



# INSTALLATION, OPERATING & MAINTENANCE INSTRUCTIONS FOR CIRCULATION HEATERS

## WARNING

Carefully read and understand these instructions before installing equipment. Retain this document for future use.

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## GENERAL

Circulation Heaters are designed to provide years of trouble-free operation if properly installed and maintained. Please read and follow these instructions for installing and maintaining the heater.

Circulation Heaters are welded pressure vessels with inlet and outlet connections to allow fluid flow and heat transfer to a customer fluid. An Immersion Heater with tubular electric resistance elements is used as the heating source. It may be designed specifically for the circulation heater when identified on the product nameplate.

Vessels of 3" pipe and larger typically utilize immersion heaters with pipe flange mounting. Vessels of 2 1/2" pipe and smaller are typically constructed using pipe thread (screw plug) mounted immersion heaters.

Prior to installation, refer also to additional instruction manual(s) supplied for each immersion heater and for each component, control, or auxiliary device where additional field installation, operation and maintenance is required.

Where Industrial Control Panels are provided as integral with the Circulation Heater assembly, the end user is responsible to ensure all provided limit controls, level controls, flow controls or pressure controls operate as

necessary to maintain the safety and suitability of the installation.

A variety of designs and sizes are available with outlet temperatures up to 1200°F. Due to these high temperatures, the heater design features must be closely matched to the application.

The heating elements are available in various watt density ratings. Outlet temperature, watt density and flow velocities determine the element surface temperature. Life expectancy of the heating element is directly related to its surface temperature.

## CAUTION

Failure to follow recommendations could result in premature failure and/or serious equipment damage.

Temperature regulating devices, temperature limiting controls, low liquid level, or low flow controls are recommended for use with circulation heaters to control the heating process and safeguard the heater from excessive temperatures that can cause damage. One or more factory installed sheath high temperature sensors are typically provided with the immersion heater near the outlet.

Make sure that it is interconnected in addition to the other required controls to de-energize the heater prior to achieving the maximum sheath temperature when the maximum temperatures are defined on the circulation heater nameplate.

Also, on liquid systems, damage to fluid could occur if the heater is allowed to exceed the maximum fluid film temperature recommended by the manufacturer.

**It is the ultimate responsibility of the user to verify that the construction materials being provided in the Circulation Heater are suitable for use with the process fluid. Specifically, corrosion issues must be reviewed.**

Circulation Heaters can be specially designed for use in hazardous areas as specified in Article 500 through 516 of the National Electrical Code, Section 18 the Canadian Electric Code and/or UL, CSA, EN or IEC 60079. Refer to the heater nameplate or Circulation Heater Application Data for classification of the heater provided.

See section below labeled Hazardous Areas for specific requirements.

## INSTALLATION

### CAUTION

Installation shall be performed by qualified personnel familiar with the National Electrical Code and/or Canadian Electric Code and all local codes and standards. The installation must be effectively grounded to eliminate shock hazard. It is the responsibility of the installer to verify the safety and suitability of the installation.

### WARNING

DO NOT install heaters in an atmosphere containing combustible gases, vapors, dusts, or fibers unless properly marked as suitable for the condition. Refer to section below for special instructions for Hazardous Areas.

### Site Selection

Review the Environmental NEMA, TYPE or IP rating of the heater noted on the Circulation Heater Nameplate or Application Data. Do not install a heater in an area not consistent with its rating.

Allow sufficient free space around circulation heater installation site. Work space for immersion heater or electrical panel maintenance should be at least three feet in front and on either side. The minimum pull space for the Immersion Heater for installation or removal from the vessel should be at least equal to length between the inlet and outlet nozzle plus two feet.

### Handling and Storage

Care must be taken to avoid damage to the heater during storage and handling. Most heaters are provided from the factory with insulation. The insulation is covered with light gauge sheet metal jacketing which can be easily damaged.

Large horizontal vessels are normally provided with lifting lugs to assist with movement.

Protect the heater from weather damage during storage if shipping packaging is not sealed. It is recommended to store the heater in a cool dry area to help prevent the heating elements from drawing moisture.

Electric heaters are capable of developing high temperatures. Therefore, extreme care should be taken to avoid mounting heaters in an atmosphere containing combustible gases, vapors, dusts, or fibers unless properly marked as suitable for the condition.

