

**Installation and  
Operating Instructions**

# **Chromalox Industrial Medium Voltage Steam Generator**



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# Scope

These guidelines are provided to assist in the handling, storage, installation and maintenance for an MVSGI steam generator. Instructions are provided to prevent work site injury and aid in the handling, installation, and commissioning of this equipment.

If the steam generator is being installed with a Chromalox process controller and/or Chromalox power control system, please refer to the associated instruction manual for its proper instructions.

It is the responsibility of the site user to fully read and understand this manual prior to performing any work in conjunction with Chromalox equipment.

It is the responsibility of the purchaser of the steam generator to ensure that safe systems of work are adopted for all personnel operating and maintaining the steam generator including testing.

It is a warranty requirement to comply with these instructions and documented evidence shall be maintained in the form of a signed checklist as per the Appendix A or operator's equivalent.

**NOTE:** Chromalox medium voltage systems, “DirectConnect”, are composed of both a Heater and Power Converter unit. Both units must be employed for proper operation. Installation review, Start-up, and Commissioning shall only be performed by Chromalox personnel. Seller assumes all responsibilities and all warranties, both written and implied are voided otherwise. The Chromalox Service Group can be contacted at 1-800-443-2640 or by visiting [www.chromalox.com](http://www.chromalox.com) for additional contact information.

**NOTE:** A completed Maintenance Checklist or equivalent will be required in the event of any safety or warranty claim.

Chromalox has a team of fully trained technicians and engineers who are able to offer a specialist inspection, commissioning, start-up and/or maintenance service. For further details, please contact our customer service department at 1-800-443-2640

# Precautions & Warnings

## General Equipment Warnings

The user must ensure that their employees are fully trained and supervised in the proper working procedures in order to ensure their safety. The plant must be maintained in a safe condition.

Personnel must be fully aware of the risk associated with electricity and hazardous area usage. Only qualified personnel shall perform work on this unit during installation, operation, and maintenance procedures.

This equipment was specifically designed for its intended purpose and shall not be used for any other application without a complete re-evaluation by the manufacturer. The operator shall ensure these instructions are kept with the equipment to prevent any misuse for which the equipment has not been designed.



The Safety Alert Symbol is found throughout this document to identify potential hazards that if not avoided can result in personal injury. The seriousness of the potential hazard is identified by one of three signal words.



**DANGER** – will result in serious injury or death.



**WARNING** – could result in serious injury or death.



**CAUTION** – may result in minor or moderate injury.



Means Protective Earth (ground) terminal.

## Electrical Safety

### **⚠ WARNING**

**ELECTRIC SHOCK HAZARD** Disconnect all power before installing or servicing steam generator. Steam generator must be installed or serviced by a qualified person. Failure to do so could result in personal injury or property damage.

All personnel working on electrical equipment shall strictly adhere to the applicable local, countrywide, and industry-recognized standards. Examples of such standards may include, but are not limited to, the IEC (International Electric Code), NEC (National Electric Code), OSHA (Occupational Safety and Health Administration), NFPA (National Fire Protection Association), Health and Safety Work Act 1974, Factories Act 1961, and others. Failure to adhere to proper safety standards, including proper use of PPE (Personal Protective Equipment) may result in injury or even death. Chromalox will not be liable for failure of customer to adhere to governing standards.

De-energize all equipment before opening junction boxes and control panels and follow the appropriate lockout / tagout procedures. Do not work on live circuits. Qualified persons and associated equipment must be effectively grounded in accordance with the applicable governing standard, such as the IEC (International Electric Code) to eliminate shock hazard. During any service work, please follow the proper electrical isolation, lockout / tagout, and disconnection procedures.

## Pressure & Explosion Warnings

### **⚠ WARNING**

**EXPLOSION HAZARD** When heating in closed vessels, controls and back-up controls must be used to regulate build-up of temperature and/ or pressure. Failure to do so could result in personal injury or property damage.

User must understand the pressure and temperature ratings applicable to the particular heater unit.

Before contemplating fill/pressurization, discharge or disconnection, the installation, operation, and maintenance instructions must be read fully. The equipment is not to be disassembled while under pressure or vacuum. The operator must provide devices to prevent physical access whilst pressure or a vacuum exists.

The system owner must provide adequate means of draining and venting of pressure from equipment. The system owner must make provision to ensure proper sealing and pressurization integrity at all connection points.

The system owner must provide for suitable pressure relief measures and procedures to avoid dangerous discharge of pressure relief blow off and to protect against exceeding the vessel maximum design pressure. The operator must ensure that momentary pressure surges be kept to 10% of maximum allowable pressure.

Pressurization of the system shall be gradually applied, if possible, in order to protect pressure connection integrity and minimize risk in the event of improper sealing of connections.

## Temperature & Combustion Warnings



The system owner must provide devices and warnings to prevent physical contact of personnel with hot surfaces.

### **⚠ WARNING**

**Since heaters are capable of developing high temperatures, extreme care should be taken to provide adequate spacing between hot surfaces and combustibles. Avoid operation of heater near combustible fluids or combustible gas laden atmospheres. Failure to do so could result in personal injury or property damage.**

The steam generator should be installed with over temperature protection and process flow interlock devices. These devices must be connected to the appropriate alarm/shutdown devices in the control panel. These safety systems must be tested and their correct operation verified prior to applying power to the steam generator.

Minimum designed flow must be maintained through the steam generator before energizing.

The heater shall be allowed to cool off to approximately 35-90°F (20-50°C) prior to the elimination of flow through the system in order to eliminate the risk of over temperature due to latent heat in the elements/system. Where necessary, the system owner must provide means of safe removal of residual heat after shutdown.

The system owner must ensure that steps are taken to avoid a dangerous accumulation of ignitable mixtures of combustible substance that could result in explosion or fire. Where necessary, the system owner must provide for sampling of the vessel from time to time to allow evaluation of the properties of the fluid so as to avoid risks related to deposits and/or corrosion.

Where necessary, the system owner must provide suitable accessories to meet damage-limitation requirements in the event of external fire.

# General Product Overview



**Figure 1: Unjacketed MVSGI Unit**

The MVSGI High Capacity Steam Generator is an electrically heated steam generator unit designed to operate at either 250psig or 450psig, and output steam 3,466 to 33,000 pounds/hour. It is a packaged unit comprising an insulated, jacketed ASME carbon steel, code "S" pressure vessel and a flanged immersion heater of INCOLOY 800 sheathed medium voltage heating elements. The steam generator is designed to give years of service, with minimal maintenance required, if properly installed and operated.

Be sure to refer to the Chromalox catalog page(s), data sheet(s), unit drawing(s), or other associated documentation for product features that may be unique to your unit.

Solid state power components and optimized logic control allow for an almost infinite number of step controls, delivering instantaneous power conversion to heat energy and ensures all available power is delivered directly to the process.

Water feed control and low water cutoff automatically maintain the correct water level and shut off the generator if the water level drops below safe limits, while auxiliary low water cutoff provides redundancy.

Product specifications can vary depending on model. Equipment model and part numbers are located on a nameplate, typically located on the body/shell or enclosure of heater. Upon receiving equipment, take note of model and part number and document in Appendix A.

# Receiving, Handling & Lifting



The packaging supplied is only suitable for short term indoor storage.

Any outdoor storage is considered temporary (less than 48 hours) and the entire system must immediately be protected from the outdoor elements with appropriate coverings. The coverings shall be suitably covered for protection against adverse weather, using a tear-free waterproof membrane such as a tarpaulin. The equipment shall be placed on dry ground or on blocks to lift it clear of any possible water.

Heater equipment shall be unpacked within 48 hours of receipt for proper inspection.

*For long term storage needs, please refer to the Appendix for Long Term Storage Instruction.*

The unit must be handled with care and stored in clean, dry conditions as befits any electrical apparatus. Units must not be exposed to wet or damp atmospheres. Units shall be stored in areas with uniform temperature control to prevent condensate accumulation.

## Cardboard Packaging

All staples to be removed with extractor tool only. Open cardboard flaps and remove heater from packaging. Remove any polyethylene covering using sharp knife, taking care not to damage equipment or paintwork with knife blade.

## Wood Crating

All nails to be removed with nail extractor tool only.

Extract nails, remove batten, and remove lumber from each side individually. Be sure to secure equipment from each side after removing crating. The recommended order for panel removal is – top, side panel, front panel, opposite side panel, and rear panel.

Remove any plastic covering using a sharp knife, taking care not to damage equipment or paintwork.

## Equipment Handling & Lifting

Ensure that the steam generator unit is correctly moved and installed by technically qualified and competent persons experienced in the class of work involved. Know the capabilities of the lifting equipment available to handle the weight of the system. At no time should any person be under, or in contact with, a suspended load.

Ensure that all precautions are taken regarding the weight of the steam generator. Lifting equipment shall have capacity for the given weight. Personnel involved in the installation need to be aware that one end of the

heater will be heavier than the other and that this will affect the lifting.

Exercise care during any movement and placement operations to prevent falling or unintentional rolling or tipping.

Handle the systems with care to avoid damage to the heater electrical enclosure(s) and other protruding device(s).

The unit will be shipped with skid framing; keep the system secured to the shipping skid to prevent distortion of the frame during moving and to minimize tipping.

Equipment can be moved by either crane or fork lift truck (preference should be given to crane handling whenever possible). Slings or ropes must be of good condition, showing no signs of fraying or damage. Using suitable lifting chains, ropes, or slings to prevent damage to the heating elements, observe the following safety points:

- All lifting tackle / equipment must have a safe working load (SWL) capacity in excess of that of the equipment weight and include for snatch factors etc.
- The slings or ropes must have sufficient length to keep the angle between the slings / ropes and the top of the equipment greater than 45°.
- Too short a sling / rope will reduce this angle and so lead to unacceptably high stresses on the eyebolts/lifting lugs.
- Certain equipment configurations may require a lifting beam to achieve a safe lift.
- Additional support should be provided, as necessary, when lifting, to counteract any out of balance that may be present.
- The swinging of the suspended load must be prevented and / or eased by suitable means.
- Forklift arms should be spaced as far as the configuration of the equipment allows and be long enough to go completely under the equipment.
- Move equipment by forklift truck only as far as is absolutely necessary, particularly at the assembly site and on uneven ground.

The destination needs to be free from obstructions. Ensure equipment is lowered gently to clean and level support to prevent damage.

