



OPERATION AND  
SERVICE GUIDE  
O-1650  
DECEMBER 1996

# INSTALLATION & MAINTENANCE INFORMATION FOR ELECTRIC IMMERSION HEATERS

*Refers to Bulletin A-102*

F.O.B. Northbrook, Illinois



**SERFILCO<sup>®</sup>, LTD.**

2900 MacArthur Blvd. 847-509-2900  
Northbrook, IL 60062-2005 U.S.A. 800-323-5431  
e-mail: sales@serfilco.com FAX: 847-559-1995  
www.serfilco.com

# CONTENTS

		Page
SECTION I.	Inspection Procedures.....	3
SECTION II.	Heater Installation Procedures.....	3
	I.    Quartz Heaters.....	4
	Installation Instructions for Flexible Non-Metallic Conduit Connectors.....	4
	Illustration of a Typical Heater Installation in a Process Tank.....	5
	General Wiring Instructions.....	6
	II.   Electric Screwplug Heaters.....	7-8
	Wiring.....	8
	III.  Flanged Heaters.....	9
	IV.  Flex Riser for Teflon Heaters.....	9
	V.   Flex Riser for Metal L-Shaped Heaters.....	10-11
	VI.  Heating Coils.....	12
	VII. Cooling Coils.....	13
SECTION III.	Operation and Maintenance.....	14
	I.    General Procedures.....	14
	II.   Overtemperature Protectors.....	15
	PI., PQI. & PT-I. Protectors for Metal, Quartz & Teflon Heaters.....	15-16
	PII. & PQII. Resettable Protectors for Metal and Quartz Heaters.....	17
	PTII. Resettable Protectors for Teflon Heaters.....	18
	PIII. Resettable Protector for Teflon Heaters.....	19-20
	Troubleshooting.....	20-21
	Conversion of PIIIA Board for PI./PII. or PT-I./PT-II. Operation.....	21
	Converted PIIIA Board Tests.....	22
	PIII Conversions with Wired Enable Terminals.....	22
SECTION IV.	Immersion Heater Solution Guide.....	23-24
SECTION V.	ATTENTION/CAUTION.....	25

## SECTION I.

### INSPECTION PROCEDURES

Once you have received your order, please check the following items carefully.

- Is the equipment received the correct model?
- Has there been any damage which occurred during shipment?
- If multiple heaters were ordered, is the shipment complete?

If the shipment is not what you ordered, or if the order was not received in its entirety, please contact the factory to correct any problems. **Any damage which occurred during shipment must be noted upon receipt and immediately brought to the attention of the delivering carrier and a claim should be filed.**

#### **CAUTION:**

*Extreme care should be taken in the unpacking and handling of all heaters. Heaters that are fabricated with a Teflon® sheathing can easily be nicked or damaged with a knife or razor. Damage to the Teflon® sheathing will result in premature failure.*

## SECTION II.

### HEATER INSTALLATION PROCEDURES

***WARNING: Hazard of electrical shock. Disconnect all power before installation. Customers must install adequate controls and safety devices with their electric heating equipment. Protective clothing and eye protection should be worn near any hot or corrosive fluids.***

Prior to installation verify the following:

- a. Line voltage agrees with nameplate heater voltage.
- b. Correctly sized electrical service is provided (a fused disconnect or circuit breaker of sufficient capacity is provided).
- c. All equipment is properly grounded.
- d. Heater sheath material is compatible with solution to be heated. (See Section IV.)
- e. The tank is equipped with a low liquid level shut-off device.
- f. A temperature controller (thermostat) with proper amperage rating is provided.
- g. The temperature controller contains the necessary circuitry to include the heater's Protector overtemperature system if applicable, and the low liquid level cut-off.

When handling the heater, do not bend or stress the element. Attempts to support the heater weight by using the heating elements may result in element damage.

**ELECTRIC IMMERSION HEATERS ARE COMPONENTS USED IN  
CONJUNCTION WITH OTHER DEVICES AND INSTALLED  
IN PROCESS HEATING SYSTEMS.**

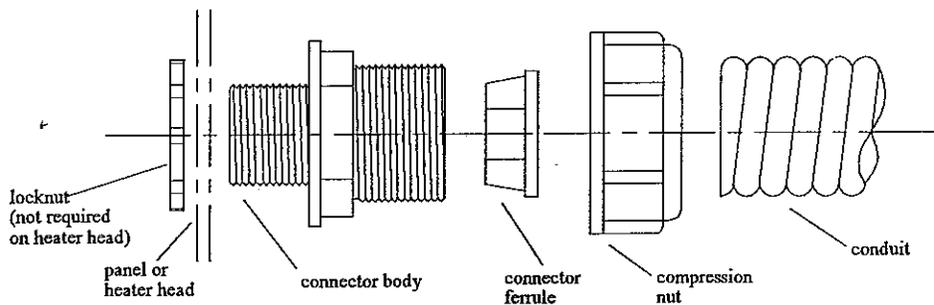
In dipping operations where parts pass over or near the heater junction box, additional protection such as drip shields and guards should be provided.

**WARNING:** Always mount the heater in the tank so that the liquid level will cover the effective heated portion of the element. If the elements are not properly submerged they will overheat, damaging the elements, posing a fire hazard.

## I. Quartz Heaters

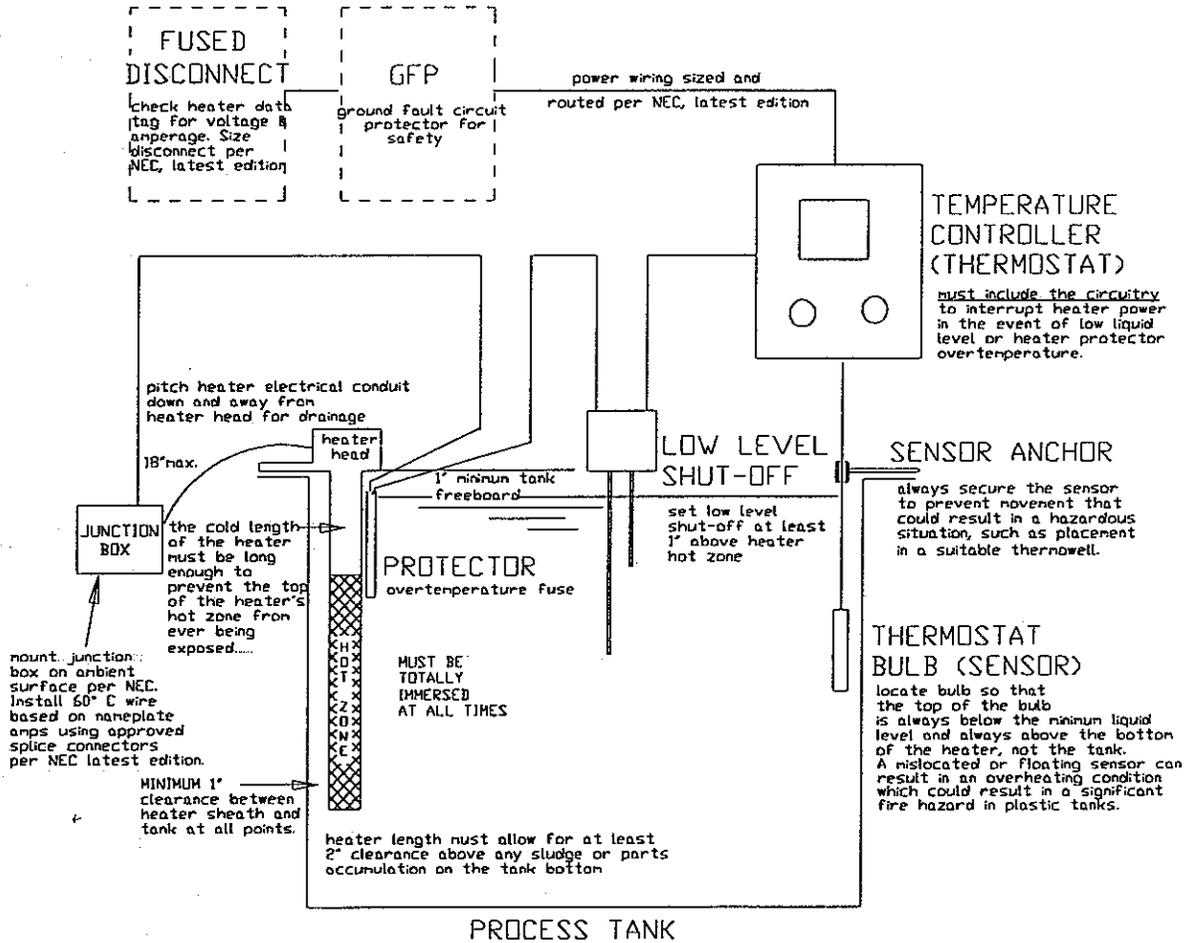
1. Quartz tubes are very fragile and require care when handling and assembling.
2. Remove the quartz heater head cover by carefully unscrewing in a counterclockwise direction.
3. Tilt the quartz tube slightly toward you and slowly insert the heating element assembly until seated.
4. Route the element wires through the conduit opening in the quartz heater's head.
5. Install the quartz heater head cover by screwing it in a clockwise direction until it's tight.
6. When installing flexible conduit, connector ferrule must be properly placed to insure liquid-tight operation. See below.

### INSTALLATION INSTRUCTIONS FOR FLEXIBLE NON-METALLIC CONDUIT CONNECTORS



1. Cut conduit end square.
2. Apply compression nut over conduit.
3. Apply connector ferrule over conduit.
4. Insert conduit, with nut and ferrule, into the connector body interior.
5. Thread or slip the connector ferrule along the conduit until seated against the connector body.
6. Engage the compression nut onto the connector body threads and **HAND TIGHTEN** firmly.
7. Insert this assembly into the heater head on a 7/8" diameter panel box opening.
8. Secure the assembled body into the panel or box using the locknut.