### Heater Orientation

This heater has been constructed for a specific mounting orientation. It must be mounted in this manner, to prevent improper operation or damage. Refer to the Circulation Heater Nameplate or Application Data for the correct mounting and/or figure number when applicable.

The location selected must be capable of safely supporting the heater's weight plus the fluid weight.

### Mechanical Instructions

### WARNING

Potentially lethal voltages are present in this equipment. Lock out the branch circuit disconnect switch and tag the circuit "Out for Maintenance" before installing this heater.

Mount the heater with structural quality bolts matching the holes provided in the mounting feet. When Figure 33 (Vertical Floor Mounting) is provided, the mounting channels must be drilled by the user. Where slotted holes are provided, install the bolts to the outside of the slots to allow the heater to thermally expand. Mount on a smooth surface. Do not use lock washers, and apply minimum torque necessary to contain the equipment but not prevent expansion on bolts in slotted holes.

The heater should be mounted plumb horizontally and vertically to assure proper flow and avoid draining or venting problems.

Pipe the incoming fluid connection to the nipple or mating flange marked "Inlet". Pipe the hot outgoing connection from the nipple or mating flange marked "Outlet". The inlet and outlet references on the attached standard mounting figures are shown for general reference. The actual markings on the heater may be reversed. Do not operate the heater with a flow direction different from the nozzle markings.

The heater may include instruments that will not operate properly if the flow direction is reversed or incorrect.

Note that customer piping must be supported to minimize nozzle loading on the heater inlet and outlet. Consider using expansion joints or flex hoses to allow connections at the slotted end of the heater to move with the heater. Failure to do so may result in damage or leaking of the heater vessel.

Thermal expansion of the heater can be approximated as:

$$\begin{matrix} \text{Nozzle to} \\ \text{Nozzle length} \\ \text{(Inches)} \end{matrix} \times .00001 \times \left[ \begin{matrix} \text{Operating} \\ \text{Temp (}^\circ\text{F)} \end{matrix} - 70^\circ\text{F} \right]$$

With liquid systems, the customer piping must be routed and piped to ensure proper venting of the heater. Trapped pockets of air will result in improper operation and potential heater damage. High points must be vented and low points drained to allow equipment maintenance. A low point drain plug is provided in the heater to allow draining.

The heater is designed for operation for fluids with certain inlet and outlet sizes. Customer piping size should match the inlet/outlet of the heater to meet the flow requirements unless otherwise noted.

**If the heater is installed in a pressurized system, a relief valve must be installed at the outlet of the heater.**

A pressure relief valve may be sufficient, unless local codes require a pressure-temperature relief valve.

- The opening pressure setting of the device shall not be higher than the design pressure marked on the pressure vessel.
- The valve must be sized to relieve at a rate equal to the rate that the heater can thermally expand fluid trapped in the heater due to downstream blockage.
- It shall be connected as close as possible to the pressure vessel heater outlet or parts of the system that it is intended to protect.

- It shall be installed so it is readily accessible for inspection and repair and cannot be readily rendered inoperative.
- It shall have discharge opening located and directed to prevent the risk of scalding, and to prevent the deposit of fluid on bare live parts, on insulation or components affected by the fluid.

DO NOT place a shutoff of any type between the pressure relief valve and the heater, or on discharge pipes between the relief valve and the atmosphere.

On heaters with flanged type inlet/outlets, take care to prevent scratching the flange faces. Select a gasket rated for the application service and temperature and pressure. Clean and flush or purge the system prior to initial startup to remove contamination generated during fabrication. Provide filters or strainers on liquid systems as required.

### Insulation

#### **WARNING**

Some surfaces of the heater vessel or Immersion Heater may be extremely hot. Avoid contact to prevent personnel injury or fire.

Insulation is typically provided on the heater shell. Handle the heater with special care to avoid compromising the integrity of the metal jacket covering the insulation. The customer may prefer to add additional insulation to the bottom head and nozzles of the vessel for added personnel safety and energy conservation.

#### **WARNING**

On heaters with extended terminal boxes and exposed element tubes, do not insulate above the Immersion Heater fitting unless approved by the factory. Dangerous over-heating of the terminal box, internal components or terminal box wiring could result.

### Electrical Instructions

The potentially high operating and ambient temperatures of Circulation Heaters require field wiring to the heater to be carefully matched to the application to avoid serious injury or damage to the equipment. The wiring must be de-rated for the expected terminal box temperature.

