regarding the steam boilers, control panels and accessories, please contact Chromalox.

WATERSIDE PROTECTION

The best corrosion-control program of operating boilers and ancillary equipment can be completely offset by neglect during outages, as metal surfaces are often attacked and damaged by oxygen during shut-downs. Protection can be achieved by:

1. Excluding all air from the boiler and ancillary equipment (wet lay-up).

2. Keeping the surfaces completely dry (dry lay-up).

The choice between wet and dry lay-up depends on the length of time a boiler and ancillary equipment will be out of service. Wet lay-up is recommended for short outages (30 days or less); dry lay-up is recommended for longer periods. The wet method has the advantage of permitting the boiler to be returned to service on short notice. Dry lay-up is practical only if the unit can be drained while hot.

Boilers and ancillary equipment should be drained and inspected prior to any layup. When time does not allow for inspection, the boiler and ancillary equipment may be stored wet without draining if the chemical treatment is injected into the boiler before it comes offline.

DRY LAY-UP

1. Secure fire equipment and close all steam stop and water feed valves.

2. Drain the boiler and ancillary equipment completely and dry all waterside surfaces by opening all handholes and manholes while the unit is still warm enough to vaporize all moisture (180 degrees F – 200 degrees F).

3. Inspect for scale and sediment deposits on waterside surfaces. Consider that a 0.1” scale deposit may increase fuel consumption as much as 16%. Cleaning should be done before final lay-up preparation.

4. Thoroughly dry internal surfaces with hot air. Fans and other air driven blowers can be used by directing them into the bottom handholes or manhole opening.

5. All areas that are not completely dry should be blown with dry compressed air. No steam or feedwater can be allowed to enter the boiler and ancillary equipment. Moisture on the waterside will cause oxygen corrosion to begin in a very short period of time and will ultimately cause serious corrosion problems.

6. Leave boiler and ancillary equipment open to atmosphere if boiler room is dry and well ventilated.

7. In damp boiler rooms or for periods exceeding the normal summer shutdown, one of three following commercial grade desiccants should be spread on water-tight wood or corrosion resistant trays.

   · Quick lime -- used at a rate of six pounds per 100 cu. ft. of boiler volume.

   · Silica gel -- used at a rate of eight pounds per 100 cu. ft. of boiler volume.

   · Activated alumina -- used at a rate of eight pounds per 100 cu. ft. of boiler volume.

8. Trays are to be placed on the top tubes of the boiler. All manholes, handholes, vents, and connections are to be blanked and tightly closed to seal the boiler and ancillary equipment.

9. Inspect every two months for evidence of active corrosion. Check the desiccant and regenerate or replace when necessary. Reseal and restore the boiler and ancillary equipment to proper conditions.

WET LAY-UP

1. Drain boiler and ancillary equipment and thoroughly inspect for sediment and scale, and clean as in points 2 through 6 above.

2. Fill boiler and ancillary equipment completely using feedwater preheated to a minimum of 208 degrees F taking care to vent all air from boiler.

3. While filling, feed in treatment chemicals recommended by a reputable water treatment firm. Levels of approximately 300-500 parts per million (ppm) phenolphthalein (P) alkalinity and 100-150 ppm sulfite residual should be reached and maintained.

4. Fire boiler and ancillary equipment to ensure good mixing and vent boiler to purge the unit of air. All feed and blow down valves should be leak free to prevent loss of treated water or addition of untreated water. It is important to seal off and keep the unit air-tight since any air entering the boiler will promote corrosion.

5. Test the boiler water bi-monthly during the outage to ensure proper control levels are being maintained.

6. If a piece of equipment is not able to be isolated and airtight, a dry layup of that equipment may be necessary.

FIGURE 7 - CORRECT PRESSURE ON GASKET

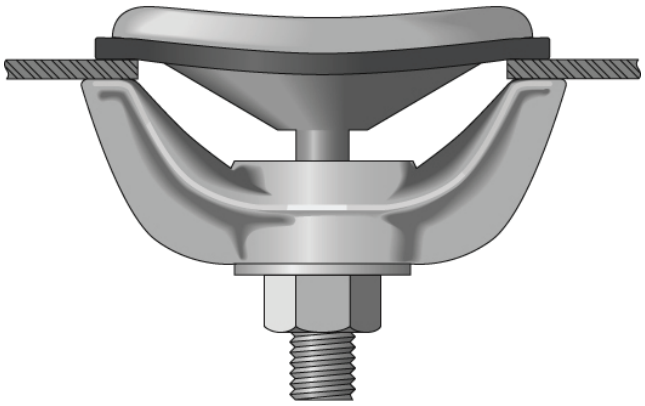
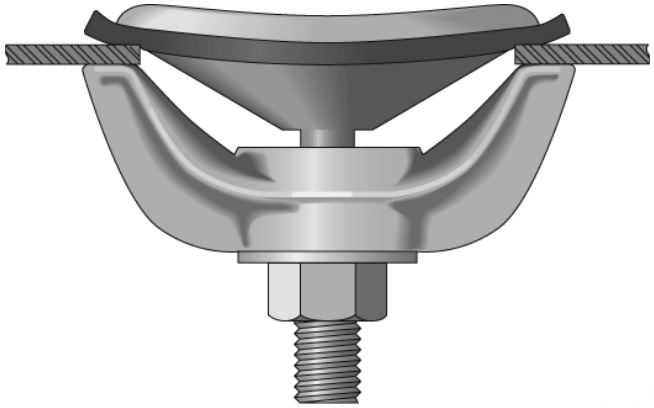