# Inspection & Storage

Each unit is manufactured with great care from the highest quality materials and thoroughly inspected before leaving the manufacturing facility. Examine the equipment against the packing list to check that the quantity received, and its identity is complete.

The unit must be handled with care and stored in clean, dry conditions as befits any electrical apparatus. Units must not be exposed to wet or damp atmospheres. Units shall be stored in areas with uniform temperature control to prevent condensation accumulation.

Any outdoor storage is considered temporary (less than 48 hours) and the entire system must immediately be protected from the outdoor elements with appropriate coverings. The coverings shall be suitably covered for protection against adverse weather, using a tear-free waterproof membrane such as a tarpaulin. The equipment shall be placed on dry ground or on blocks to lift it clear of any possible water.

Inspect the equipment/system to ensure no damage has occurred within 48 hours of receipt. If damaged, please report any claims to your carrier and contact Chromalox within 7 days for repair options. Do not attempt to operate damaged equipment.

***For long term storage needs, please refer to the Appendix for Long Term Storage Instruction.***



Following inspection, units that are not going to be immediately installed and energized shall be properly stored to ensure no damage will occur from moisture accumulation. Units must be stored in clean, dry conditions as befits any electrical apparatus. Units must not be exposed to wet or damp atmospheres. Units shall be stored indoors in a heated area with uniform temperature control to prevent moisture accumulation.

Units with anti-condensation heaters shall be powered, according to instructions.

Units without anti-condensation heaters shall have new desiccant packs installed in the terminal housing, according to volume size, with any conduit hubs plugged and the housing shrink-wrapped in a moisture proof material. Refer to the Long Term Storage instructions for guidelines on desiccant sizing.

For units that will be de-energized for a period of more than four weeks after receiving must be stored in accordance with Chromalox Long Term Storage Instructions – Refer to the Appendix Section B.

It is a warranty requirement to comply with these instructions and documented evidence shall be maintained in the form of a signed checklist as per the Appendix A or operator's equivalent.

**NOTE:** A completed Maintenance Checklist or equivalent will be required in the event of any safety or warranty claim.

# Site Preparation & Heater Design Considerations

## Maintenance & Safety Considerations

Provide adequate space at the terminal end to permit proper access to terminal housing for installation and maintenance.

When positioning the steam generator, at least 180" of clearance shall be provided for the removal of the heater bundle from the installation, for servicing purposes. Be sure to consult local building codes for minimum distance for clearance, access, and personnel protection.

Provide adequate spacing from the chamber and related piping to nearest combustible material.

Do not operate steam generator near combustible fluids or in combustible vapor or gas laden atmosphere unless specifically designed for such conditions.

The use of insulation on the heating system is recommended to avoid excessive energy loss through exposed surfaces. Insulation shall be of such a type suitable for the temperature classification of the system. Closed cell insulation is recommended to avoid the absorption of any liquids that may be present in the area. Terminal enclosures are not part of the thermal process and **MUST NOT** be insulated. If a unit is equipped with standoff design, the area around the standoff tubes **MUST NOT** be insulated. This area shall remain open to the surrounding air flow to allow for heat dissipation.

## Mounting, Connection, & Support Considerations

In a forced circulating system, the pump outlet should be connected to the heater inlet nozzle.

If using two or more steam generators for an in-line application, they should be arranged in a parallel configuration.

For horizontal vessel installations, the chamber inlet and outlet should be mounted in the upward facing plane to help prevent air pockets.

Unit should never be located at the highest point of a system due to the possible accumulation of air pockets.

A solid foundation pad should be prepared for mounting of the steam generator and Medium Voltage Control Panel. If the steam generator will be located in an enclosed or confined space, a minimum of 28" of clear walking area around the unit must be maintained for personnel safety.

## Process Flow Considerations

Do not allow steam generator to operate when flow is interrupted or when liquid levels will expose the heating elements. The installation should have level and flow or pressure switches to ensure proper flow is maintained and to provide equipment and personnel protection.

Foaming in process flow can create artificially high water level readings within water columns. Precautions must be taken to prevent foaming in boiler water. Artificially high water level readings will allow continued operation with inadequate water levels resulting in damage to or failure of heating elements.

Care must be taken to ensure that total dissolved solids in process flow is adequate for electrical conductivity between water level probes. Inadequate conductivity will result in artificially low water level readings, halting boiler operation.

Reference Appendix G for specific water quality guidelines

## Temperature Sensor Considerations

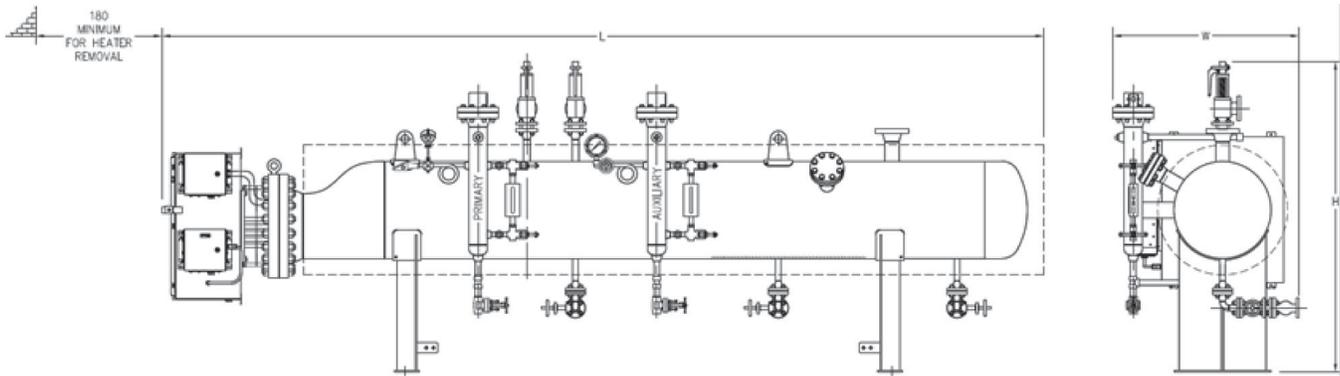
When using an element sheath sensor, be sure to install flange with the sensor in the TOP position, also indicated on the heater flange, and near the outlet area. This is to ensure that any drop in liquid level will expose the sheath/sensor first. This position will also help in reading the highest internal sheath temperature due to rising heat.

The element sheath sensor is to be used as a protection device for the heater unit. Additional sensors and controls must be utilized as part of a complete operating system for proper and safe usage.

For liquid applications, element sheath temperature control setting has a recommended range of 28-56°C (50-100°F) higher than the process operating temperature. This setting can be adjusted higher or lower based on liquid suitability, heater unit materials, and specific operating conditions.

In all circumstances, the sheath temperature **MUST NOT** be allowed to exceed the maximum material temperature rating of the element sheath and/or pressure boundary material(s).

# Installation



## General

This section outlines the contractor's responsibility for the erection and installation of the equipment supplied.

The steam generator unit shall be installed by the contractor under the surveillance of the client's site engineers, in accordance with these instructions.

The installation shall be carried out in complete accordance with this document, which shall be read as complimentary to all associated contract documents (such as site conditions, contract specifications and drawings) and national legislation / regulations.

The erection contractor shall ensure that their employees are fully trained and supervised in the appropriate site working procedures in order to ensure their safety. The site must be maintained in a safe condition at all times.

The erection contractor shall ensure that their site installation personnel are issued with copies of all relevant drawings, material schedules and specifications to enable them to fulfil their obligations.

The erection contractor shall be responsible for providing all tools and equipment necessary to carry out the installation as required on the schedule drawings.

General safety precautions listed in the plant Safety Manual shall be complied with to prevent injury to personnel or damage to equipment.

***This unit must be installed in accordance with all local codes. The local specifications and codes define the requirements of use for installation and operation of equipment in potentially hazardous atmospheres. The operator installing the heater must either be fully conversant with local specifications or have access to it to ensure the heater is correctly installed.***

Ensure that the area safety supervisor and others in the vicinity are aware that work is being undertaken

and post warning notices. A Job Hazard Analysis or

Work Permit Review should be completed prior to installation. Ensure that the appropriate safety equipment and clothing is worn. Beware of wet or slippery ladder rungs and working areas if working aloft.

Any persons about to perform installation procedures with any electric heater must first educate 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.

Confirm all electrical power has been disconnected using properly calibrated metering or detection equipment. Lockout/tagout shall always be performed prior to entering electrical panels.

Main disconnect switch will typically lock and remove all power in a panel except for low level DC control circuits being input by the PLC (Programmable Logic Control) or DCS (Distributed Control System). Only qualified, trained electrical personal shall perform any work on energized equipment.

Where work will pass over or near equipment, additional protections such as a metal guard may be needed to prevent damage to the unit or accessory components.

Modifications made to the equipment during installation, other than those explicitly defined by Chromalox, are prohibited and will null and void warranty, and may cause injury to personnel and equipment.

It is a warranty requirement to comply with these instructions and documented evidence shall be maintained in the form of a signed checklist as per the Appendix A or operator's equivalent.

**NOTE:** A completed Maintenance Checklist or equivalent will be required in the event of any safety or warranty claim.

## Mechanical

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

For flange bundle heaters, the installer shall confirm the correct orientation of the unit to design specifications. Items such as sensors, baffling, thermowells, or other position specific devices must be installed correctly. Take extra care to not bend the heating elements during installation. Refer to Appendix C for additional lifting details.

Ensure the unit is properly certified for the intended site usage and area classification. Ensure that the equipment is appropriate to the surface temperature class and the heater temperature class is stamped on the terminal box label.

Unless specifically designed otherwise, the terminal box shall not be subjected to direct sunlight at ambient temperatures above 30°C. For outdoor installations in arid environments, a sunshade should be installed to shield the enclosure from direct solar radiation. Unless specifically designed otherwise, the air surrounding the terminal enclosure shall not exceed the maximum design temperature of 40°C.

Steam generator connection nozzles are not designed to support piping loads. The foundation must be sufficiently designed to prevent the heater from settling or heaving, which could cause the piping to transmit excessive strains to the chamber nozzles. It is recommended that for concrete footings pipe sleeves should be fitted on each foundation bolt. These should be at least one size larger than the bolt diameter, as they allow the bolt center to be adjusted after the foundation has cured.