The recommended minimum size and type of incoming field wiring is indicated on the Circulation Heater Nameplate or Application Data and will depend upon the heater terminal box temperature, heater current draw per conductor, number of conductors per conduit, and wire insulation rating

as described in publications such as the National Electrical Code.

The terminal box temperature is a function of the orientation, enclosure type and process fluid temperature at the terminal box end of the heater. Extended terminal boxes are typically provided on heaters where enclosure service temperatures may otherwise be exceeded or to allow moisture seals on the heating elements, or to avoid costly high temperature wire.

Field supplied conductors must be sized for at least 125% of the circuit current.

To calculate the circuit current (in amps):

$$\text{Single phase Line current} = \frac{\text{KW} \times 1000}{\text{Line Voltage}}$$

$$\text{Three phase Line current} = \frac{\text{KW} \times 1000}{1.732 \times \text{Line Voltage}}$$

Wiring to the heater should be permanently installed in metallic or non-metallic electrical grade conduit or cable in accordance with all applicable electrical codes, and should include a grounding conductor if non-metallic conduit is used.

Field supply wiring must be rated for 600Vac. Use copper conductors.

The electrical installation should include a service disconnect switch in sight of the heater as well as branch circuit over-current protection and over-temperature protection (if not provided with the heater).

Refer to the wiring diagram included with this instruction sheet for wiring recommendations. An additional copy is provided inside the heater terminal box.

Where RTD, thermocouple or other type of sensor extension wire is required between the heater and control panel, verify it is connected with proper polarity as shown on the wiring diagram. Failure to do so may result in an uncontrolled heater. Refer to the wiring diagram for the required wire type. Shielded wire is recommended to reduce signal interference.

**WARNING**  
Retighten all electrical connections that may have loosened during shipment. Failure to do so may result in damage to the heater or risk of fire.

Confirm all unused conduit holes in the terminal box are sealed with plugs suitable for the heater environment.

Attach a ground conductor to the stud located in the heater terminal box or when supplied to the external enclosure ground pad or by other appropriate means per NEC Article 250.

Be sure the terminal box cover is properly installed at all times to ensure personnel protection. Also, contaminants can create leakage, (shock) hazards, permanent heater damage or failure and should be avoided.

It is recommended to perform an insulation resistance test prior to energizing the equipment. If the value is less than 1 Meg Ohm using a 500Vdc or similar tester, refer to Maintenance and Troubleshooting sections.

For installations in the presence of combustible gases, vapors, dusts or fibers refer to the section "Hazardous Locations"

## OPERATION

**WARNING**  
**DO NOT TURN ON HEATING ELEMENTS UNTIL TANK IS COMPLETELY FULL OF FLUID.**  
Permanent damage may result if elements are energized when heater is dry.

**WARNING**  
This heater is designed to operate only up to the maximum pressure and temperature as shown on the nameplate.

To operate this heater, ensure the tank is completely filled with fluid, start circulating pump, and energize the main

supply disconnect. Set the controlling device to the desired temperature.

During initial heating, it is recommended to slowly ramp up the process set point and inspect the heating system for problems.

**DO NOT** operate heaters at voltages in excess of that marked on the heater. Excess voltage can result in elevated temperatures, shorten heater life or overload the branch circuit wiring.

**DO NOT** operate heaters at sheath temperatures higher than the recommended maximum for the sheath material. Excess temperatures can cause premature failure.

Generally, sheath materials are limited to the following absolute maximum temperatures.

Sheath Material	Maximum Sheath Temperature
Copper	350° F (177° C)
Steel	750° F (399° C)
Stainless Steel (304,316,321)	1400° F (760° C)
Incoloy (800 840)	1700° F (927° C)

\*for other materials refer to UL1030 or CSA C22.2 No. 72

**DO NOT** operate heaters with inadequate flow rates or flow rates where sheath or process temperature may:

Exceed the fluid film temperature value.

Exceed limit values marked on data plate(s).

Reduced flow can shorten heater life, cause nuisance tripping of thermal safeties, or potentially exceed vessel shell design temperatures.

DO NOT place the heater in service until all safety interlocks are tested. During initial startup ensure the safety interlocks will properly de-energize the heater in the event of system malfunctions or when the heater elements are not fully immersed in the process fluid. After 10 days of operation, retighten all electrical connections.