# ILLUSTRATION OF A TYPICAL HEATER INSTALLATION IN A PROCESS TANK



**Heaters should not contact anodes, cathodes or any electrified portions of the tank.**

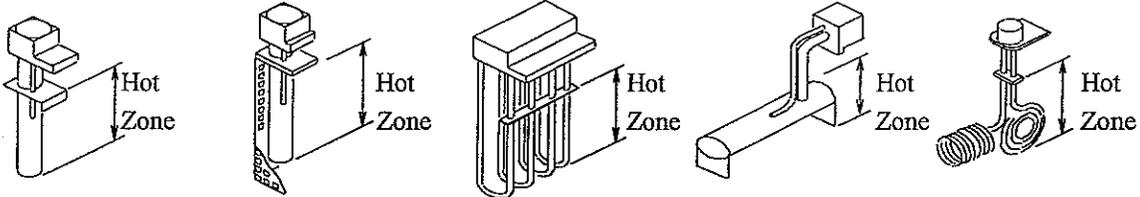
**Isolate heaters from any electrified source.**

**Connect all green heater ground leads to building ground**

**(or rectifier ground, if present, to prevent voltage potential difference.)**

## GENERAL WIRING INSTRUCTIONS

IDENTIFY YOUR HEATER STYLE AND PROTECTOR SERIES USING THE FOLLOWING ILLUSTRATIONS AND THE ENCLOSED CATALOG SHEET:



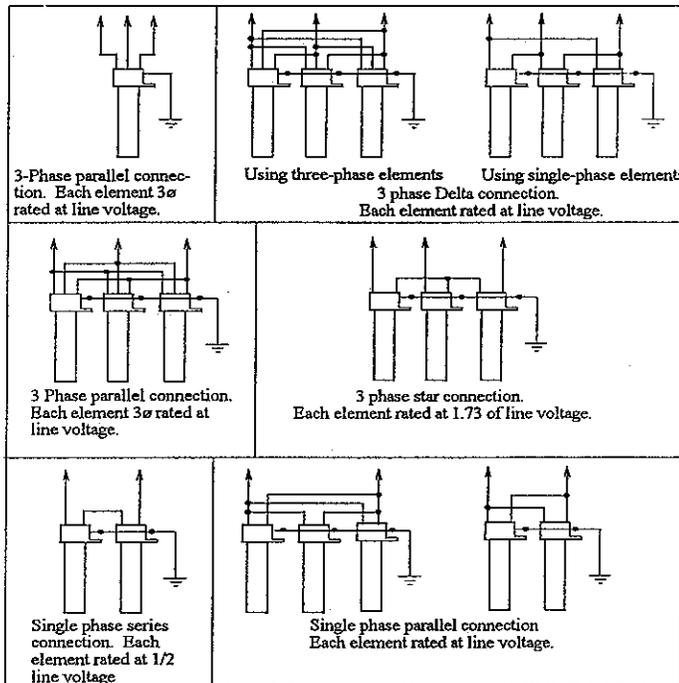
**Metal Heaters**  
PI or PII  
protectors

**Quartz Heaters**  
PQI or PQII  
protectors

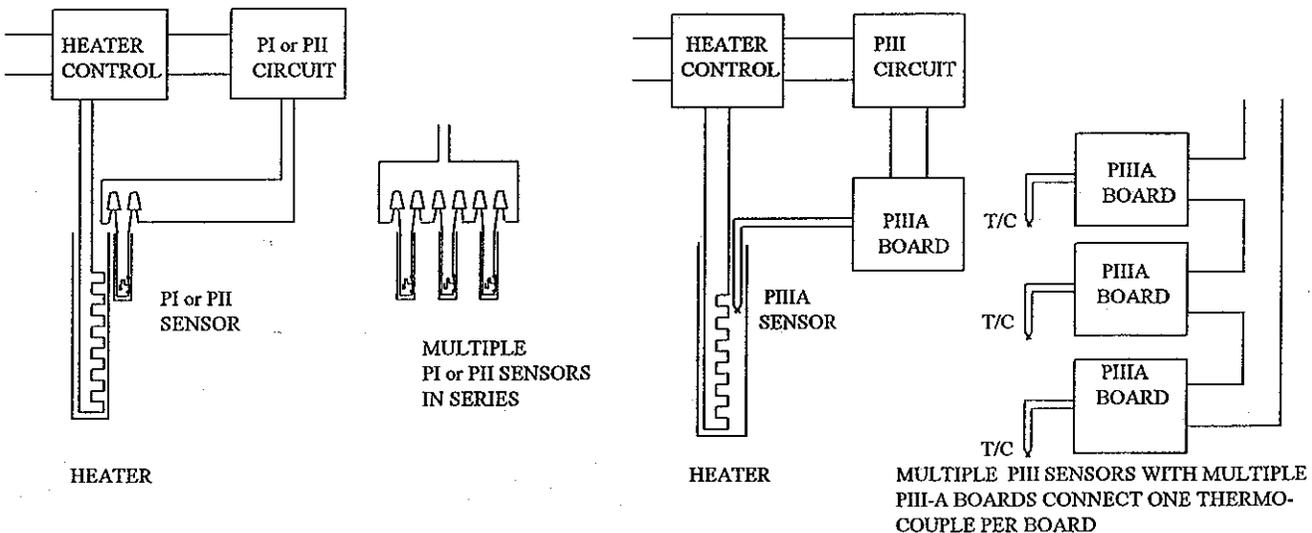
**6/9 HX/HIS**  
PI, PII or PIII  
protectors

**Metal L-shaped Heaters**  
PLI or PLII  
protectors

**Teflon Heaters**  
PTI, PTII or PIII  
protectors



Connect power wires to terminals provided in the temperature controller. Refer to the following illustrations to assist in wiring multiple heater Protector thermal fuses in a single installation.



## II. Electric Screwplug Heaters

Do not operate the electric screwplug heater in sludge. Operation under these conditions will cause a premature failure of the elements and can pose a fire hazard. Provide a 2" clearance between maximum sludge depth and the bottom of the heater.

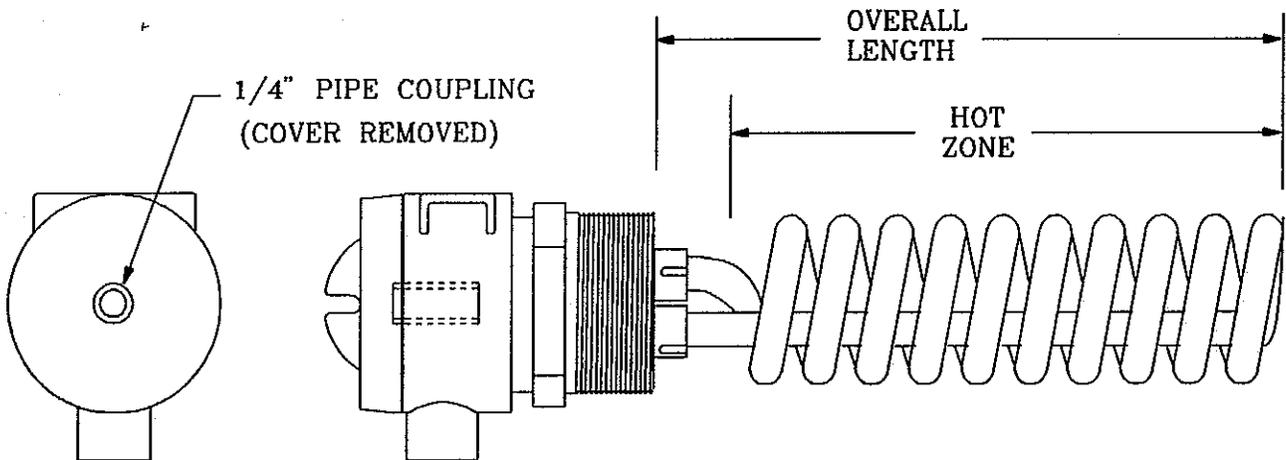
In dipping operations where parts pass over or near the heater head, an additional protection such as drip shields and guards should be provided.

When installing an electric screwplug heater, inspect the female threads of the pipe port to make certain the threads are clean and in good condition, making any necessary repairs prior to installation. Carefully apply several wraps of Teflon® thread seal tape to the male threads on the heater. When applying the tape, wrap the tape in a counterclockwise direction so that when the unit is threaded in, the tape tightens and does not unwrap.

When installing Teflon® heaters be careful not to drag the heaters across the female threads in the tank fitting. In doing so there is a chance of damaging the Teflon® sheath causing premature heater failure. Place a piece of cardboard or a sheet of plastic on the female threads and remove it as the head of the Teflon® screwplug approaches the tank wall.

Use **EXTREME CAUTION** while engaging the threads of the plug, these threads are made of PVDF plastic and if cross threaded will not permit a proper seal, resulting in a leak.

Once properly engaged, securely tighten using a tight fitting fixed jaw wrench. (Destruction of heater hex nut may make future removal impossible.)



With the Teflon® heater installed into the vessel, the junction box can be rotated up to 180 degrees to allow for easy wiring.

When mounting Teflon® screwplugs, remove the junction box cover on the heater and locate the 1/4" pipe coupling. The pipe coupling is designed to assist in the mounting of units when installed horizontally. Use a section of 1/4" pipe threaded into the coupling to provide leverage when threading the heater into the vessel. See drawing on the previous page.

Note: Standard Heater Junction Box housings are designed for indoor service only. Outside installations require optional moisture resistant housing.

**LOW MEGOHMS CONDITION:** The insulation material in metal screwplug heaters may absorb some moisture during shipping, after long periods of storage, or when subjected to a humid environment. This can result in a low insulation resistance, in which case the heater will not pass a hi-pot or megger test (this does not apply to epoxy sealed units). This condition can be corrected by removing the terminal hardware and baking the heater in an oven at 350-500F (177-260C) for 3-4 hours. If an oven is not available, an alternate method is to energize the heater at half voltage. The first procedure is preferred and particularly recommended if the heater has long cold ends and/or low watt density. When unsure about the correct procedure, consult the factory. **Do not bake any heater with plastic junction boxes or Teflon® screwplug heaters.**

## ***WIRING***

1. Electrical service to heater must be sized and installed in accordance with the latest edition of the National Electrical Code and with applicable local codes.
2. Install an adequately sized ground. Verify ground path impedance.
3. To keep corrosive vapors and liquids out of the heater junction box, the electrical wiring to heater should be contained in rigid conduit or watertight flexible conduit. Pitch electrical conduit down and away from heater junction box for condensate drainage.
4. If flexible cord is used, watertight strain relief connectors should be used for entry of cord into the heater junction box.