Mount steam generators to permit unrestrained expansion of the chamber and inlets / outlets due to thermal expansion. This can be accomplished by using slotted mounting assembly in conjunction with the support members (mounting lugs, saddles, or other supports). Piping allowances must be made to allow expansion without putting stress on the heater nozzles. If the feedwater pump is plumbed within 30 feet of the MVS-GI unit, best practice dictates that two check valves should be included between the pump and feedwater inlet to prevent backflow of hot water, which could cause damage to the feedwater pump.

When completing piping to boiler, ensure that all piping and process connections are correctly mated to the appropriate tagged nozzle. For steam outlet connections, a globe valve should be placed as close as possible to the boiler outlet. To ensure maximum efficiency, all piping from the steam outlet should be insulated. Drain and relief valve piping should be in compliance with all relevant state and local codes.

The steam generator skid, supporting structure, or mounting lugs should be adequately protected against mechanical damage, extreme temperatures, and other adverse conditions.

Unit should be adequately secured to avoid excessive vibration. Excessive vibration can result in increased wear on heating element sheath(s), cause erratic operation for unit mounted thermostats, and pre-mature loosening of proper torque specification on bolting and electrical connections.

All steam generator openings and terminal housings shall be inspected for foreign material. Protective plugs, covers, and desiccant shall not be removed until just prior to installation.

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 in the piping specification. Refer to Appendix D for tightening guidelines.

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

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 chamber vessel.

## Pressure Boundaries / Vessels

Due to the hazardous nature of pressure applications, it is highly recommended the purchaser, user, and installer consult with those certified in such installations to ensure proper compliance. Also refer to section 'Precautions & Warnings' for further guidance.

**This unit must be installed in accordance all local pressure boundary codes. The specific local specifications and codes define the code of practice for pressure apparatus. The operator installing the heater must either be fully conversant with local specifications or have access to it to ensure the heater is correctly installed.**

It is the responsibility of the user to fully understand the equipment pressure rating and correction operations. Refer to the Chromalox unit design drawing for specific rating.

For units not certified by a third party and supplied with a 150# or 300# flanged heater connection, proper rat-

ings are defined by the American National Standards Institute (ANSI). The ANSI B16.5 table defines the proper pressure and temperature ratings, by material, that can be used with Chromalox 150# or 300# flanged heater connection units. Proper operating conditions, including ambient temperatures, must be maintained at all times.

For American Society of Mechanical Engineers (ASME) certified units, the operating conditions and maximum limitations will be defined by the code calculations and listed on the unit design drawing and ASME nameplate. All installation recommendations and warning as defined by ASME must be followed.

For Pressure Equipment Directive (PED) certified units the details of the Fluid Category, Maximum Allowable Pressure, Maximum Working Temperature, and the Hydrostatic Test Pressure, the details will be listed on the check list for the Essential Safety Requirements of the PED produced for the heater.

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## Electrical

**This unit must be installed in accordance all local electrical codes. The specific local specifications and codes define the code of practice for electrical apparatus for use in potentially hazardous atmospheres. The operator installing the heater must either be fully conversant with local specifications or have access to it to ensure the heater is correctly installed.**

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.

Only qualified, trained electrical personnel shall perform any service on energized equipment. Lockout / tagout shall always be performed prior to entering electrical panels. Main disconnect switch will lock and remove all power in the panel except very low-level dc control circuits being input by the DCS.

Ensure that any grounding on the steam generator 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 Personal Protection Equipment (PPE). Never open junction boxes or work on live circuits. De-energize all equipment prior to starting any service or maintenance

A dielectric withstand test has been performed on the heating elements and flange assembly. No further dielectric test is necessary.

## Heater Terminal Housing, Internal Bussing & Connections



### **⚠ WARNING**

***ELECTRIC SHOCK HAZARD Disconnect all power before installing or servicing heater. Unit must be installed or serviced by a qualified person. Unit 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.***

Refer to steam generator drawing to review unit voltage, circuits, phase, and kW rating. Check to ensure that the line voltage and phase listed on the wiring diagram are in agreement with values stamped on the unit nameplate. Verify wattage rating against the capabilities at the installation site.

Units equipped with a polycarbonate panel will need to have the panel removed to properly access the electrical connections.

All silica gel packs, internal packing, caps, plugs, etc. need to be removed before operation. Verify any internal lead wires do not contact the enclosure surface or other conductive materials.

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

Prior to wiring installation, check all bussing and heater element hardware is tightened per the below specifications:

- For units rated 1,000 to 7,200 volts, the #10 screws at the bus bar connections should be tightened to 20 in-lbs (2.25 N-m). The 1/2" bolted connections to the bus bar should be tightened to 48-66 ft-lbs (65-90 N-m).

Sufficient clearance shall exist between live and electrical parts and live to ground. Creepage and clearance distance must be in accordance with the following table.

Voltages up to:	Creepage	Clearance
250	0.375 in [9.5mm]	0.25 in [6.4mm]
600	0.5 in [12.7mm]	0.375 in [9.5mm]
2500	1.26 in [32mm]	1.14 in [29mm]
3200	1.57 in [40mm]	1.42 in [36mm]
4000	1.97 in [50mm]	1.73 in [44mm]
5000	2.48 in [63mm]	1.97 in [50mm]
6300	3.15 in [80mm]	2.36 in [60mm]
8000	3.94 in [100mm]	3.15 in [80mm]

Source: IEC 60079-7, Table 2 - Min. creepage distance, clearances, and separations

Chromalox MVSGI Steam Generators will be supplied with a Power Converter system that includes ground fault monitoring equipment.

The terminal points for each heater are as follows:

- Power terminals (entry through cable gland plates or conduit connections)
- Equipment earth / ground terminals (internal and/or external)
- Sensor and/or control terminals (entry through cable gland plate or conduit connections). Refer to Sensor Wiring section for further details

Ensure that the equipment is earthed in accordance with the plant grounding / earthing philosophy.

Power to terminal ends of heater must be protected from drippings, condensation, spray, or direct spill-over of material whose presence at the terminal may damage heater electrical insulation. Liquid tight enclosures, anti-condensation heaters, or other appropriate apparatus(s) should be used for proper operation, where needed.

### Heater Terminal Housing, Power Wiring / Cabling Recommendations

All cable connections must be installed in accordance with all local electrical codes. The specific local specifications and codes define the code of practice for electrical apparatus for use in potentially hazardous atmospheres. The operator installing the heater must either be fully conversant with local specifications or have access to it to ensure the heater is correctly installed.

Due to high operating temperature conditions, minimum of 125°C wire shall be used for terminal connection. Higher temperature cabling may be needed, based on process conditions. Please review terminal housing temperature classification to ensure proper compliance.

The current carrying capacity of the power supply leads shall exceed the heater amperage by at least 25%. Be sure to consider the applicable electrical codes, ambient temperature, terminal box operating temperatures, and conduit loading factors to apply the appropriate correction factor to the ampacity rating of the wire. Cables entering the terminal housing shall be secured to prevent damage and stress to the heater connections. Sufficient space should be allowed for wire bending radius.

Electrical wiring should be contained in a rigid conduit or in a sealed flexible conduit when corrosive vapors or liquids are present. If high humidity or similar moisture conditions will be present, the conduit should slope down and away from the heater in a 'drip-loop' configuration with appropriate breather drains installed.

Ensure the electrical protection is satisfactory. Lead wires, cables and glands shall show no signs of dam-

age and shall be adequate for the stated electrical duty. Ensure cables connecting the control panel to the heater junction box are installed in conduit and all openings & transitions are protected to prevent moisture intrusion. Ensure cables and conduits are bonded correctly and secured to prevent damage and stress to the connections.

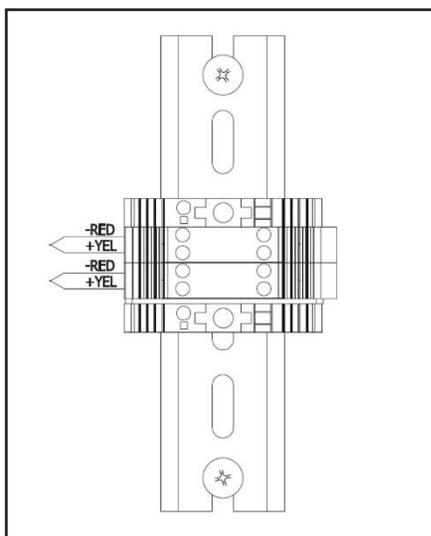
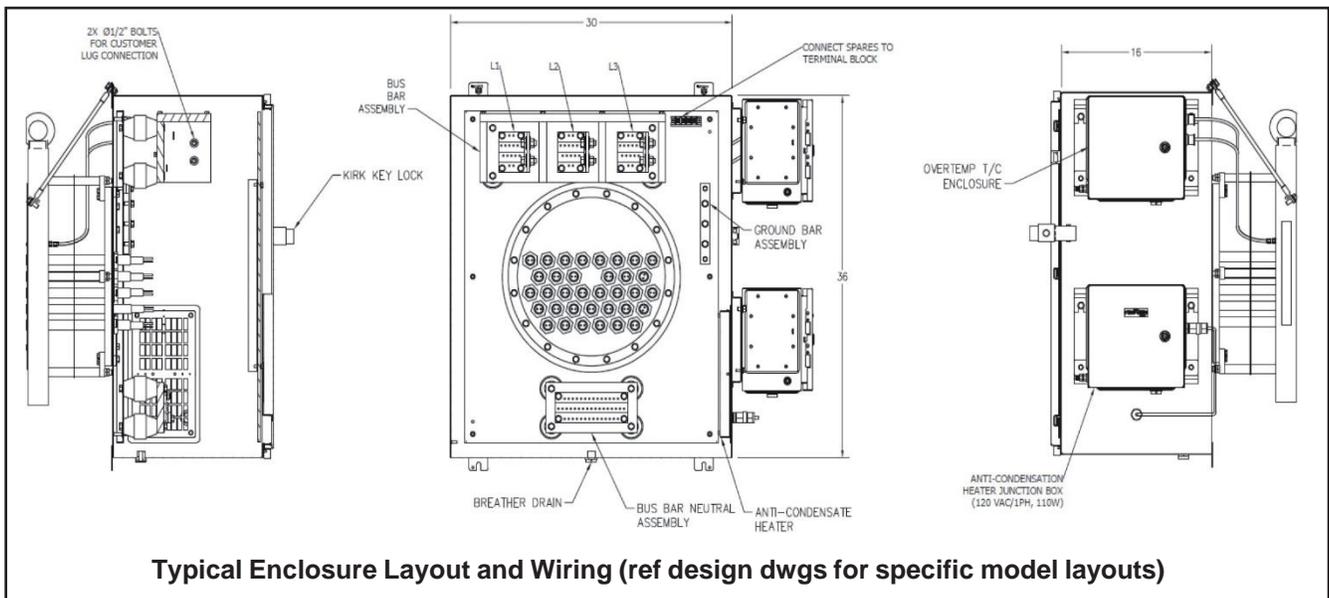
Conduit or cable gland opening diameters shall not exceed 6.5 in (165mm). The grounding conductor must be at minimum the same size as the phase conductors, unless dictated otherwise by presiding electrical code.