FIGURE 8 - OVERCOMPRESSED GASKET



TROUBLESHOOTING

PROBLEM	CAUSE	REMEDY
Control Circuit Failure	Fuse	If a break is detected, shut off power and remove fuse. Replace with a new fuse of same voltage and amps. Turn power on.
	Voltage	Trace wiring diagram through each component to verify power in each stage. If voltage is not detected at any point, replace component and continue test until circuits test clear.
	Control Switch	Check all wires from switch terminals for looseness or corrosion. Replace if either is evident. Next check for proper make and break of switch.
	Low Water Safety Relay	Verify that boiler has water. Check to verify power on terminal #1. If power is present, check to verify power on terminal #10. If power is not present, press the low water reset button to reset relay. If relay does not reset, inspect terminals for loose connections. Inspect probe connection. Check to see if the LED display on the relay is blinking. Refer to fault codes/replace relay.
	Corrosion of Probes	Check all wires to verify proper wiring to each probe. If a wire is suspected to be in the wrong place, shut off power and check wire with a continuity light. Check probes. If probes are dirty, clean with very fine emory paper and replace.
	Staging Controller	Verify paper and replace. Staging Controller Verify timing and stage selection on DIP switches.
Pump Circuit Failure	Fuse	If a break is detected, shut off power and remove fuse. Replace with a new fuse of same voltage and amps. Turn power on.
	Corrosion of Probes	To verify proper wiring to each probe. If a wire is suspected to be in the wrong place, shut off power and check wire with a continuity light. Check probes. If probes are dirty, clean with very fine emory paper and replace.
	Wiring Connections	With power off, check continuity of circuit through each point in the circuit. If a break in the circuit is found, repair. After repair, recheck with continuity light with power off. Turn power on and check with an amp meter.
	Motor Starter Relay	Check power supply to coil on motor starter coil is being powered, check if contactors are being engaged completely. If coil and contactors are engaging, check power in and out on the control circuits. If contactor is chattering, clean contacts. If motor starter relay is weak or bad, replace.

PROBLEM	CAUSE	REMEDY
Primary Voltage Circuit	Fuse	If a break is detected, shut off power and remove fuse. Replace with a new fuse of same voltage and amps. Turn power on.
	Voltage	Trace wiring diagram through each component to verify power in each stage. If voltage is not detected at any point, replace component and continue test until circuits test clear.
	Wiring Connections	With power off, check continuity of circuit through each point in the circuit. If a break in the circuit is found, repair. After repair, recheck with continuity light with power off. Turn power on and check with an amp meter.
	Burned or Broken Wing	With power off, check continuity of circuit through each point in the circuit. If a break in the circuit is found, repair. After repair, recheck with continuity light with power off. Turn power on and check with an amp meter. Verify wire size is sufficient for amp draw.
	Contractor Contact Points	If burned or dirty, clean with fine emory paper. If burned through, replace. If not engaging completely,coil may be weak. Replace.
	Elements Shorting or Open Circuit	With power using a continuity tester, check to see if an element is burned out between each point. If power is on, a volt meter may be used. If an element is bad, replace.
Check piping for any leaks.	Circulating Pump	Clean or replace all filters or screens to assure proper water flow through them.
	Water Makeup Supply	Check to see that your supply water has not been shut off or that there are no restrictions in the line leading to the boiler.
	Leaks in the System	Check piping for any leaks.
Scale Formation Elements	Hardness, salt, precipitation	Softener performance
	High dissolved solids	Blowdown schedule
Poor Steam Quality	High alkalinity in boiler water	Adequate blowdown schedule or over feeding of water treatment chemicals.
	High organics in boiler water	
	High total dissolved solids in boiler water	

Limited Warranty:
Please refer to the Chromalox limited warranty applicable to this product at
http://www.chromalox.com/customer-service/policies/termsofsale.aspx.

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