**Outdoor applications require optional moisture resistant housing,  
liquid-tight conduit and connections.**

Typical diagrams for wiring configurations on the screwplug and flanged heaters will be shipped as per each application. If any questions arise in the wiring of these heaters, consult the factory for technical assistance.

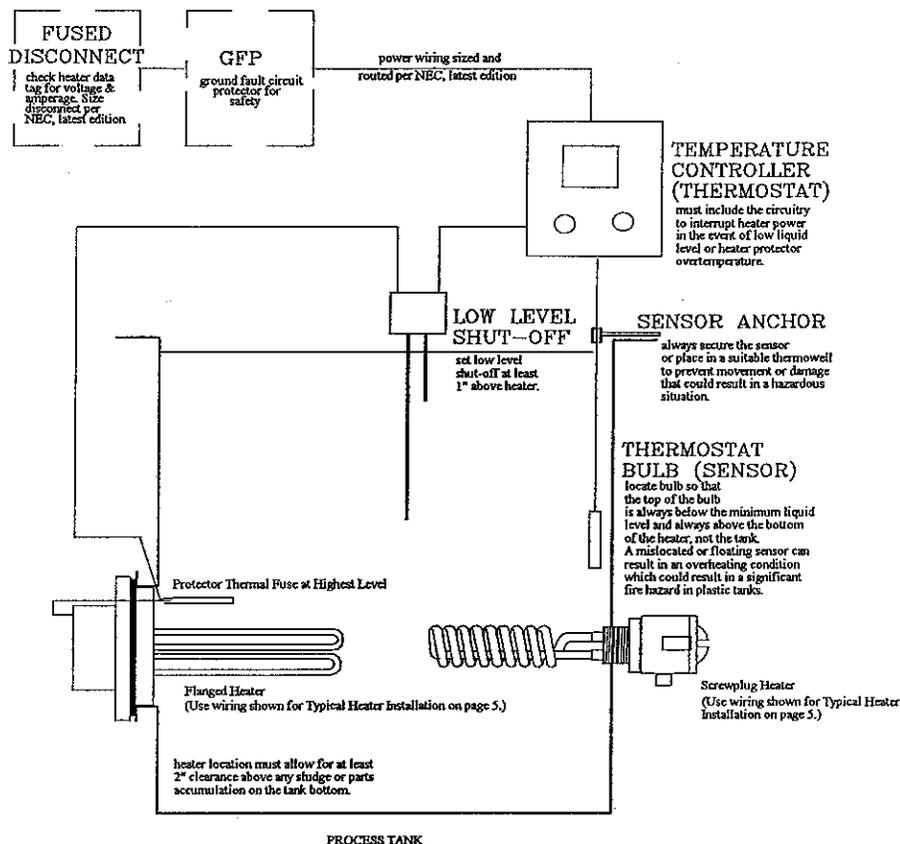
### III. Flanged Heaters

When mounting flanged heaters, the flange gasket surfaces must be suitable for the intended gasket and must be clean and dry before the gasket is seated. Always tighten flange bolting in an alternating diagonal sequence.

#### DANGER

HEATERS ARE CAPABLE OF DEVELOPING HIGH TEMPERATURES AND WILL IGNITE MANY PLASTIC TANKS SUCH AS POLYPROPYLENE AND POLYETHYLENE.

AVOID INSTALLATION OF HEATERS IN THE PROXIMITY OF COMBUSTIBLE MATERIALS.



**Heaters should not contact anodes, cathodes or any electrified portions of the tank.**

**Isolate heaters from any electrified source.**

**Connect all green heater ground leads to building ground  
(or rectifier ground, if present, to prevent voltage potential difference.)**

### IV. Flex Riser for Teflon Heaters

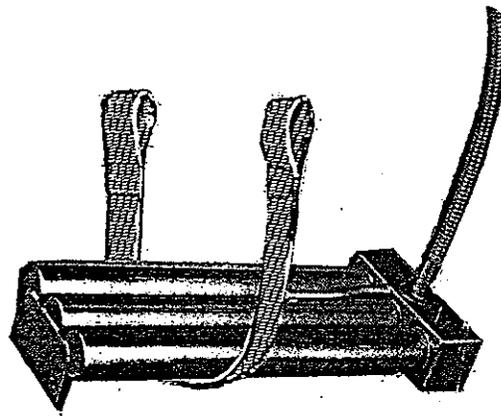
All teflon heaters provided with either flexible leads or potted lead configurations require sealing of open ends when installed. Failure to seal ends may allow moisture and corrosive vapors to enter the heating element causing premature failure. Recommended sealing methods include properly sized compression fittings, cord grip fittings or hose clamps.

## V. Flex Riser for Metal L-Shaped Heaters

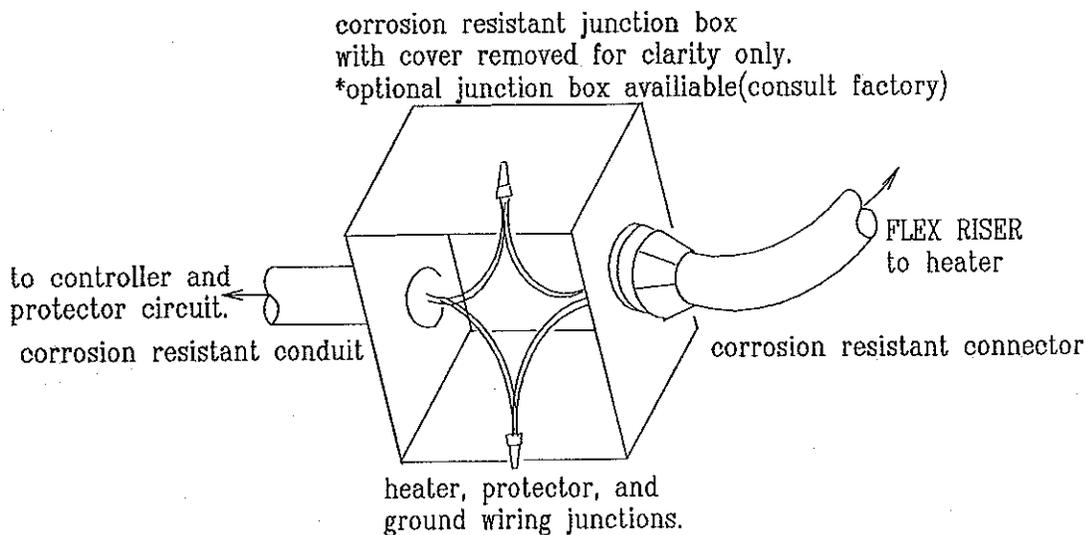
The Flex Riser system on metal L-shaped heaters offers simplified electric immersion heater installation in chemical processing tanks. The fluoropolymer FLEX RISER is chemically inert and electrically nonconductive while the stainless steel reinforcing core is bonded to the heater shell and ground wire to afford maximum shock protection in the event of sheath penetration.

### RECOMMENDED INSTALLATION PROCEDURE

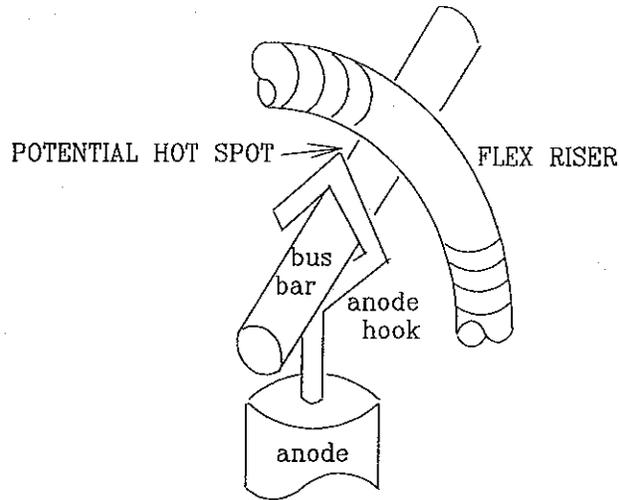
- 1. DO NOT LIFT AND LOWER THE HEATER USING THE FLEX RISER.**  
Use a sling or rope to carry the weight of the heater during installation or removal. Improper handling may result in damage to the flex junction and result in heater failure.



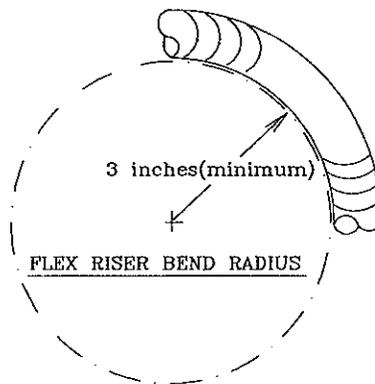
- 2. ALWAYS TERMINATE THE FLEX RISER** in a sealed corrosion resistant electrical junction box and wire to a properly rated temperature controller with a PII protector circuit in accordance with national and local electric codes. (See page 5)



3. Although the fluoropolymer material has outstanding temperature tolerances, **NEVER ALLOW THE FLEX RISER TO CONTACT HOT SURFACES** such as bus bar connections where overheating may occur. Avoid sharp or abrading surfaces which could damage the riser.