If flexible cord is used, as permitted by code, a water-tight connector should be used for entry of the cord into the terminal box. Outdoor applications require liquid-tight conduit and connectors.

To prevent moisture accumulation in cryogenic applications or when heater is exposed to freezing temperatures:

- Slope conduit away from enclosure (drip loop).
- Seal all conduit openings to moisture/explosion resistant terminal enclosure.
- Externally insulate terminal enclosure.
- Fill open thermowell(s) with silicone fluid when heater is mounted with terminal enclosure up.

Units equipped with a kirk key lock system will have matching locks on the power control system. The key must be removed from the power control system which will disable power to the system before either the control panel and/or the heater junction box can be opened. The key for the control panel will be used to open the heater junction box.



**Over-Temperature Thermocouple Wiring**

## Hazardous and/or Classified Areas, Electrical

Use only certified hazardous rated enclosures in hazardous location environments. Refer to the Chromalox unit design drawing for specific certifications(s) and/or classification rating. Certified enclosures **MUST NOT** be modified, altered, or repaired by anyone other than the manufacturer. Improper usage will void the warranty and could create a dangerous environment.

Installation of electrical wiring must comply with National Electrical Code (NEC) or International Electric Code (IEC) requirements for hazardous locations. Installers must be suitably trained personnel in full accordance with IEC 60079-14/IEC 60079-1 in required areas.

Heaters located in hazardous locations must operate within the specified ambient temperature ranges to comply with the applicable certifications. Extended ambient ranges may be possible with increased terminal box standoff distances. Be certain to verify the product certification parameters with the site conditions prior to use.

Terminal enclosures must be torqued to 55 in-lbs (6.2N-m) when securing the door to maintain certification.



### **⚠ WARNING**

***No operation involving the use of an open flame or other source of ignition shall be attempted until the condition has been made safe (gas free) by the control of the flammable material that may give rise to the risk. Electrical test equipment can constitute a hazard and shall not be used in the presence of a flammable material, unless specifically designed for the purpose and suitably certified.***

Due to the nature of hazardous area location installations, it is highly recommended the purchaser, user, and installer consult with those certified in such installations to ensure proper compliance.

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## Maximum Temperatures



Safe operation in a hazardous location requires the maximum operating temperatures of all exposed surfaces of the heater including temperatures on the outside of the vessel, piping, flanges, screw plugs, enclosures and other heat conducting parts be limited. The flammable liquids, vapors or gases present determine the maximum surface temperature permitted in any hazardous location. The end user or purchaser of the electric heating equipment is responsible for determining the proper classification of an area and for providing Chromalox with hazardous area specifications and requirements for proper equipment design.

### **⚠ WARNING**

***The system owner must provide devices and warnings to prevent physical contact of personnel with hot surfaces.***

### **⚠ WARNING**

***Since heaters are capable of developing high temperatures, extreme care should be taken to provide adequate spacing between hot surfaces and combustibles. Avoid operation of heater near combustible fluids or combustible gas laden atmospheres. Failure to do so could result in personal injury or property damage.***

## Heater Sensors and Power Controls

Steam generator units will be equipped with temperature and water level sensors and power controls. These components form part of a more complex system installed at the site. It is the responsibility of the end user to ensure that all components are designed and installed properly to ensure safe operation.

Steam generator units are regulated by a power control system that monitors process temperature, pressure, and water level. Please review the control system design and instructions with a certified professional for proper performance and safe usage.

Be sure to consult all appropriate manufacturers' instructions for proper system design and usage.

The user must ensure that safety interlocks are provided and maintained to so that the heater can only be energized when the design flow rate through the heater is present. Heater should be de-energized or have a de-rated power output, should this flow rate be reduced or stopped.

Separate wiring must be used for all process or high limit temperature sensors. Ensure longer runs use the appropriate extension wire and meet ground shielding requirements.

Ensure torque on the temperature sensor terminal block and anti-condensation terminal block is tightened to 7 to 11.5 in-lbs. (0.8 to 1.3 M-m).

Below is a listing of typical sensors used in conjunction with heater units. This is not an all-inclusive list. If you are unsure of any operation, please consult with a certified professional.

Any sensor wiring should be run in a conduit or cable tray isolated from the power wiring. Sensor extension wire should match the factory installed wiring for proper readings. Thermocouple wire should not extend beyond recommended lengths for proper reading – typically limited to 150 ft (45m).

**Process Sensor(s)** – This unit contains a thermocouple and pressure transmitter to provide temperature and pressure feedback on the process stream to the unit control system.

**Overpressure Switch** – This unit contains an overpressure switch that will trip power to the unit if process pressure exceeds the overpressure setpoint. This switch requires a manual reset if it is tripped.

**Overtemperature Sensor(s)** – This unit contains a thermocouple to provide temperature feedback of the heating elements. These are typically used to prevent an overtemperature situation of the process heating elements. These sensors shall be wired to a dedicated safety shutdown control system.

Overtemperature sensors are to be connected to the appropriate monitoring and safety devices in the power control system. The safety system in hazardous locations used for overtemperature protection must operate in accordance with IEC 60079-7, Section 5.8.10-11. The heater overtemperature set point shall not exceed the maximum recommended element sheath temperature, as defined by UL 1030, Table 13.1.

# Commissioning

Anyone unfamiliar with steam generator operation should contact the Chromalox Service Group for Start-up and Commissioning services.

**NOTE:** Chromalox medium voltage systems, “Direct-Connect”, are composed of both a Heater and Power Converter unit. Both units must be employed for proper operation. Installation review, start-up, and Commissioning shall only be performed by Chromalox personnel. Otherwise, the User assumes all responsibilities, and all warranties, both written and implied, are voided otherwise.

**The Chromalox Service Group can be contacted at 1-800-443-2640 or by visiting [www.chromalox.com](http://www.chromalox.com) for additional contact information.**

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 at the operating voltage, but with direct current and within a tolerance  $\pm 25$  VDC. For example, a 4160 volt heater should be measured with 4160 volts direct current. Individual circuits shall be greater than 5 megaohm. If measuring individual elements, insulation resistance shall be greater than 20 giga-ohm.

If there is a low insulation result, it will be necessary to dry the heater elements and bussing assembly. For detailed procedures, please refer to Appendix E, ‘Electric Heaters with Low Insulation Resistance’, or contact the Chromalox Service Department at 1-800-443-2640

Heater unit shall not be energized until all checks are complete. The terminal enclosure cover shall only be removed when there are no hazardous gases present.

1. Check overall physical condition of the heater for any signs of damage.
2. Installation layout should be neat in appearance. Check for any loose components.
3. Remove all debris from enclosures.
4. Ensure that any preservation items such as VCI pads or desiccant bags are removed.
5. Ensure all bussing hardware is tightened per ‘Installation’ Section. Reconnect the wiring / cabling ensuring terminations are secure.
6. Ensure both heater and instrument enclosure covers are closed and all fastenings are tight.
7. Check that labels and tags are secure and correct.
8. Ensure the operating conditions for which the heater was designed are matching the actual process settings. Ensure the process flow is available.
9. Ensure process media is not corrosive to the heating elements or chamber.
10. Ensure the process controller and overtemperature controller have the correct operating settings and are functioning properly.
11. Ensure all other safety and / or shutdown devices are functioning properly.
12. Check all piping connections are properly torqued. A system hydro-test or leak test is recommended to verify no leakage will occur in the system.

It is a warranty requirement to comply with these instructions and documented evidence shall be maintained in the form of a signed checklist as per the Appendix A or operator’s equivalent.

**NOTE:** A completed Maintenance Checklist or equivalent will be required in the event of any safety or warranty claim.

## Boil-out of New Unit

The MVSGI chamber and elements may have a residue of grease, oil, or industrial solvents used in the manufacturing process. The presence of such chemicals can impede heat transfer between the heating elements and process fluid, reducing operating efficiency and potentially resulting in damage to the new unit. It is a warranty requirement that a boil-out be performed prior to normal operation. A Chromalox field-service technician will be able to advise an appropriate boil-out procedure for your unit. The following general guidelines for boilout procedures may be used to plan and prepare for the procedure:

1. The procedure will require chemical agents added to boiler water to remove any residue from the internal surfaces. A commonly used combination is sodium carbonate and sodium hydroxide (1lb per 50 gallons of water).
2. Chemicals must be fully dissolved into warm water outside of the MVSGI chamber, added in small amounts to prevent excessive heating.
3. Safety valves must be removed prior to the procedure to prevent contamination and degreasing by the caustic solvents used. It is recommended that an overflow pipe be added to one of the safety valve openings, and piped to a safe and suitable discharge location.
4. The MVSGI unit must be completely isolated from the steam process piping system to prevent contamination. All valves on the chamber must be closed to prevent contamination.
5. Prior to adding the cleaning solution to the MVSGI chamber, the chamber must be filled with ambient temperature water until all heating elements are covered. Add the cleaning solution, then continue filling the chamber to the top.
6. Energize the unit and operate at low temperature to maintain cleaning solution at boiling point. Do not exceed temperature necessary to maintain boil. Continue operating at sufficient temperature to maintain boil for 4-5 hours.
7. Feed a small, continual flow of fresh water into the chamber, allowing overflow to carry off surface impurities. De-energize the heater once overflow water clears, allow water to cool, and drain while still warm.
8. Wash all internal surfaces using high pressure water and inspect surfaces for cleanliness. If surfaces are not clean, repeat boil-out procedure

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## Operation

Before operating the equipment, the installation must be approved by a supervisor and Chromalox service technician to ensure that the system is safe for operation with all commissioning checks completed.