**On Flanged Immersion heaters, re-tighten heater flange bolts after the heater has completed one or two heating cycles.**

For operation in the presence of combustible gases, vapors, dusts or fibers refer to the section “Hazardous Locations”

## MAINTENANCE

### CAUTION

Troubleshooting and repairs should only be attempted by qualified maintenance personnel.

Periodically check all electrical connections, including field and factory-made connections for tightness, and all wiring for deterioration at least once a year.

Periodically inspect for leakage and retighten Immersion Heater flange bolts when required.

Inspect the terminal enclosure and conduit connections for evidence of water leaks or moisture collection. Tighten connections as required. Clean up any corrosion. Do not continue using a heater with signs of damage.

Where the heater is installed in cold climates, consider safety precautions to prevent damage due to freezing fluid when the heater is not in service.

Where buildup of solids on the heating elements or significant corrosion is expected, periodically remove the Immersion Heater to inspect the vessel and heating elements.

If the heater is removed, it is recommended to replace the flange gasket. Do not continue using a heater with signs of damage. Before removing, note the orientation of the flange or pipe plug relative to the vessel.

**Place a reference mark on the vessel and Immersion Heater or use other methods, such as drawing a sketch showing the conduit hub orientation, to ensure proper orientation when re-installing.**

### CAUTION

Immersion Heaters with multiple circuits, cross-baffles or over-temperature thermocouples are specifically oriented to match the vessel. Do not rotate the Immersion Heater without consulting with the factory.

For operation in the presence of combustible gases, vapors, dusts or fibers refer to the section “Hazardous Locations”

## TROUBLESHOOTING

### CAUTION

Troubleshooting and repair should only be attempted by qualified maintenance personnel.

The nature of the magnesium oxide used to electrically isolate the nickel chromium resistance wire in the heating elements is such that over a long period of storage, they will absorb considerable moisture from the atmosphere unless hermetically sealed. It is recommended to perform an insulation resistance test prior to energizing the equipment. If the value is less than 1 Meg Ohm using a 500Vdc or

similar tester, care must be taken to dry out the heater to prevent failure. It is recommended that the elements be turned on at a reduced voltage at first to boil off the moisture. Meg Ohm readings may drop initially after a few minutes of operation, indicating moisture being forced out of the elements. The terminal enclosure lid should be left open during this period to allow the moisture to escape.

If the heater has a manual-reset high limit thermostat, be sure that the reset button is pressed in.

The heating elements are not field-repairable. The only recommended field repairs are to remove and replace the faulty Immersion Heater, or to return the heater to the factory for repair.

If reduced heat output is suspected, verify the condition of the heating elements by using an ammeter to check the current draw of each input line. All input lines should draw approximately equal current, which should agree with nameplate rating. If they do not, one or more of the heating elements could be damaged.

## HAZARDOUS AREAS

(where applicable)

### WARNING – Explosion Hazard

Installation must be performed by qualified personnel familiar with the National Electrical Code and/or Canadian Electric Code, and/or IEC 60079 derived standards and all local codes or standards regarding equipment for use in the presence of combustible gases, vapors, dusts or fibers. It is the responsibility of the installer to verify the safety and suitability of the installation.

Per Article 500-516 of the National Electrical Code and Section 18 of the Canadian Electric Code, a hazardous area is defined by a “Class”, “Division”, “Group”, and “Temperature Code”.

Typical markings on the circulation heater may include the following North American approval designations:



Class I, Divisions 1 & 2, Groups B and/or C & D  
Class II, Division 1, Groups E, F, & G

Per standards derived from IEC 60079 from agencies such as (UL, CSA) for North America, or (EN, IEC) for international communities a hazardous area is defined by various explosion protection schemes using typical identifiers or symbols such as ATEX, IECEx and/or related symbols. The Schemes define Equipment Types or Equipment Categories specific for certain conditions. The hazardous area is further defined by these schemes using “Ex”, followed by a “Protection Method”, followed by a level (a,b, or c) followed by Gas Group, followed by either a Temperature Class or Surface temperature followed by the Type of substance followed by the overall protection level (a,b or c)

Typical markings on the circulation heater may include the following International approval designations:

CE 0539 Ex II 2 G D  
SIRA 19ATEX1174 X

IECEx CSA 19.0020 X  
Ex db IIB+H<sub>2</sub> T1-T6, Tx°C Gb  
Ex Zone 1  
Ex tb IIIC Tx°C Db  
Ex Zone 21  
IP66  
Ambient: -60°C < Ta < 60°C

NEVER operate the heater in the presence of combustible gases, vapors, dusts or fibers unless the heater and each installed component is specifically marked for the hazardous location or where the marking provided have been determined to meet all requirements of the hazardous location.