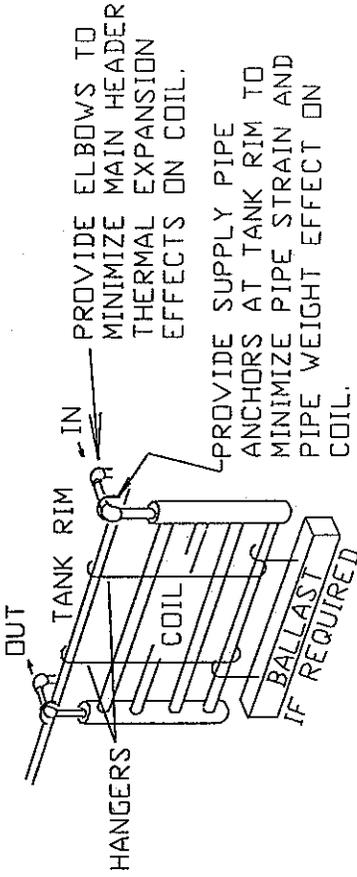
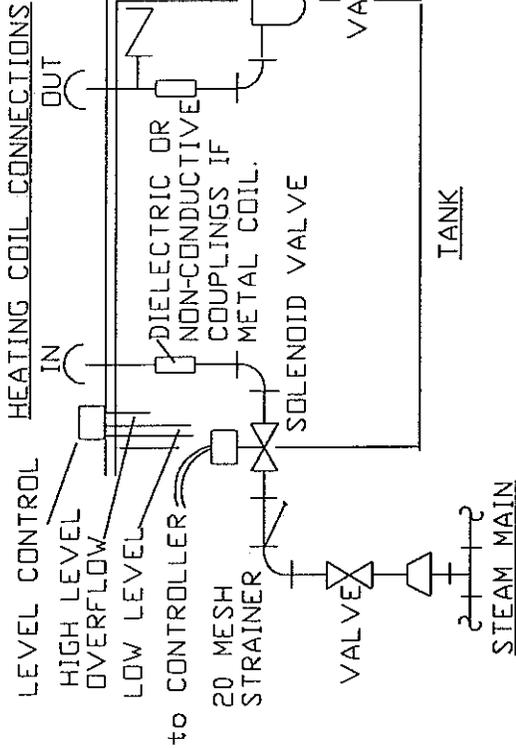
4. To avoid potential kinking, **NEVER FORCE THE FLEX RISER BEND RADIUS TO LESS THAN 3 INCHES.**



5. If stray plating currents prohibit the installation of a grounding conductor, **INSTALL A PROPERLY SIZED GFP** (ground fault circuit protector) to reduce the possibility of electrical shock in the event of a heater failure.

VI. Heating Coils

RECOMMENDED HEATING COIL INSTALLATION



VIEW FROM INSIDE OF TANK

VACUUM BREAKER (PLASTIC COILS)

INVERTED BUCKET or FLOAT/THERMOSTATIC TRAP  
Safety Factor = 4

DISCHARGE CONDENSATE TO WASTE  
TREATMENT WHEN HEATING:

ACID

PLATING SOLUTIONS

or other boiler fouling chemistry

STEAM MAIN

TANK

RETURN CONDENSATE TO  
BOILER WHEN THE HEATED SOLUTION IS:

ALKALINE CLEANER

DETERGENT CLEANER

RINSE or other non-corrosive chemistry

IMPORTANT

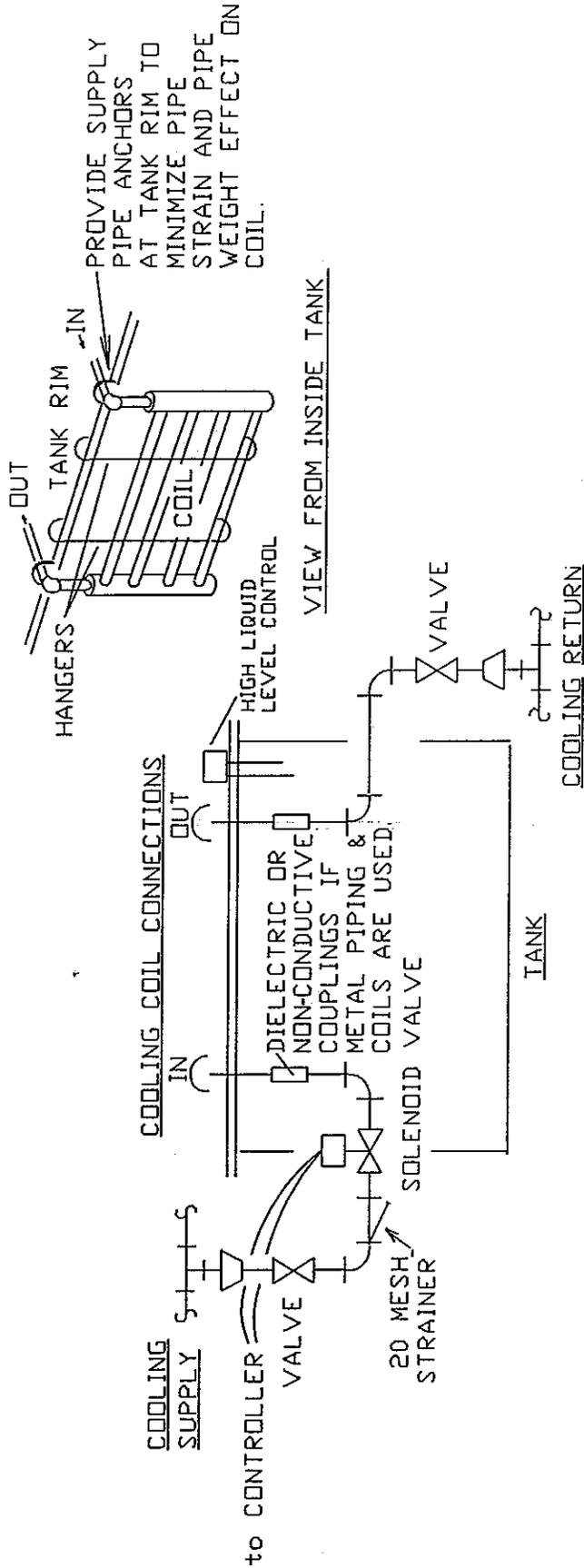
RELYING ON A CONDENSATE ANALYZER/DIVERTER ONLY TO DETECT A COIL LEAK IS STRONGLY DISCOURAGED SINCE THE RELIABILITY OF SUCH SYSTEMS IS BASED ON THE MAINTENANCE RECEIVED. ANY COIL LEAK WILL RESULT IN THE INSPIRATION AND SYPHONING OF THE TANK CONTENTS INTO THE CONDENSATE SYSTEM. SEVERE DAMAGE TO THE CONDENSATE SYSTEM AND THE BOILER MAY RESULT. DO NOT EXCEED THE PRESSURE/TEMPERATURE RATING OF THE COIL AS PROPERTY LOSS AND PERSONAL INJURY MAY RESULT.

Added Flight trap	6-20-93
DESIGNED	10-20-92
REVISED	9-13-89
REVISED	5-19-89
REVISION	DATE

DRAWN BY	DKR	CHKD	TOLERANCE
DATE	4/89	DATE	SCALE
CUSTOMER	STANDARD		

HEATING COIL HOOK-UP H1-890

VII. Cooling Coils



# RECOMMENDED COOLING COIL INSTALLATION

THE USE OF COOLING SUPPLY AND RETURN PIPING THAT IS COMPATIBLE WITH THE CHEMICAL CONTENTS OF THE TANK IS STRONGLY ENCOURAGED BECAUSE ANY COIL LEAK MAY INSPIRATE THE TANK CONTENTS INTO THE COOLING SYSTEM. COIL LEAKS MAY CAUSE TANK OVERFLOWS THE RISK OF WHICH CAN BE LESSENERED BY TURNING OFF SUPPLY VALVING WHEN COOLING IS NOT IN USE. THE USE OF HIGH LIQUID LEVEL DETECTION/ALARM SYSTEMS IN CONJUNCTION WITH FREQUENT COIL AND SYSTEM INSPECTIONS ARE RECOMMENDED. DO NOT EXCEED THE PRESSURE/TEMPERATURE RATING OF THE COIL AS PROPERTY LOSS AND PERSONAL INJURY MAY RESULT.

REVISED	9-12-89
REVISED	5-19-89
REVISION	DATE

DRAWN BY	DJR	CHKD	TOLERANCE	±
DATE	4/89	DATE	SCALE	
CUSTOMER	STANDARD			
COOLING COIL HOOK-UP				H1-893

## SECTION III.

### OPERATION AND MAINTENANCE

#### General Procedures

NOTE:

1. At no time should the heater come in contact with electrified accessories within the tank.
2. Verify that the heater sheath material is compatible with the solution to be heated.
3. ***DO NOT OPERATE THE HEATER WITHOUT THE HOT ZONE OF THE HEATER COMPLETELY IMMERSSED IN LIQUID.***
4. Quartz or Teflon® heaters may fracture if removed from solution while at operating temperatures. Allow three to five (3-5) minutes after power down for all types of heaters to cool before removal or tank drainage.
5. Sludge or particle accumulation on, or around, the heater will result in excessive temperatures and will shorten heater life. Heaters should be checked for buildup frequently and cleaned if accumulation is present. (Wear appropriate eye and body protection when handling the heaters.) Check all wiring for positive connections of power leads. Inspect gaskets for deterioration and replace if necessary. Check tightness of flange mounting bolts.
6. If the heater sheath fails, there is a probability that full line voltage is resident in the tank. It is strongly recommended that the heater and tank be grounded properly.

**ALL POWER SHOULD BE TURNED OFF AND LOCKED OUT BEFORE INSPECTION OR REMOVAL OF SUSPECTED PROBLEM HEATERS.**

When replacing a PI (PT-I) or PII (PT-II) Protector thermal fuse, follow the instructions on the following pages or the thermal fuse could be rendered ineffective. Use the correct replacement thermal fuses when repairing heaters.