**Low Megohm Condition** — The refractory material used in electric heaters may absorb moisture during transit, storage or when subject to humid environments that will reduce the insulation resistance (low megohm). Low megohm may result in high leakage current to ground and nuisance trips of ground fault protection equipment. Normally, the megohm value increases after heat-up. If persistent conditions persist, the heating elements may need to be dried out to remove moisture. Refer to Appendix E for details

## Operation

The MVSGI unit functions in conjunction with the supplied Medium Voltage Power Converter. Reference the supplied MVPC manual to familiarize yourself with settings and operating modes and procedures.

It is a warranty requirement to comply with these instructions and documented evidence shall be maintained in the form of a signed checklist as per the Appendix A or operator's equivalent.

**NOTE:** A completed Maintenance Checklist or equivalent will be required in the event of any safety or warranty claim.

**IMPORTANT:** The Manufacturers' Data Report enclosed within the instruction sheet is very important and must be put in a safe place. You may be called upon to produce it by a state agency.

Initial start-up of the MVSGI steam generator and converter system must be performed by Chromalox Personnel during commissioning service.

## **⚠ WARNING**

*The generator should be operated by authorized and trained personnel only. Protective coverings must be worn when interacting with the valves associated with the steam generator. Serious risk of burn exists due to high temperature steam passing through the equipment.*

### **Start-Up Procedure**

1. Ensure the following valves are closed: drain/blowdown valves, water column valves, and steam outlet globe valve (customer supplied)
2. Ensure the water inlet valve is fully open
3. Using the Medium Voltage Power Converter HMI, turn ON the generator. For MVPC start-up, please see the DirectConnect™ Converter System IOM (PK526).
4. Observe the generator sight glass, the vessel will fill until water reaches the PUMP OFF level.
5. Once the water level reaches the PUMP OFF level, allow the pressure to build up to operating pressure.
6. Once at operating pressure, slowly open the steam outlet gate valve a quarter turn at a time to introduce small amounts of steam into the process. Avoid opening the globe valve all at once; this will minimize large temperature swings and the occurrence of water hammer in the process piping as well as the effects of pressure drop in the generator.

# Maintenance

## **⚠ WARNING**

**No operation involving the use of an open flame or other source of ignition shall be attempted until the condition has been made safe (gas free) by the control of the flammable material that may give rise to the risk. Electrical test equipment can constitute a hazard and shall not be used in the presence of a flammable material, unless specifically designed for the purpose and suitably certified.**

If installed steam generators are not used for a period longer than 3 months, they must be tested for insulation resistance. Low megohm may result in high leakage current to ground and nuisance trips of ground fault protection equipment. Normally, the megohm value increases after heat-up. If persistent conditions persist, the heating elements may need to be dried out to remove moisture. Refer to Appendix E for details.

Heaters shall be routinely checked and maintained to ensure sustainable operation. The following preventative maintenance shall be carried out at the intervals shown below. Chromalox service technicians are also available to assist in on-site work or personnel training.



## **⚠ WARNING**

**HAZARD OF ELECTRIC SHOCK. Disconnect all power before working on boiler.**

Chromalox Electric Steam Boilers are designed for years of trouble-free performance. To establish a good preventative maintenance program, we suggest the building maintenance team or engineer familiarize themselves with these simple rules:

### **Daily**

The sight glass should be checked daily to ensure the boiler has adequate water.

Boiler blowdowns are critical to prolonging the operational lifespan of any steam generator. Solids are brought into the chamber vessel by feedwater and will become concentrated in the chamber as water is boiled off to generate steam. Accumulated solids contribute to the formation of harmful scale buildup on heating elements, decreasing operational efficiency and heat transfer, and accelerating degradation of heating elements. Blowing down the boiler is imperative to mitigating scale buildup and prolonging the life of the MVSGI unit by maintaining a low level of total dissolved or suspended solids in the boiler water.

Intermittent manual blowdowns and water column blowdowns should both be conducted daily. The pro-

cedure will be most effective if performed at a time when steam generation and feedwater input rates are low. The length of a blowdown should be determined by water analysis.

### **Monthly**

A monthly inspection should be made of internal wiring. All electrical connections should be checked for tightness. A check for water or steam leaks should also be made and any loose fittings immediately tightened.

### **Every 3 months**

The elements should be inspected for scale and deposits using the inspection port. If scale has begun to form, boiler should be drained and flushed.

Visual inspection of equipment for any external damage, wear, or leakage.

Lifting eyes and lugs must be regularly checked for corrosion and appropriate measures taken to remedy corrosion such that the integrity is not compromised.

The paint condition of the equipment must be checked periodically to ensure the corrosion allowance is not exceeded.

All electrical power connection, sensor connections, and mechanical bolting shall be re-torqued to proper specifications.

The solid-state low water cutoff probes should be checked for deposits and cleaned, if necessary. This is accomplished by removing water column cap, removing the probe (with a standard sparkplug wrench) cleaning and replacing. Note: Care must be taken that total dissolved solids are high enough to allow for electrical conductivity between water level probes. Inadequate electrical conductivity will result in artificial low water readings.

### **Every 6 months**

Isolate the electrical supply and remove the terminal enclosure cover. Do not remove the terminal enclosure cover during wet or humid conditions as this can lead to a reduction in insulation resistance of the heater. Ensure that internals are clean, dry, and free from debris.

Ensure that all grounding / earthing conductors are correctly fitted between all points and main structure.

Visually inspect wire and wire terminations. Replace any which show signs of oxidation which would interfere with establishment of reliable electrical connections.

If corrosion is indicated in the terminal enclosure, check terminal enclosure gasket and replace if necessary. Check conduit layout to correct conditions that allow moisture to enter the terminal enclosure.

If the presence of moisture is detected in the terminal housing, measure the insulation resistance of the heating assembly and/or elements to ensure it is within operating tolerance.

Low megohm may result in high leakage current to ground and nuisance trips of ground fault protection equipment. Normally, the megohm value increases after heat-up. If persistent conditions persist, this may indicate moisture ingress into the terminal enclosure. The leakage will need to be corrected, and the heating elements may need to be dried out to remove moisture. Refer to Appendix E for details.

Ensure terminal housing gasket is in good condition and refit cover.

Functional check of all related process controllers, power systems, and safety interlocks.

### **Every 12 months**

Check for element operation by comparing phase resistance values from the legs of each circuit. On a healthy system these values should be equal (+/- 10%).

When resistance values show a large variance, bus- ing can be removed from the identified circuit to isolate the underperforming element(s). An open circuit element can be 'un-bussed' from the circuit so that operation can continue. While the legs of the circuit may be unbalance, this will not affect heater operation outside of the reduced power output. If desired, the unit can be sent back to the manufacturer for element replacement at an appropriate time.

Measure insulation resistance of the heating elements. This can be carried out by taking a reading between the element sheath and the phase terminals, using a 500v DC megohmmeter. Refer to Appendix E, Low Megaohm Resistance, for further details.

Low megohm may result in high leakage current to ground and nuisance trips of ground fault protection equipment. Normally, the megohm value increases after heat-up. If persistent conditions persist, the heating elements may need to be dried out to remove moisture. Refer to Appendix E for details.

Remove heater from its mating flange and check the external condition of the heating elements. Heater elements can be visually inspected for:

Discoloration - due to overheating must be investigated further to ascertain the cause.

Coatings – the presence of fluid fouling, scale build- up, deposits, or similar coatings. Any product build- up on the surface of the element must be cleaned. The use of high pressure steam, water jets, or suitable solvent is acceptable. The chloride content of steam or water shall not exceed 20 ppm, otherwise the element sheath can fail through stress corrosion cracking.

Area around elements should be checked for sedi- ment or sludge build-up that would shorten heater life. Correct operating conditions, as needed, to minimize any sheath deterioration due to corrosion.

Corrosion – the presence of acidic solutions can de- teriorate the element sheath. Common indicators in- clude scaling, pitting, pin-hole, oxidation, or similar degradation of the metal. While corrosion may not al- ways be avoidable, it is best controlled through proper material selection and process flow chemistry. Consult with Chromalox for alternative material selections, if needed. In more extreme solutions, full heater replace- ment may be needed as part of a regular maintenance schedule.

*Chromalox will not warrant any electric heater against failure by sheath corrosion if such failure is the result of operating conditions beyond the control of the heater manufacturer. It is the responsibility of the purchaser to make the ultimate choice of sheath materials based on their knowledge of the chemical composition of the corrosive solution, character of materials entering the solution, and controls by which the process can be maintained.*

Mating surfaces and bolting must be evaluated for po- tential corrosion and if necessary covered with a rust- preventative suited for the materials and as recom- mended by the manufacturer.

A new gasket should be used when re-installing heater. Gasket and mating surfaces must be clean and dry prior to reinstalling heater bundle. Retighten bolt con- nections per guidelines in Appendix D.

It is a warranty requirement to comply with these in- structions and documented evidence shall be main- tained in the form of a signed checklist as per the Ap- pendix A or operator's equivalent.

Chromalox heating elements are designed and manu- factured to provide a long trouble-free life and rarely fail if they are operating in the conditions for which they were designed. Should one or more elements re- quire replacement, please note that heater designs that have welded or brazed elements can not be replaced on site. Please contact the Chromalox Service Depart- ment at 1-800-443-2640. Heater designs that have a replaceable element design can be replaced on-site by qualified personnel. Please refer to Appendix F for fur- ther details.

With heater bundle removed, make a general inspec- tion of the vessel interior for any signs of pitting, scale buildup, or corrosion. Remove any visible contami- nants before re-installing heater bundle.

**NOTE:** *A completed Maintenance Checklist or equiva- lent will be required in the event of any safety or war- ranty claim*

# Fault Finding and Correction

Below is a listing of common occurrences and solutions that may occur during heater operation. This is not an all-inclusive list. Each application is unique, and heating equipment is mostly likely integrated with sensors and controllers outside the scope of this manual. Be sure to consult a certified professional if you are unsure of the situation.