NEVER operate the heater in an atmosphere with an ignition code temperature LOWER THAN the nameplate rating. The user must determine the actual area classification.

Special design considerations for electric circulation heaters used in hazardous locations:

1. Locate all electrical connections in an appropriate enclosure.
2. Prevent surface temperatures of the heater from exceeding the design ignition temperature.

A hazardous area heater must be powered and controlled by a heater control panel designed to provide necessary over-temperature, fluid level, or fluid flow rate safety interlocks to ensure compliance with approvals. The control panel may be located in the hazardous area or it may be located in an adjacent non-hazardous area with interconnection methods as described in the applicable national or local regulations. Consult the factory if

assistance is required to properly control and protect the heater.

Never apply power to a heater in a hazardous atmosphere unless all terminal box covers are properly installed. Where cover bolts are required all cover bolts shall be torqued as described with each component approval.

**WARNING - Risk of Explosion**

Operating the heater at a voltage higher than the nameplate value may result in elevated temperatures and amperage above the design ratings.

All conduits entering the heater terminal box must be supplied with a cable or conduit seal as required by the applicable electrical code. Each conduit or cable fitting shall be sealed as marked on each component.

**Where components with hazardous ratings require direct field wiring during equipment installation, the specific instructions for each component must also be reviewed during equipment installation and prior to operation.** If on-going maintenance is required it should be incorporated into the equipment maintenance schedule.

Any unused openings must be properly sealed with a suitable, blanking element or pipe plug. Follow the applicable hazardous code requirements for conduit in the hazardous area such as the requirement for Rigid Conduit.

To ensure proper flamepath, all NPT threaded conduits must use rated fittings and be tight, with a minimum of 5 good threads engaged or as otherwise specified by the national or local codes or standards.

To ensure proper flamepath for any supplied metric or straight threads such as threads with class of fit 6g6H per ISO-965-1 and ISO965-3 a minimum of 8 good threads must be engaged or as otherwise specified by the national or local codes or standards.

**WARNING - Risk of Explosion**

All threaded or machined metal-to metal flamepath surfaces on terminal boxes must be carefully handled to prevent scratches, nicks or gouges which may void the explosion-proof or flameproof rating.

Gaskets and/or O-rings supplied as integral to the hazardous terminal boxes and especially for locations in the presence of combustible dust are required to maintain the proper hazardous or environmental ratings. Replacement components such as a Cover O-Ring or Cover Gasket must be coordinated with the factory.

For equipment installed in hazardous locations in the presence of combustible dust, the paint used on the Immersion Heater terminal box under certain extreme cases may generate an ignition-capable level of electrostatic charge. If possible for equipment in the presence of combustible dust, provide installation in a location where the environmental humidity is controlled to minimize the generation of static electricity. Use only a damp cloth to clean the enclosure of excess dust.

Heaters used to heat explosive fluids such as methane at a temperature above their ignition temperature must remain free of oxygen.

**WARNING - Risk of Explosion**

The heated fluid surrounding the tubular elements must be classified as non-hazardous or not capable of ignition during operation. Operating the heater with fluids other than what is indicated on the nameplate may result in heater failure and void the explosion-proof or flameproof rating.

**WARNING - Risk of Explosion**

The installation must include the provision of an approved liquid level control and/or temperature limiting control and/or pressure control which will reliably de-energize the heater in the event of system malfunctions or when the heater elements are not fully immersed in the process fluid temperature limit controls, nameplate value may result in elevated temperatures and amperage above the design ratings.

Proper grounding of equipment in hazardous areas is critical to eliminate potential sources of sparking. Refer to national or local codes and standards as required.

Replacement of electrical components should only be done by authorized personnel familiar with the requirements of maintaining electrical equipment in an explosion-hazard area.

Fasteners supplied with flameproof or explosionproof hazardous enclosures are selected with adequate strength to contain the extreme pressures which may be generated inside the enclosure. Refer to Immersion heater instructions or coordinate with the factory prior to replacing any cover hardware.

**WARNING - Risk of Explosion**

After De-energizing all devices in the Circulation Heater assembly allow at least 90 minutes before opening the Immersion Heater cover to allow internal hot spots to cool.

# STANDARD CIRCULATION HEATER MOUNTING OPTIONS