## Overtemperature Protectors for Heaters

PI. (metal), PQI. (quartz) and PTL. (teflon) Protectors (Do not interchange)

### RECOMMENDED FOR ALL HEATER INSTALLATIONS

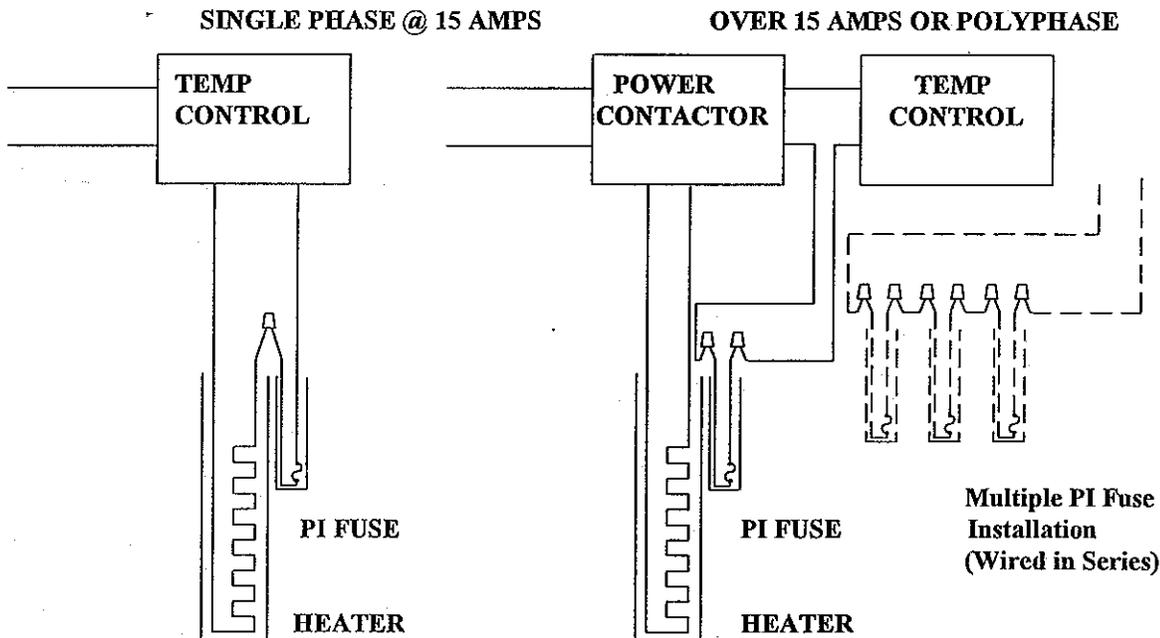
The PI Overtemperature Protector is an eutectic switch with a pre-specified melt temperature. The "one-shot" or "one-time" characteristic is useful in alerting operators to identify and remedy the cause of the overtemperature condition in the course of PI fuse replacement. **ALWAYS FOLLOW THE REPLACEMENT PROCEDURES OUTLINED IN THE PROTECTOR I INSTALLATION BULLETIN. FAILURE TO DO SO MAY RESULT IN A FIRE OR PREMATURE HEATER BURNOUT.** For Teflon heaters: PIII. Protector recommended for temperature applications exceeding 195°F (90°C)

The UL/CSA listed rating of 15 amps up to 277 VAC permits direct connection in many heating applications affording an economical installation. Where heater power requirements exceed:

1. 15 amps (full load current will derate thermal trip setting),
2. 277 VAC, or
3. single phase power,

indirect connection to the heating load via a power contactor is required.

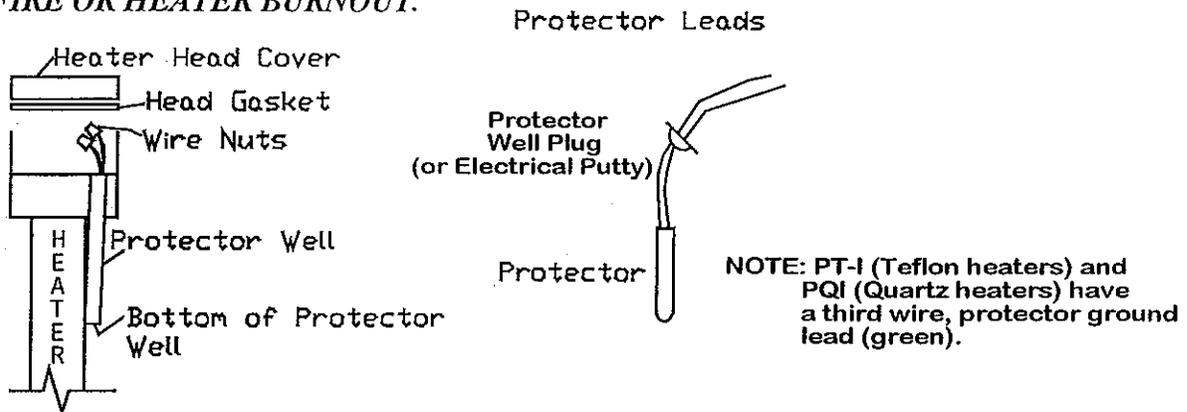
<u>Designation</u>	<u>Bath Temperature</u>	<u>Lead Length/Color</u>
PI or PQI	to 190°F (88°C)	18 inches (457mm)/White wires
PIM or PQIM	to 230°F (110°C)	18 inches (457mm)/Blue wires
PIH or PQIH	to 300°F (149°C)	18 inches (457mm)/Red wires
PLI	to 190°F (88°C)	52 or 85 inches (1320/2159mm)/White wires
PLIM	to 230°F (110°C)	85 inches (2159mm)/Blue wires
PLIH	to 300°F (149°C)	85 inches (2159mm)/Red wires
PT-I	to 195°F (90°C)	26 inches (660 mm)/Red wires
PTL-I	to 195°F (90°C)	48 inches (1219mm)/Red wires



**REPLACEMENT THERMAL CUTOFFS  
MUST BE PURCHASED FROM THE VENDOR  
(Required by Underwriters Laboratories)**

## PROTECTOR I INSTALLATION

**CAUTION: FAILURE TO FOLLOW THIS PRESCRIBED PROCEDURE MAY RESULT IN A FIRE OR HEATER BURNOUT.**



1. SHUT-OFF AND LOCKOUT HEATER ELECTRICAL POWER.
2. Remove Heater Head Cover. Retain for reuse.
3. Mark the insulation of the "spent" Protector Leads at the point they exit the Protector Well within the Heater Head. This mark will be transferred to the new Protector and will be used as a reference to ensure that the new Protector has been inserted to the bottom of the Protector Well.
4. Remove Wire Nuts secured to the "spent" Protector Leads, noting where the wires are to be reconnected, and separate wires. Retain Wire Nuts for reuse.
5. Remove the Electrical Insulation Putty from the spent Protector and retain for reuse.
6. Remove "spent" Protector. Retain for lead measurement.
7. Using the old "spent" Protector leads as a measuring guide, cut and strip the new Protector leads to a similar length. Line up the Protectors next to each other and transfer the marks that were made on the insulation of the spent Protector Leads to the new Protector Leads.
8. Examine the Protector Well for moisture by inserting a long wooden dowel or similar suitable device. If moist, thoroughly dry the Protector Well using cloth swabs or other similar means. Insure no material is left in the well. Once dry, insure that no further moisture is seeping into the Protector Well. If moisture reoccurs DO NOT RETURN THE HEATER TO SERVICE. Consult factory for advice and/or further testing.
9. Insert new Protector into the dry, empty Protector Well until the Protector "bottoms out". Verify Protector is "bottomed out" by feeling it through the Protector Well or by using a push rod to ensure that it is pushed to the bottom of the Well. Use the marks on the Protector Lead to make sure they are lined up with the top of the Protector Well within the Heater Head. If the marks are above the top of the Protector Well, there is a possibility the Protector has not been fully inserted. Using the heater without the Protector in the proper position will result in an unsafe operating condition. The Protector MUST be located at the bottom of the Protector Well.
10. Reinstall the connecting wires using the old Wire Nuts.
11. Reapply the Electrical Insulation Putty. Seal the opening of the Protector Well to prevent moisture from entering.
12. Examine and, if necessary, replace the Heater Head Cover, Head Gasket and, if provided, cover hold-down screws to insure a moisture tight seal when reinstalled.
13. Reinstall the above assembly.
14. Examine conduit connection at heater head and repair, if necessary, to provide a liquid tight connection.
15. Return heater to normal operating service (reconnect power).

**PII. & PQII. Resettable Protectors for Metal and Quartz Heaters**

**RECOMMENDED FOR HEATERS IN METAL OR PLASTIC TANKS**

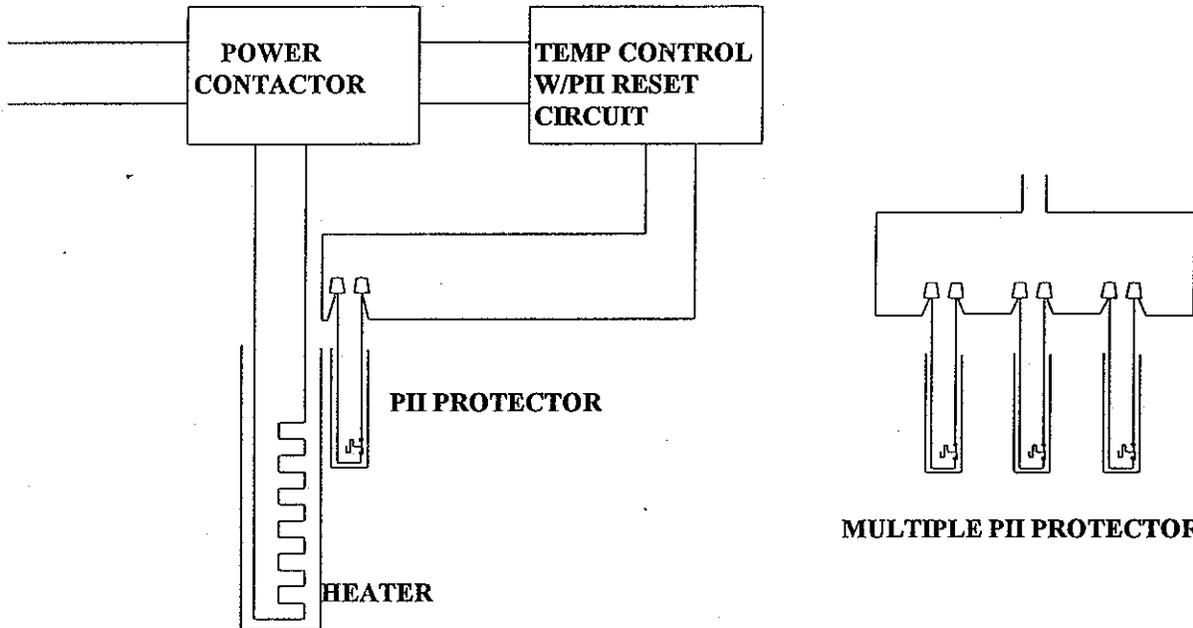
The PII Overtemperature Protector is a slow make/slow break bimetallic thermostat with a pre-specified calibration temperature. The slow break characteristic coupled with the push button reset feature is extremely useful when a low liquid level occurs.