Chromalox Service Department is available at 1-800-443-2640

Fault	Possible Correction
Process temperature is too low	<ul style="list-style-type: none"> <li>• Isolate power supply</li> <li>• Check supply fuses</li> <li>• Check that the temperature control device set points are correct.</li> <li>• Check sensors for correct location, wiring, operation, and accuracy.</li> <li>• Check that all elements are still operative by taking a load resistance reading. Resistance between phases should be equal.</li> <li>• Check that the process flow is matching the design rating.</li> </ul>
Process temperature too high	<ul style="list-style-type: none"> <li>• Check that the temperature control device set points are correct.</li> <li>• Check the actual flow conditions match the design parameters.</li> <li>• Check the sensor location operation</li> </ul>
Heater Shutdown	<ul style="list-style-type: none"> <li>• Check that the supply voltage is correct</li> <li>• Check all trip devices are functioning correctly and sensors have not failed.</li> <li>• Check ambient temperature is within rating</li> <li>• Check overtemperature control settings and adjust as needed</li> <li>• Check any liquid level control settings</li> <li>• Check ground fault settings</li> </ul>
Process temperature too high	<ul style="list-style-type: none"> <li>• Check piping and flange connections are tightened to specifications</li> <li>• Check gasket materials and mating surfaces</li> </ul>
Noisy flow or cavitation	<ul style="list-style-type: none"> <li>• Check piping and flange connections are tightened to specifications</li> <li>• Check gasket materials and mating surfaces</li> </ul>

# Health & Safety Statements



## Decommissioning, Disposal, and Recycling

There may come a time when equipment needs to be replaced or is no longer required. Prior to decommissioning, make sure equipment is properly shut down and de-energized. Follow guidelines within installation and maintenance sections of this document to disconnect equipment. Check local codes and regulations for proper disposal and recycling of materials. Chromalox is not responsible for improper disposal.



## ROHS Compliance

This unit complies with the Restriction of Hazardous Substance (ROHS), also known as Directive 20011/65/EU.



## Non-Potable Use Only

Under the US Federal Safe Drinking Water Act, it is unlawful to install or use this product in any service that comes into contact with water for human consumption. This product is intended exclusively for use in non-potable service.

There are no hazardous or toxic substances supplied with this equipment.

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# Service & Replacement Parts

Any service work must be performed by trained personnel.

For on-site technical support, please contact the Chromalox Service Department at 1-800-443-2640. Provide your unit part number, model number, and Chromalox purchase order number to properly identify the equipment.

Replacement parts are available by contacting Chromalox Service Department at 1-800-443-2640. Provide the unit part number, model voltage, and wattage to properly identify unit.

# **Appendix**

**Section A – Installation, Commissioning, and Maintenance Checklist**

**Section B – Long Term Heater Storage**

**Section C - Lifting**

**Section D – Flange Bolt Tightening Procedure**

**Section E – Insulation Testing & Dry-out Procedure**

**Section F – Heater Element Replacement**

**Section G – Water Quality Guidelines**

# Appendix A

## Maintenance Schedule & Record Form

Equipment Received Date \_\_\_\_\_

Equipment Model Description: \_\_\_\_\_ Chromalox PO # \_\_\_\_\_

Equipment Part Number \_\_\_\_\_ Tag No: \_\_\_\_\_

### Receiving, Storage, Commissioning, & Operation Verification – Performed per Instructions

<b>Equipment received &amp; inspected (within 48 hours)</b>	Date		<b>Equipment stored per Short Term Instructions</b>	Date	
	Sign			Sign	
	Print			Print	

<b>Commissioning performed per Instructions</b>	Date		<b>Start-up Operation performed per Instructions</b>	Date	
	Sign			Sign	
	Print			Print	

This blank form may be photocopied, as required, to record the full service history of the equipment.

### Yearly Maintenance Inspection Verification – Performed per Instructions

<b>3 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	

<b>6 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	

<b>9 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	

<b>12 Month Inspections</b>	Date		
	Sign		
	Print		

This blank form may be photocopied, as required, to record the full service history of the equipment.

**Notes:**

1. This checklist, duly completed, must be submitted with any safety or warranty claims.
2. A separate checklist must be completed for each piece of equipment.
3. Where equipment is removed from service a new checklist must be completed upon re-commissioning.
4. Where equipment has been placed in Long Term Storage, a separate checklist must be maintained to confirmed proper maintenance. Refer to Section B.
5. Where equipment has been supplied certified for use in a hazardous area, compliance with the relevant code of practice and installation instructions, regarding operation and maintenance, shall also be required.

Chromalox has a team of fully trained technicians and engineers who are able to offer a specialist inspection, commissioning, start-up and/or maintenance service. For further details, please contact our service department at 1-800-443-2640

# Appendix B

## Long Term Heater Storage



Shipping containers are temporary protective covers. Additional protection must be taken to prepare unit for storage to ensure sustainability.

When equipment is stored, as listed below, equipment will remain safe and protected for up to twelve months in the as-supplied condition. High humidity, tropical, or other extreme environments may require reduced time intervals for each inspection.

During long term storage, any desiccant used must be checked at least once a month, and replaced if needed.



Unit shall be stored in a heated building with adequate air circulation and protected from dirt and water. Unit shall be stored in a clean, dry space where a uniform temperature prevents condensation. Unit shall be stored a minimum of 6" off the ground. If the stored area is not heated, desiccant shall be removed from the terminal housing and an anti-condensation heater shall be installed and connected to a suitable supply and kept in operation.

An anti-condensation heater must be energized in the heater terminal enclosure. Ensure all conduit holes are properly sealed and covers fully intact and secured.

If no anti-condensation heater or associated power source is available, desiccant shall be used in the heater junction box to prevent moisture intrusion into the heating elements. Desiccant shall have color saturation indicators to ascertain effectiveness. The heater junction box shall be opened monthly and desiccant shall be inspected. Replace when warning indicators indicate a change is required. Please refer to the guidelines at the end of this section for recommended desiccant sizing.

Desiccant preservation warning labels to be attached at each access point.

VCI (Volatile Corrosion Inhibitors) shall be used in all terminal enclosures during long term storage and regularly checked for effectiveness. VCI can be changed per manufacturer's recommendations.

For units that have unprotected metal surfaces on the internal chamber and/or heating elements, a nitrogen blanket may be installed to help limit oxidation or corrosion that could occur during storage.

All openings shall be properly covered by caps, plugs, water-proof tape, etc.

All fragile parts, sharp edges, and projection shall be properly cushioned.

If flanges are opened for inspection during storage, mating faces shall be cleaned and the gaskets renewed before covers are replaced. Nozzles and flanges shall be blanked with a full face gasket and plate blank flange (coated with primer) secured by 4 bolts minimum, (coated with preservative).

Any spare heater elements shall be stored in the same manner as the primary unit.

## Recommended Sizing for Desiccant bags with Color Saturation Indicators

Drying agents should be inspected regularly and replaced when necessary. The desiccant is to be fitted prior to dispatch.

A general guideline is to use 28 grams of desiccant for each 2 cubic feet (0.06 cubic meters) of volume.

For a more robust storage set-up, please use the following equation:

$$\frac{A \times R \times M \times D}{74} = \frac{W}{2}$$

### Where:

W = Weight, in kg, of the basic desiccant

A = Area, in square meters, of water vapor-proof barrier

D = Weight, in kg, of hygroscopic blocking, (timber cushioning), and other materials inside barrier

M = Maximum time of storage, in months, (12 min)

R = Water vapor transmission rate of the barrier, in grams per square meter per 24 hours, measured at 90% relative humidity differential and 38°C

The waterproof barrier will be polyethene, and the transmission rate is dependent on thickness. Standard thickness is 0.25mm, for which R = 2.

# Long Term Storage Checklist

Equipment Received Date \_\_\_\_\_ Placed in Storage Date \_\_\_\_\_

Equipment Model Description: \_\_\_\_\_ Chromalox PO # \_\_\_\_\_

Equipment Part Number \_\_\_\_\_ Tag No: \_\_\_\_\_

Proper long term storage includes regularly scheduled maintenance checks-to ensure the integrity of both the unit and storage location.

## Every three months:

Sealed, shrink-wrapped, or plastic covered areas shall be visually inspected to confirm integrity of the wrapping material. No moisture or condensation should be present.

Confirm anti-condensation heaters are still operating correctly.

Any desiccant or drying materials must be inspected and replaced if necessary.

Inspect all covers, caps, taping, or similar devices for seal integrity. Retighten or replace if loosened.

Confirm surrounding condition for proper compliance – ambient temperature maintained, no roof leakage, no moisture on floor, no work being performed in area, etc.

## Yearly Maintenance Inspection Verification – Performed per Instructions

<b>3 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	
	Date		Date	
	Sign		Sign	
Print		Print		

This blank form may be photocopied, as required, to record the full service history of the equipment.

## Every twelve months:

The unit must be unpacked from storage so that a complete visual inspection can be done of all internal components – bussing, wiring, sensor housings, heating elements, etc. Care should be given to note any signs of corrosion, moisture, physical damage or similar damage that may have resulted from improper storage or damage to the packaging that may have occurred during storage.

If any damage is noted, please contact Chromalox Service Department at 1-800-443-2640 for recommendations of proper repair.

Upon satisfactory inspection of the equipment and storage are, the unit may once again be repackaged per the Long Term Storage Instruction, if needed.

**Storage Verification Checklist – Performed per Instructions**

<b>3 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	
	Date		Date	
	Sign		Sign	
	Print		Print	
	Date		Date	
	Sign		Sign	
	Print		Print	

<b>12 Month Inspections</b>	Date		Date	
	Sign		Sign	
	Print		Print	
	Date		Date	
	Sign		Sign	
	Print		Print	

This blank form may be photocopied, as required, to record the full service history of the equipment.

If unit is to be removed from Long Term Storage for operation, a complete mechanical and electrical inspection must be performed. Refer to the Installation Manual for complete details.

Chromalox has a team of fully trained technicians and engineers who are able to offer a specialist inspection, commissioning, start-up and/or maintenance service. For further details, please contact our service department at 1-800-443-2640

# Appendix C

## Proper Lifting for Heater Bundles

An immersion heater requires extra care as to not damage the individual heating elements in the bundle during any lifting procedure.

Note that any lifting eyes provided on a heater bundle are specifically designed for only heater removal from a vessel or tank. Tapped holes provided for lifting eyes are drilled and tapped thru and may be used for “Jack Bolts” to break gasket seals prior to removal. The customer must install suitable rated lifting eyes or lugs for their intended lifting method.

Ensure that lifting equipment is of the correct capacity. Due to the uneven weight distribution, care must be taken to ensure that the bundle is lifted in such a way that it does not slant or become inclined during transport.

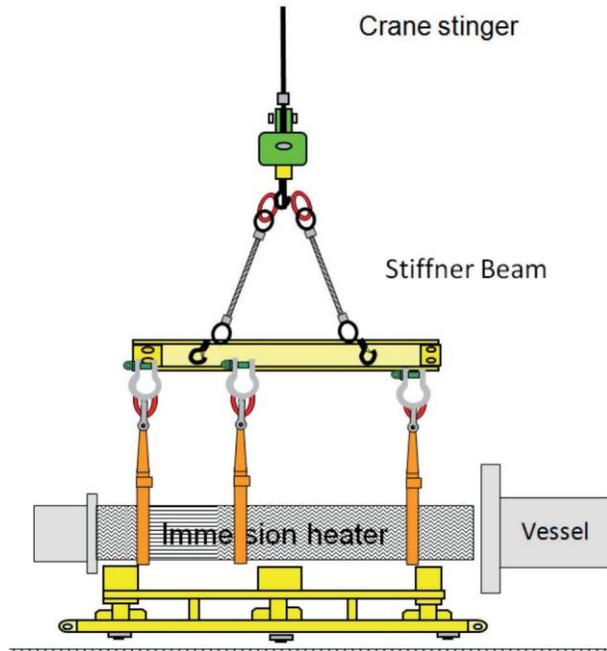
The immersion heater can be installed either by use of a crane or by a ‘running’ block and tackle attached to an overhead stiffener beam (reference figure C.1 as an example). Longer bundles should be lifted by two cranes (or two sets of blocks and tackles).

Multiple slings should be placed under multiple spacer/baffle (span not to exceed 84”) to evenly distribute the weight of the bundle. Do not position slings or supports directly under the elements and damage will occur. While some element distortion is acceptable, excess bending can eliminate the proper spacing between elements. This can result in reduced flow characteristics, overheating, and ultimate failure of the elements.

1. Hook the chains of lifting device to lifting eyes on bundle flange, and tension. Locate lifting eyes with the aid of the drawings provided.
2. If applicable, hook the chains of the second lifting device to a baffle along the length of the bundle.
3. Fit gasket over the elements and orient correctly on the flange face. Ensure the bundle is oriented correctly per the design specification.
4. Carefully begin inserting bundle, ensuring both lifting devices are moving in synchronization and taking extreme care to avoid pinch points.
5. As the bundle progresses into the vessel, remove each successive sling at the entry point into the vessel.
6. Continue slowly inserting bundle.
7. When bundle is fully inserted, bolt bundle flange to vessel flange and torque bolting per specifications. Refer to Appendix D.
8. Remove chains from flange bundle.
9. The unit is now ready for electrical connection.

10. This procedure should be followed in reverse for removal of bundle.
11. This procedure should be followed in reverse for removal of bundle.

**Figure C.1:** Example removal procedure (for reference only)



# Appendix D

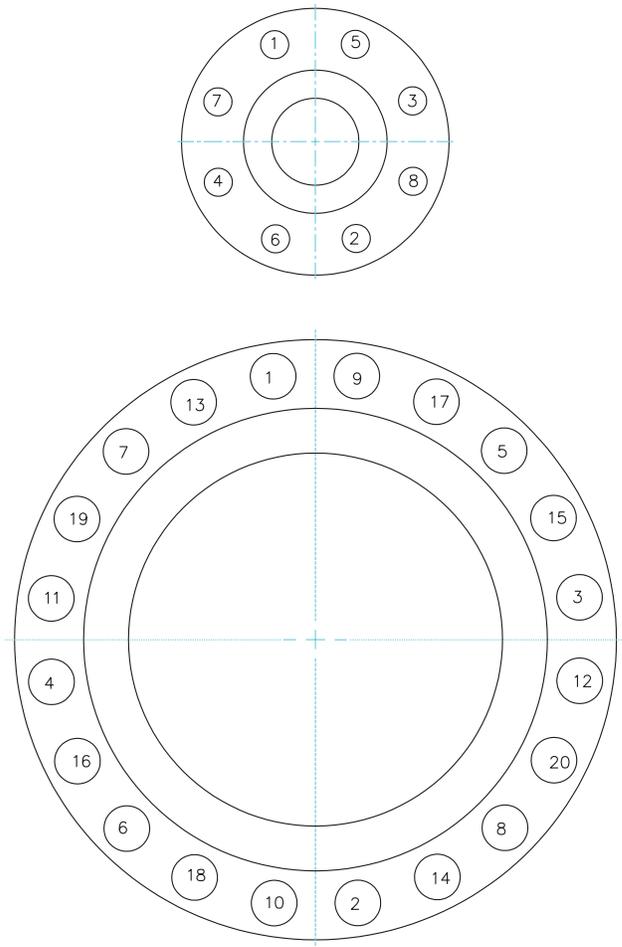
## Flange Tightening Guidelines

**NOTE:** Chromalox recommends specification ASME PCC-1 for detailed guidelines regarding bolted flange joint assembly and disassembly.

The bolt tightening procedure is as follows:

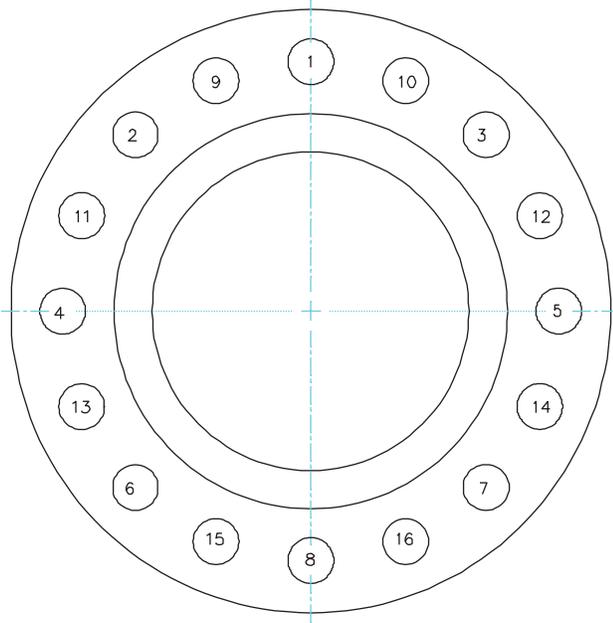
1. Flange faces must be thoroughly cleaned and inspected. Surface marks extending across the joint face or heavy pitting are not acceptable.
2. The alignment of the flanges must be in accordance with the tolerance quoted in the vessel code and manufacturing standard.
3. The gasket or sealing ring must be inspected immediately prior to use.
4. Insert stud bolts and fit the nuts so they are finger tight, checking that there is an equal protrusion of stud bolt through each nut.
5. Stud bolt tightening shall be carried out in stages to predetermined sequence. Acceptable tightening sequences are shown in Figures D.1 and D.2. The sequences shown in Figure D.2 should be used until any flange misalignment is taken up.
6. Throughout the stud bolt tightening sequence, frequent checks shall be made to ensure parallel 'pull-up' of the flanges.
7. Final tightening should be carried out by torque measurement to the value given in Table D.1. To ensure its accuracy, the torque wrench should be calibrated regularly.
8. After final assembly of the flanges, the screw thread protruding beyond the nut faces must be protected against corrosion. The use of flange protectors should also be considered.

Figure D.1: Typical bolt tightening sequence



A tightening sequence similar to that shown in Figure D.2 is recommended for use until any angular misalignment is taken up. When flange faces are parallel the tightening sequence shown in Figure D.1 should be used.

**Figure D.2:** Typical bolt tightening sequence to take up angular misalignment



**Table D.1:** Bolting Torque

Bolt Diameter (inches)	Minimum Torque (Nm)	Max. Permitted Torque (Nm)
1/2	65	90
5/8	130	180
3/4	230	315
7/8	370	515
1	560	770
1-1/8	810	1150
1-1/4	1135	1625
1-1/2	2030	2925
1-5/8	2620	3805
1-3/4	3295	4785
1-7/8	4105	5960
2	5010	7325
2-1/2	10050	14840

**Notes:**

- 1 The recommended minimum torque figures given above are considered to be sufficient for normal purposes and take into account permitted misalignment between flanges.
2. If necessary, a torque greater than the recommended minimum may be used but the maximum permitted torque should not be exceeded.

# Appendix E

## Electric Heaters with Low Insulation Resistance (Megohms)

### **⚠ 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. Chromalox Field Service people are also available to assist as required at the equipment location. For any assistance, please contact Chromalox Service Department at 1-800-443-2640.

#### **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:**

The refractory material magnesium oxide (MgO) used in electric heating elements is very hygroscopic and may absorb moisture. This moisture can be absorbed from the humidity in the air during transit, storage, long down times or when exposed to a humid environment. The heater terminals do not have to be sprayed or immersed in water for this to occur although the problem is frequently caused by terminal housings being left open during installation allowing water and/or rain to enter the enclosure. Moisture enters the open ends of the element (terminals) as humidity in the air and per-

meates throughout the MgO. Typically this process occurs very slowly over time with most of the moisture initially concentrating in the end of the element near the terminal.

#### **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).

For units less than 1000 volts, 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.

For units greater than 1000 volts ("DirectConnect"), insulation resistance shall be measured at the operating voltage, but with direct current and within a tolerance  $\pm 25$  VDC. For example, a 4160 volt heater should be measured with 4160 volts direct current. Individual circuits shall be greater than 5 megaohm. If measuring individual elements, insulation resistance shall be greater than 20 gigaohm.

#### **Dry Out Procedures:**

Often the insulation resistance value of an unsealed heater element or an open terminal enclosure can cause a low reading, but it can recover quickly during the initial heat up. While low insulation resistance usually does not affect heater efficiency or life, it can cause serious electrical problems during initial startup. Extreme dampness requires the moisture to be removed from the elements prior to start up to prevent a possible dielectric failure.

Large flange heaters with multiple elements and/or very long elements on each circuit may have relatively low Megohm values due to the combined parallel insulation resistance of multiple elements. If you are unsure of the proper readings for your equipment, please contact the Chromalox Service Department at 1-800-443-2640.

If a heater or heater assembly has a low or questionable insulation resistance (Megohms) the recommended procedure is to contact the Chromalox Service Department for further instructions at 1-800-443-2640. If it is determined that the heater has an unacceptably low insulation resistance and cannot be easily repaired in the field, the Service Department may issue a material return authorization (MRA) for rework and dry out at the factory.

#### **Alternate Dry Out Procedures:**

If it is not practical to return the heater to the factory for rework, the insulation resistance of many heaters can usually be restored (dried out) in the field by using one or more of the following procedures. These procedures only apply to heaters and heating elements that are unsealed or only have simple moisture barriers on the element terminals (RTV, conformal coating, or silicone resin). Heaters with sealed terminals, such as epoxy or hermetic (glass to metal) seal cannot effectively be dried out in the field. Units will need to be returned to Chromalox for repair.