The PII Overtemperature Protector is electrically installed with a holding circuit in conjunction with a power contactor to energize the heater. **It must never be used to directly switch heater power or as an automatic reset system.**

UL/CSA rating of 6 amps at 120 VAC or 4 amps at 240 VAC.

<u>Designation</u>	<u>Bath Temperature</u>	<u>Lead Length/Color</u>
PII (PQII)	to 190°F (88°C)	80 inches (2032mm)/White wires
PIIM (PQIIM)	to 230°F (110°C)	80 inches (2032mm)/Blue wires
PIIH (PQIIH)	to 300°F (149°C)	80 inches (2032mm)/Red wires
PLII	to 190°F (88°C)	80 inches (2032mm)/White wires
PLIIM	to 230°F (110°C)	80 inches (2032mm)/Blue wires
PLIIH	to 300°F (149°C)	80 inches (2032mm)/Red wires

**TYPICAL INSTALLATION**



**REPLACEMENT THERMAL CUTOFFS  
MUST BE PURCHASED FROM THE VENDOR  
(Required by Underwriters Laboratories)**

## PT-II. Resettable Protectors for Teflon Heaters

### RECOMMENDED FOR HEATERS IN METAL OR PLASTIC TANKS

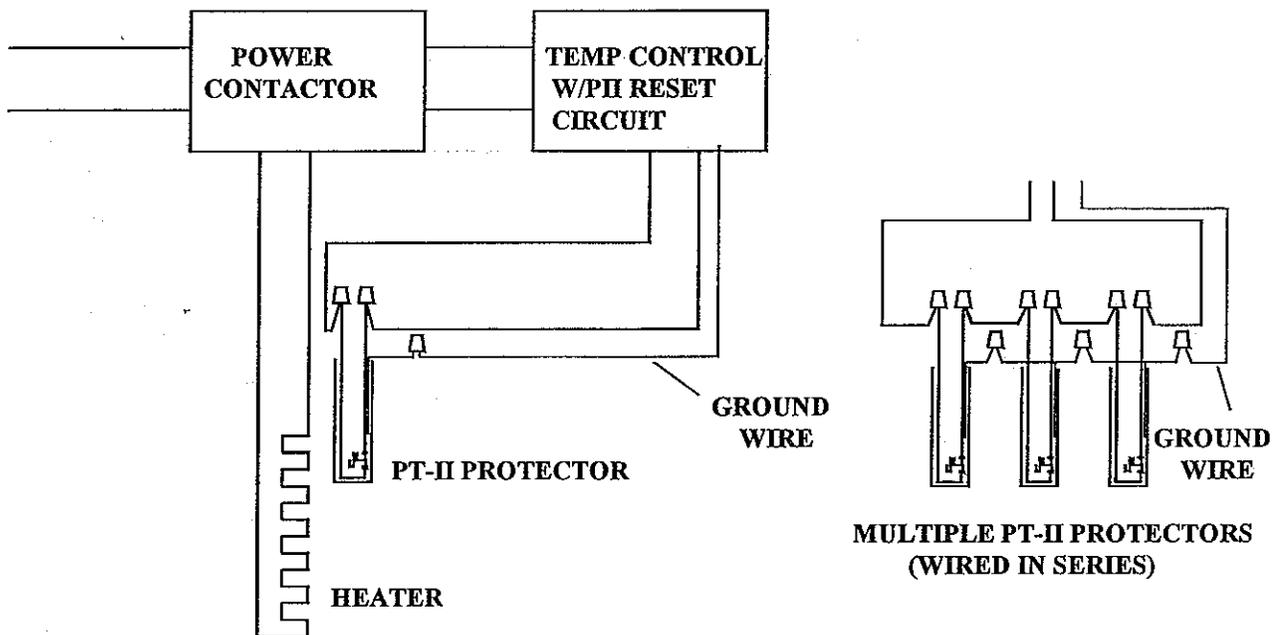
The PT-II Overtemperature Protector is a slow make/slow break bimetallic thermostat with a pre-specified calibration temperature. The slow break characteristic coupled with the push button reset feature is extremely useful when a low liquid level occurs.

The PT-II Overtemperature Protector is electrically installed with a holding circuit in conjunction with a power contactor to energize the heater. **It must never be used to directly switch heater power or as an automatic reset system.** PIII protector recommended for applications exceeding 195°F (90°C).

UL/CSA rating of 2.6 amps at 120 VAC.

<u>Designation</u>	<u>Bath Temperature</u>	<u>Lead Length/Color</u>
PT-II.	to 195°F (90°C)	26 inches (660mm)/White
PTL-II.	to 195°F (90°C)	48 inches (1219mm)/White

### TYPICAL INSTALLATION



**REPLACEMENT THERMAL CUTOFFS  
MUST BE PURCHASED FROM THE VENDOR  
(Required by Underwriters Laboratories)**

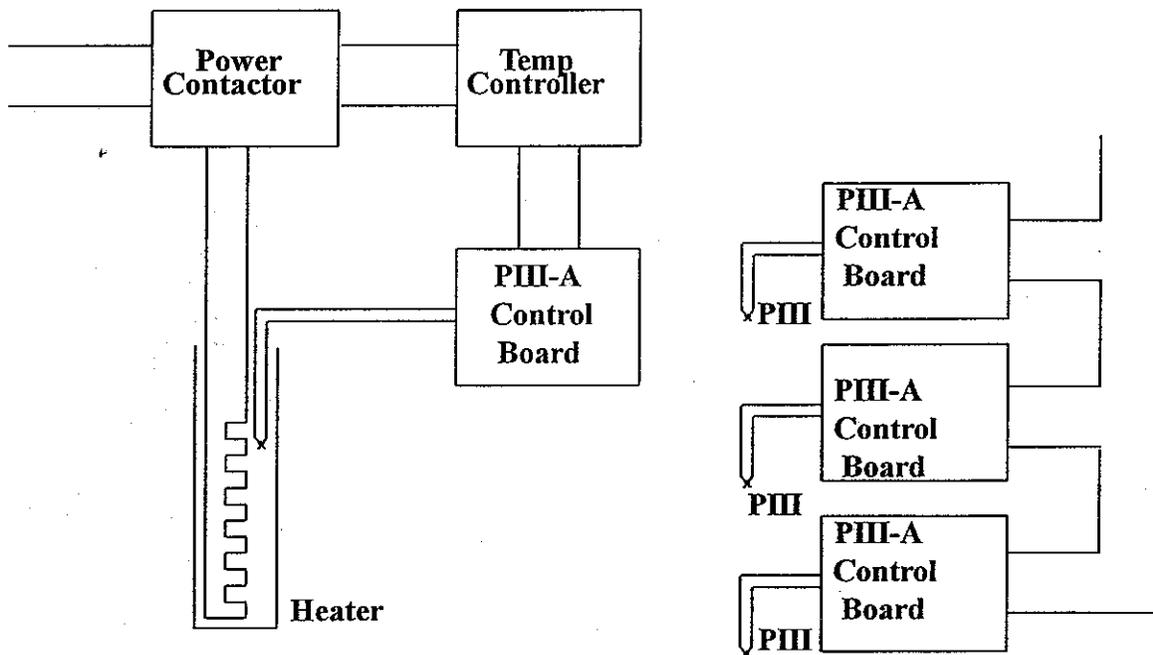
### PIII. Resettable Protector for Teflon Heaters

RECOMMENDED FOR FLUOROPOLYMER SHEATHED HEATERS WHERE  
OVERTEMPERATURE COULD RESULT IN SHEATH DAMAGE AND/OR FIRE HAZARD.

The PIII Overtemperature Protector utilizes a miniture insulated thermocouple installed between the heater surface and the fluoropolymer sheath. This thermocouple is extended to a temperature controller, PIII-A Overtemperature Board, with a factory temperature set point established to protect the sheath as well as fire hazard protection that could result in the event of an overtemperature condition.

The PIII extension wires operate at millivolt levels so that care must be exercised when installing this system to insure proper functioning. **NEVER apply voltage (power) of any level to the PIII extension wires as irreparable damage will result.** The PIII-A Overtemperature Board is equipped with "on-board" holding circuitry and output contacts that must be interconnected with the process temperature controller and heater power contactor. Any overtemperature condition will then interrupt heater power through the power contactor. Multiple PIII Protectors require multiple PIII-A Boards wired to the heater power contactor.

### TYPICAL INSTALLATION



Multiple Protectors  
- Control contacts in series -

The PIII-A board is a temperature controller (switch) with built-in thermocouple testing and momentary reset circuitry. This enables the PIII-A board to check the PIII thermocouple status and interrupt the heater power contactor in the event of overtemperature or thermocouple failure. The on-board relay must be interfaced with the power contactor and alarm circuitry.

The overtemperature set point (drop-out temperature) is factory adjusted to afford protection for the heater sheath as well as the effects of overtemperature to nonmetallic tanks, tank linings and surrounding auxiliary equipment. Field adjustment can initiate dangerous operating conditions and should never be attempted.

The board is electrically latched (relay energized) by a momentary closure of the reset (start) terminals. The board is unlatched (relay de-energized) or is prevented from latching whenever any of the following conditions take place:

- \* Power interruption (incoming power dropped-out)
- \* An open condition in the enable terminals (if used)
- \* A broken or open PIII thermocouple or thermocouple connecting leads
- \* A reversed thermocouple connection (see Troubleshooting)

Like all thermocouples, the PIII type "J" thermocouple is polarized (red lead negative and white lead positive) and must be wired correctly. The red lead is wired to the J- (R) terminal and the white lead is wired to the J+ (W) terminal. Be careful to use only type "J" thermocouple extension wire if you must extend the factory supplied wire or to do any replacement wiring. Always observe polarity at all connections. We recommend using #20 AWG or larger type "J" thermocouple extension wire to minimize line loss and associated temperature error whenever thermocouple lead extension is required.

### Troubleshooting

Warning: Troubleshooting is facilitated with an open enclosure; live circuits are exposed and extreme care is necessary. Only qualified electricians should perform these tests.

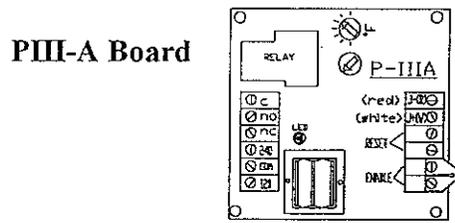
The on-board LED indicator will assist you during installation or subsequent troubleshooting. The LED is wired in the thermocouple "sense" circuitry. Prior to reset (depressing the reset button) and with incoming power applied, the LED may or may not be illuminated (no fault condition is indicated). Upon reset (depressing the reset button), the LED should extinguish (or remain off).

If, upon attempting to reset, the LED remains illuminated and the PIII-A relay fails to latch, one or both of the thermocouple leads are open (not connected or broken) or the PIII thermocouple in the heater is open.

If after a period of time in operation, the PIII-A board shuts down the controller and attempts to reset result in only short time operation, observe LED prior to reset. If illuminated, a reversed (incorrect polarity) lead condition is indicated. Examine all connections and correct wiring.

Shorted thermocouple leads will result in an ambient temperature signal. If undetected, this condition can result in damage to heater and/or damage to the tank. Always inspect for and correct any

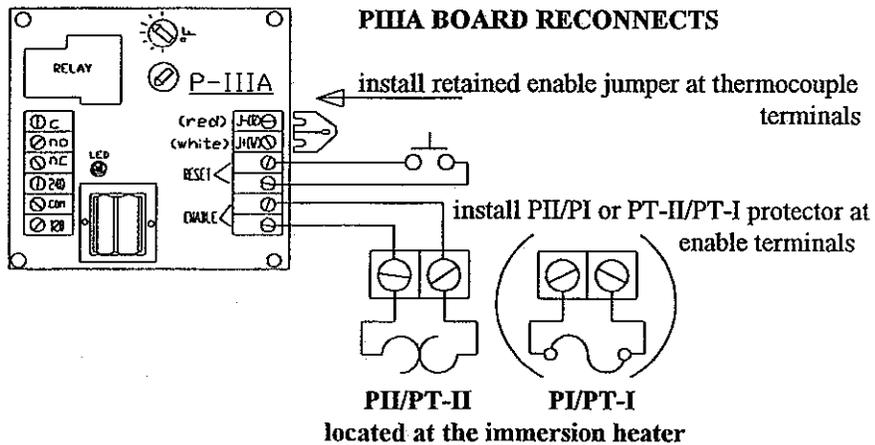
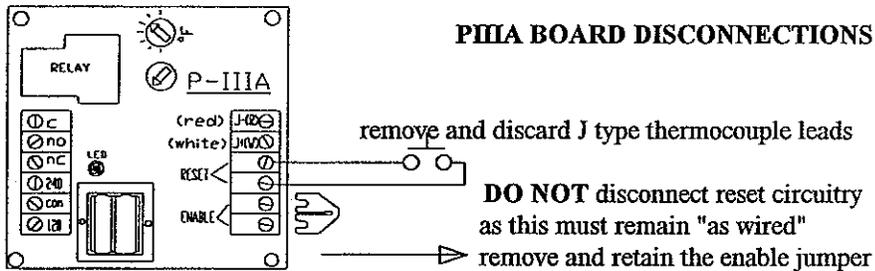
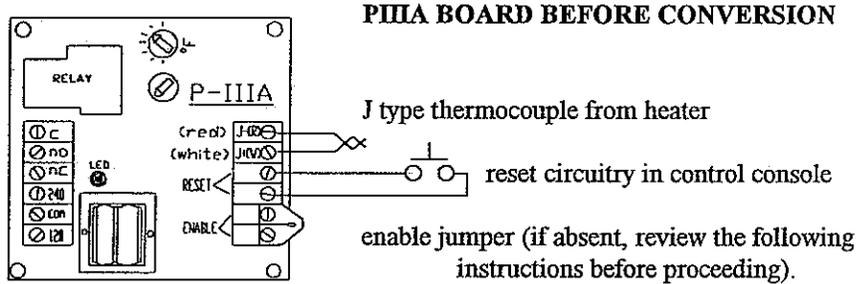
possible shorted or damaged thermocouple leads.



### CONVERSION OF PIII A BOARD FOR PI/PII OR PT-I/PT-II OPERATION

The PIII A board was designed to provide overtemperature protection for PFA, fluoropolymer sheathed immersion heaters. In most cases this board can be field converted to provide overtemperature protection for PTFE, fluoropolymer sheathed immersion heaters with the PI/PII or PT-I/PT-II overtemperature protectors.

Using the following diagrams convert your existing PIII A board as shown and perform the indicated testing to verify your conversion before placing the heater in service.



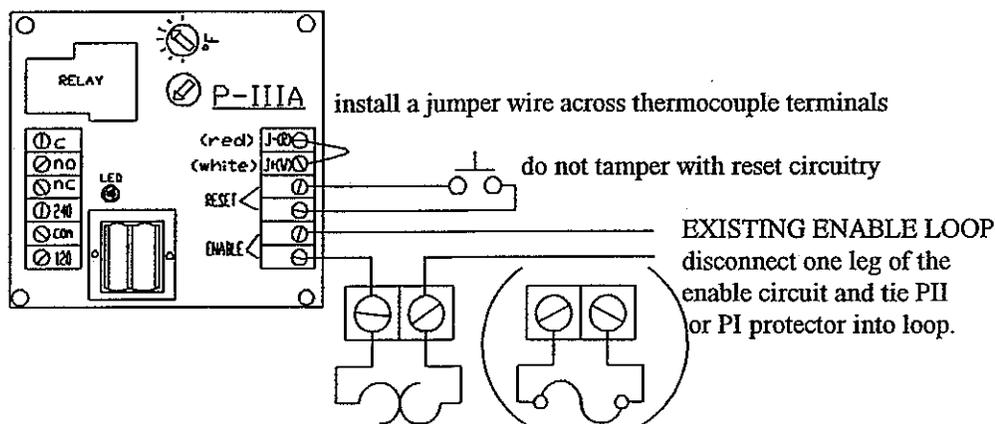
## CONVERTED PIIIA BOARD TESTS

After performing the indicated rewiring shown on the reverse side of this sheet, perform the following tests BEFORE placing the heater in service.

1. Power up the controller and momentarily depress the RESET/START button. The control alarm should silence and the HEATER ON light should illuminate (provided that the control set point is above current ambient temperature). If control does not function as described, power down and recheck wiring. Is the PII or PI wired to the enable terminals? Is the enable jumper connected to the J- terminals?
  
2. After successful trials as outlined in 1. above, power down and disconnect one of the PII (or PI) leads connected to the enable terminals. Power up the controller and momentarily depress the RESET/START button. The control alarm should remain in the alarm mode and the HEATER ON light should remain extinguished. If control appears to function as per normal, verify that at least one lead is disconnected from the enable terminal. Consult factory if corrective action can not be taken. Reconnect PII (or PI) leads to enable terminals if correct action is indicated.
  
3. Upon successful completion of tests above. Verify your wiring changes for tight connections and place heater into service.

### PIII CONVERSIONS WITH WIRED ENABLE TERMINALS

The enable terminals are sometimes used to permit external devices (level probes, high temp cut-offs, etc) to interrupt heater power. Since the enable terminals operate at discrete power levels and a virtually endless loop of interrupt devices can be linked together in series, it should be obvious that the PII (or PI) protector can be included in this "loop".



After circuit changes proceed with testing as outlined above.

## SECTION IV.

## IMMERSION HEATER SOLUTION GUIDE

SOLUTION	TYPE OF HEATER	SOLUTION	TYPE OF HEATER
Acetic	Teflon® or Quartz	Clear Chromate	Teflon® or Quartz
Actane 70,80	Teflon®	Cobalt Nickel	Teflon®, Quartz or Titanium
Actane Salt	Teflon®	Cobalt Plating	304 Stainless Steel
Acid Sulfate	Teflon® or Quartz	Cobra Etch	Teflon®
Alcorite	Teflon® or Quartz	Copper Acid	Teflon® or Quartz
Alkaline Cleaners (Electrified)	304 Stainless Steel	Copper Bright Acid	Teflon® or Quartz
Alkaline Soaking Cleaners	304 Stainless Steel	Copper Cyanide	304 Stainless Steel
Alodine	316 Stainless Steel	Copper Fluoborate	Teflon®
Alstan	304 Stainless Steel	Copper Pyrophosphate	304 Stainless Steel
Aluminum Anodizing	Teflon® or Quartz	Copper Strike	304 Stainless Steel
Aluminum Bright Dip	Teflon® or Quartz	Copper Sulfate	Teflon® or Quartz
Aluminum Cleaners	304 Stainless Steel ‡	Cyanide	304 Stainless Steel
Aluminum Chloride	Teflon® or Quartz	Deionized Water	316 Stainless Steel
Aluminum Sulfate	304 Stainless Steel	Deoxidizer (Etching)	Quartz
Ammonia	304 Stainless Steel	Deoxidizer Non-Chromated	316 Stainless Steel
Ammonia Persulfate	Teflon® or Quartz	Dichromic Seal	Steel
Ammonium Bi Fluoride	Teflon®	Diethylene Glycol	304 Stainless Steel
Ammonium Chloride	Titanium	Diversey, 511, 514	Teflon®
Ammonium Nitrate	316 Stainless Steel	Dow Therm	316 Stainless Steel ‡
Anodizing	Teflon® or Quartz	Dye Solutions	304 Stainless Steel
ARP 28, 80 Blackening Salts	Teflon® or Quartz	Ebonal C	Titanium
Arsenic	304 Stainless Steel	Electroless Copper	Teflon®
Barium Chloride	Titanium	Electroless Nickel	Teflon® or Titanium ‡
Benzoic Acid	Titanium	Electroless Tin (Acid)	Teflon® or Quartz
Black Nickel	Teflon® or Quartz	Electroless Tin (Alkaline)	316 Stainless Steel
Black Oxide (Hi-Temp)	304 Stainless Steel ‡	Electro Cleaner	304 Stainless Steel
Black Oxide (Low-Temp)	Titanium	Electro Polishing	Teflon® or Quartz
Bonderizing	316 Stainless Steel ‡	Enthone 80 Acid	Teflon®
Boric Acid	Titanium	Ethylene Glycol	Steel ‡
Brass Cyanide	304 Stainless Steel	Ferric Nitrate	304 Stainless Steel
Bright Nickel	Teflon®, Quartz or Titanium	Ferric Sulfate	304 Stainless Steel
Bright Copper-Cyanide	304 Stainless Steel	Ferric Ammonium Oxide	316 Stainless Steel
Bronze	304 Stainless Steel	Ferric Chloride	Teflon®, Quartz or Titanium
Brown Oxide	Titanium	Fluoborate	Teflon®
Burnite	Teflon® or Quartz	Formic Acid	316 Stainless Steel
Butyric Acid	Titanium	Glycerol	304 Stainless Steel ‡
Cadmium Black	Teflon® or Quartz	Immersion Gold	304 Stainless Steel
Cadmium (Alkaline)	304 Stainless Steel	Gold-Acid	Teflon®, Quartz or Titanium
Cadmium Fluoborate	Teflon®	Gold Cyanide	304 Stainless Steel
Calcium Chloride	Titanium	Grey Nickel	Teflon®, Quartz or Titanium
Calcium Hypochlorite	Titanium	Hot Seal Dichromate	316 Stainless Steel
Carbonic Acid	Titanium	Hydrogen Peroxide	Teflon® or Quartz ‡
Caustic Etch	Steel ‡	Hydrochloric Acid	Teflon® or Quartz
Caustics	Steel	Hydrofluoric Acid	Teflon®
Caustics (highly concentrated 20% & over)	Steel ‡	Indium	Teflon® or Quartz
Chlorine/Wet	Teflon® or Quartz	Iridite (4-75, 4-73, 14, 14-2, 14-9)	316 Stainless Steel
Chloride	Teflon® or Quartz	Iridite (1, 2, 3, 4-C, 7, 8, 15)	Teflon® or Quartz
Chlorosulfuric Acid	Titanium	Iron Fluoborate	Teflon®
Chromic Anodizing	Teflon® or Quartz	Iron Phosphate	316 Stainless Steel ‡
Chromic Acetate	Teflon® or Quartz	Isoprep (186, 187, 188)	316 Stainless Steel
Chromic Nickel	Teflon® or Quartz	Isoprep Acid Salts	Teflon®
Chromium (No Fluorides)	Teflon®, Quartz or Titanium	Jetal	304 Stainless Steel
Chromium (Fluoride)	Teflon®	Lead Acetate	304 Stainless Steel
Citric Acid	Titanium	Lime Saturated Water (Alkaline)	316 Stainless Steel ‡