1. Drying Out an Installed Heater: Energize the heater at approximately 1/2 the rated voltage (1/4 Wattage). Operating the heater under these conditions produces enough heat in the elements to drive the moisture out while reducing the risk of overheating the equipment. However, even at 1/4 of the wattage it is possible to overheat and damage the equipment or the heated media. The temperatures of the element sheath material, heated media and associated process equipment must still be limited to safe values. Failure to limit sheath temperatures could permanently damage the elements and void the equipment warranty. If the heater has an over temp control or sensor, use this device to limit the operating temperature (sheath temperature) to safe limits during the dry out process. Continue the process until the heater circuits read 1.0 Megohm or higher.

**NOTE:** *If the heater has a phase angle SCR / Thyristor control, set the SCR / Thyristor controller manually for 1/2 on. This procedure will produce 1/4 of the wattage while limiting the peak voltage applied to the heater to approximately 1/2 of the rated voltage.*

**NOTE:** *Heater with standoff construction can not be dried using the low voltage method alone as the heat will not adequately travel through the standoff area. An alternative is to wrap the standoff area with a heated or welding blanket in combination with the lowered voltage. Ensure all equipment in the immediate area is rated for the drying temperatures.*

2. Procedure for Heaters that cannot be Dried Out in Place: Uninstall the heater. Remove the terminal enclosure, hardware, gaskets, wiring and any other devices that may be damaged by heat. Be mindful to also remove any lower temperature materials, such as plastic labels, terminal blocks, etc., that will melt at the drying temperatures. Heaters with non-removable housings shall have the covers and gaskets removed prior to baking. Bake the entire element or heater assembly in an oven set at approximately 300°F to 350°F (150°C to 175°C) for several hours, preferably overnight. Baking ovens that are large enough to accommodate large flange heaters may be found at local electric motor rewind shops.

#### **Maintaining Insulation Resistance:**

Normally a heater with an acceptable insulation resistance will continue to maintain its optimum insulation resistance if operated on a frequent or daily basis. Non-operating units may develop low insulation reading due to a variety of factors including high humidity environments, condensation, or rapid ambient temperature fluctuations. Moisture can not only be absorbed in heating elements, but also accumulate on bussing, terminals, and exposed wiring in the terminal housing.

To help prevent moisture ingress, seal opening(s) in the terminal housing and provide a dry nitrogen purge, instrument air purge, or heated air above the current dew point. Install the appropriate anti-condensation heater in the terminal enclosure to be used during non-operating periods.

# Appendix F

## Heater Element Replacement

### **⚠ WARNING**

*No operation involving the use of an open flame or other source of ignition shall be attempted until the condition has been made safe (gas free) by the control of the flammable material that may give rise to the risk. Electrical test equipment can constitute a hazard and shall not be used in the presence of a flammable material, unless specifically designed for the purpose and suitably certified.*

### **⚠ 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.**

Chromalox heating elements are designed and manufactured to provide a long trouble-free life and rarely fail if they are operating in the conditions for which they were designed. Heater designs that have welded or brazed elements can not be replaced on site. These will need to be sent to the Chromalox Service Department for proper bundle repair. Please contact the Chromalox Service Department at 1-800-443-2640.

Chromalox heating elements over 1000 volts ("Direct-Connect") will be factory installed by varying methods and may only be replaced with a qualified Chromalox field service technician. Please contact the Chromalox Service Department at 1-800-443-2640.

Chromalox heating elements under 1000 volts that have replaceable elements can be replaced on-site by qualified personnel. There are two styles of replaceable element design. Please refer to the proper section for removal and replacement.

## Replaceable 'U' Bend Elements

- a. Isolate the heater from electrical supply, together with the ancillary supplies to control devices.
- b. Unlock the lid of the flameproof enclosure and remove any bolting or screws to fully remove the cover.
- c. Disconnect all cabling from the heater terminal box.
- d. Unbolt and dismantle the busbars, then unscrew the element flameproof glands from the flameproof box base.
- e. Unbolt the stand-off nuts holding the terminal box to the flange or screwed head, and then remove the terminal box.
- f. Having drained the tank or vessel, remove the heater, taking care not to damage the baffles or heating elements.
- g. Remove the top nuts from the two welded fittings or couplings (using special tool Extended Reach Socket Spanner) securing the element needing replacement. This will enable the element to be pushed through the flange enough to expose the two bite olives.
- h. Cut through the element between each olive and the flange, enabling the element to be withdrawn back through the flange and baffle assembly.
- i. The new element should be checked electrically before fitting using two new olives and following the reverse procedure. Note that the internal sharp edge in the olive should go on first and ensure that the ends of the new element protrude through the flange by the same amount as the other elements.
- j. The top nuts should be tightened down finger tight, plus one and a quarter turns, which is equivalent to a torque of 35 foot pounds force (47.5Nm).
- k. The heater should be re-fitted using a new gasket. For flange heaters, the studbolt nuts must then be tightened uniformly and in a diametrically staggered pattern.
- l. Refit the terminal box, flameproof glands and busbars using the reverse procedure. The brass nuts holding the busbars to the element terminations should be tightened to 1.8 foot pounds force (2.5Nm). All flamepath threads should be lubricated with copper anti-seize compound.
- m. Refit the supply cabling to the heater terminal box and reconnect the thermal control devices where fitted.

- n. Lubricate the main flameproof box thread with copper based anti-seize compound and screw on the lid (fitted with its o-ring gasket) then lock with the M4 socket head cap screws. These should also be lubricated and fitted with their o-ring seals to maintain the standard of ingress protection.

## Withdrawable Cartridge Elements

- a. Isolate the heater from electrical supply, together with the ancillary supplies to control devices.
- b. Unlock the lid of the flameproof enclosure and remove any bolting or screws to remove cover.
- c. Disconnect all cabling from the heater terminal box.
- d. Unbolt and dismantle the busbars, then unscrew the element flameproof glands from the flameproof box base.
- e. Before the terminal box can be removed, it may be necessary to squeeze together the element terminals so that they will pass through the element holes in the base of the enclosure.
- f. Unbolt the stand-off nuts holding the terminal box to the flange, and then remove the terminal box.
- g. The slotted flameproof bush fitted to the end of the element pocket must be unscrewed using the necessary special tool.
- h. By gripping the sheath of the cartridge element, pull it from the pocket. Some force may be required to do this and it can be advantageous to rotate the element back and forth whilst effecting the withdrawal.

- i. The replacement element(s) should be checked electrically before fitting.
- j. Each element should be pushed into its pocket so as to protrude by the same amount as the others fitted to the heater. There is clearance at the bottom end of the pocket to allow for expansion of the element. Be sure that the terminals are correctly aligned for refitting the busbars.
- k. The slotted flameproof bush should now be replaced using Loctite 222 thread locking adhesive on the thread on the end of the pocket.
- l. Refit the terminal box and the element flameproof glands before carefully bending the terminal pins back to shape so that the busbars can be refitted. The brass nuts holding the busbars to the element terminations should be tightened to 0.74 foot pounds force (1.0 Nm). All flamepath threads should be lubricated with copper anti-seize compound.
- m. Refit the supply cabling to the heater terminal box and reconnect the thermal control devices where fitted.
- n. Lubricate the main flameproof box thread with copper based anti-seize compound and screw on the lid (fitted with its o-ring gasket) then lock with the M4 socket head cap screws. These should also be lubricated and fitted with their o-ring seals to maintain the standard of ingress protection.

# Appendix G

## Boiler Water Recommendations

Proper boiler operation requires appropriate water quality be maintained to prevent scale buildup on the heating elements and boiler chamber as well as preventing corrosion from acidic contaminants in the supply. Providing the proper water supply will help the unit deliver the highest efficiency possible, while decreasing the amount of downtime needed for inspections and cleaning.

Water treatment can vary based on based on steam pressure, application temperatures, and a variety of other operating conditions. Chromalox recommends supplying the unit with hot water at 140°F/60°C to minimize the heat-up time and conserve power. Colder water can be used but will result in a longer heater up time.

It is recommended to always use soft water with the following ASME general guidelines for water values and/or limits:

Total Hardness	0 to 0.3 parts per million as CaCO <sub>3</sub>
Iron	0.1 parts per million
Copper	0.05 parts per million
Silica	150 parts per million
Alkalinity	700 parts per million
Total Dissolved Solids	2200 to 2800 parts per million
Conductivity	7000 Micro Ohm s/cm
Oxygen	0 to 0.007 parts per million
pH	8.5 to 10.0

The recommendations account for the most common factors but care must be taken to address any other elements that may be present in the local water supply. Generally, scaling is caused by hard minerals and suspended metal oxides such as those from iron and copper. Corrosion is typically attributed to the presence of dissolved oxygen, acids, or dissolved sour gasses. Foaming can result from the presence of suspended solids/oils and high alkalinity.

In addition, water conditions may vary throughout the year and it is recommended to periodically verify and adjust the treatment process. It is recommended to enlist a reliable and recognized water treatment company to review the specific site conditions, regularly perform water analysis, and provide for a specific water treatment program.

Once your water treatment equipment is installed and your boiler is operational, efforts must continue to ensure conditions stay within an acceptable range. Typically, water treatment companies will establish a plan that involves frequent, if not daily, testing and appropriate equipment adjustment to maintain optimal conditions. This monitoring along with regular blowdowns and inspections per your boilers installation and operation manual can dramatically improve performance and system longevity.

**Sample**

**Date:**

**Record:**

<b>Recommended Substances</b>	<b>Supply</b>	<b>Feed</b>	<b>Condensate Return</b>	<b>Boiler Chamber 1</b>	<b>Boiler Chamber 2</b>	<b>Boiler Chamber 3</b>	<b>Any actions taken</b>
Dissolved Oxygen							
Total Iron (ppm Fe)							
Total Copper (ppm Cu)							
Total Hardness (ppm CaCO <sub>3</sub> )							
Silica (ppm SiO <sub>2</sub> )							
Total Alkalinity (ppm CaCO <sub>3</sub> )							
Specific Conductance (μohms/cm)							

Tested By: \_\_\_\_\_

Company: \_\_\_\_\_

Initials: \_\_\_\_\_

**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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