®Teflon is a registered trademark of DuPont.

‡Should be Derated Heater

**SOLUTION**

**TYPE OF HEATER**

Linseed Oil .....	304 Stainless Steel
Magnesium Hydroxide .....	304 Stainless Steel ‡
Magnesium Nitrate .....	Teflon® or Quartz
Manganese Phosphate .....	316 Stainless Steel ‡
McDermid 629.....	Teflon®
Mercuric Chloride .....	Titanium
Muriatic Acid .....	Teflon® or Quartz
Nickel (Plating Solution)(Watts) .....	Teflon®, Quartz or Titanium
Nickel Acetate Seal .....	316 Stainless Steel
Nickel Chloride .....	Titanium
Nitric Acid .....	Teflon® or Quartz
Nitric Hydrochloric Acids .....	Teflon® or Quartz
Nitric Phosphoric.....	Quartz ‡
Oil.....	Steel ‡
Oleic Acid .....	Teflon® or Quartz
Paint Stripper (Alkaline) .....	304 Stainless Steel ‡
Perchlorethylene .....	316 Stainless Steel ‡
Phosphoric Acid (No Fluoride) .....	Teflon® or Quartz ‡
Phosphate Cleaner .....	304 Stainless Steel ‡
Phosphate .....	316 Stainless Steel ‡
Potassium Acid Sulfate .....	Teflon® or Quartz
Potassium Cyanide .....	304 Stainless Steel
Potassium Hydroxide .....	304 Stainless Steel
Potassium Hydrochloric .....	Teflon® or Quartz
Potassium Permanganate .....	Teflon® or Titanium ‡
Rhodium .....	Teflon® or Quartz
Rochelle Salt Cyanide .....	304 Stainless Steel
Ruthenium .....	Teflon® or Quartz
Salt (Actine).....	Teflon®
Sea Water .....	Titanium
Silver Bromide .....	316 Stainless Steel
Silver Cyanide .....	304 Stainless Steel
Silver Lume .....	304 Stainless Steel
Silver Nitrate .....	316 Stainless Steel
Sodium Bisulfate .....	Teflon® or Quartz

**SOLUTION**

**TYPE OF HEATER**

Sodium Carbonate .....	Titanium
Sodium Chlorate .....	Titanium
Sodium Chloride .....	Titanium
Sodium Cyanide .....	304 Stainless Steel
Sodium Dichromate (Hot Seal) .....	316 Stainless Steel
Sodium Hydroxide.....	Steel
Sodium Hypochlorite.....	Teflon®
Sodium Persulfate .....	Teflon® or Quartz
Stannate.....	Steel
Stanostar .....	Teflon® or Quartz
Stearic Acid.....	Quartz
Sulfamate Nickel .....	Teflon®, Quartz or Titanium
Sulfur .....	Teflon® or Quartz
Sulfuric Acid .....	Teflon® or Quartz
Sulfur Peroxide .....	Teflon® or Quartz
Sulphamic Acid .....	Teflon® or Quartz
Tannic Acid .....	Titanium
Tin Nickel.....	Teflon®
Tin Plating (Acid)(Stanus/Sulphate).....	Teflon® or Quartz
Tin Plating Acid (Fluoborate).....	Teflon®
Tin Plating (Alkaline) .....	304 Stainless Steel
Trichlorethylene .....	316 Stainless Steel ‡
Trioxide (Pickle) .....	Teflon® or Quartz
Turco (4181, 4338) .....	316 Stainless Steel ‡
Unichrome .....	Teflon® or Quartz
Water .....	316 Stainless Steel or Quartz
Wood's Nickel Strike .....	Teflon® or Quartz
Yellow Dichromate .....	Teflon® or Quartz
Zinc Acid .....	Teflon® or Titanium
Zinc Ammonium Chloride .....	Quartz or Titanium
Zinc Cyanide .....	304 Stainless Steel
Zinc Phosphate .....	316 Stainless Steel ‡
Zincate .....	304 Stainless Steel

®Teflon is a registered trademark of DuPont.

‡ Should be Derated Heater

THE DATA LISTED IS PROVIDED GRATIS AND IS OFFERED AS A GUIDE ONLY. IT IS NOT INTENDED TO BE USED AS THE SOLE BASIS OF DESIGN OR TO ESTABLISH SPECIFICATION LIMITS. THE FACTORY ASSUMES NO OBLIGATION OR LIABILITY FOR ANY ADVICE FURNISHED BY IT OR FOR RESULTS OBTAINED FROM ITS USE. DUE TO THE COMPLEXITIES OF SOLUTIONS AND APPLICATIONS, IT IS THE CUSTOMER'S RESPONSIBILITY TO CONTACT THEIR CHEMICAL SUPPLIER FOR HEATER MATERIAL COMPATIBILITY AND RECOMMENDATIONS.

**DO NOT USE ELECTRIC IMMERSION HEATERS TO HEAT FLAMMABLE SOLUTIONS!**

PLEASE INSURE APPLICABILITY OF HEATER BEFORE INSTALLATION SINCE WE CANNOT GUARANTEE HEATERS AGAINST PREMATURE FAILURE DUE TO CORROSION OR CHEMICAL DESTRUCTION CAUSED BY UNUSUAL CONDITIONS OVER WHICH WE HAVE NO CONTROL SUCH AS:

- Excessively high solution temperatures.
- The concentration of the solution.
- The presence of inhibitors.
- The presence of other acids causing a secondary reaction.
- Stray electrical currents.
- Flux floating on the surface.
- The presence of dissolved gases.
- Excessive sludge build-up.
- Stagnant or turbulent flow of the solution.
- Aeration.
- Presence of oxygen or an oxidizing agent in the solution.
- Erosion.

## SECTION V.

### ATTENTION/CAUTION

- \* Always mount the heater in the tank so that the liquid level will cover the effective heated portion of the element. If the elements are not properly submerged they will overheat, damaging the elements, posing as a fire hazard. **DO NOT OPERATE THE HEATER WITHOUT THE HOT ZONE OF THE HEATER COMPLETELY IMMERSSED IN LIQUID!**
- \* Do not operate the heater without a properly installed protector, PI, PII, PIII.
- \* Do not operate the heater without a properly installed level control.
- \* Do not operate the heater without a tested ground conductor or GFCI.
- \* Heaters are capable of developing high temperatures. Avoid installation of heaters in the proximity of combustible materials.
- \* All power should be **turned off** before inspection or removal of suspected problem heaters.
- \* Heaters should not contact anodes, cathodes or any electrified portions of the tank. Isolate all green heater ground leads to building ground (or rectifier ground if present) to prevent voltage potential difference.
- \* **Do not use electric immersion heaters to heat flammable solutions.**
- \* Heaters must never be hammered to remove built-up deposits.
- \* Failure to follow the prescribed procedures correctly may result in a fire or heater burnout.



IGNITION SOURCE

## WARNING

ELECTRIFIED IMMERSION HEATERS WILL IGNITE MANY PLASTIC TANKS SUCH AS POLYPROPYLENE AND POLYETHYLENE AND SUBJECT PERSONNEL TO SHOCK HAZARD IF NOT PROPERLY INSTALLED AND MAINTAINED. ALL HEATERS MUST BE EQUIPPED WITH A THERMAL OVERTEMPERATURE DEVICE SUCH AS A PROTECTOR I, II OR III AND THE TANK MUST HAVE A LIQUID LEVEL CONTROL TO REDUCE THE POTENTIAL OF FIRE. IT IS THE CUSTOMER'S RESPONSIBILITY TO PURCHASE THERMAL AND LIQUID LEVEL PROTECTORS.



SHOCK HAZARD