SERGE BARIL

TYPICAL SPECIFICATION
ELECTRICAL HEAT TRACING

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1.0 SCOPE

This specification covers the requirements for the design, installation, and testing of an electrical heat tracing system for insulated pipes and vessels.

2.0 GENERAL REQUIREMENTS

2.1 CONFORMANCE

The design, drawings, equipment and materials supplied shall be in conformance to this specification and the terms listed in the purchase order. It is the seller's responsibility to comply with this requirement.

2.2 EXCEPTIONS

If total compliance is not possible, each exception shall be clearly stated in writing at the time of quotation.

2.3 MATERIALS AND WORKMANSHIP

All heat tracing materials, components, and accessories shall be new, unused, undamaged and of a grade and quality specified in the manufacturer's literature.

2.4 DESIGN AND INSTALLATION

Design and installation shall be in strict compliance with the manufacturer's published recommendations and specifications.

3.0 CODES, STANDARDS, AND APPROVALS

All electrical equipment, design and installation shall comply with the latest edition of the following codes and standards as applicable.

National Electrical Code (NEC)
Canadian Electrical Code (CEC)
National Fire Protection Association (NFPA)
Certified by Nationally Recognized Testing Laboratory (NRTL)
National Electrical Manufacturers Association (NEMA)
Occupational Safety and Health Act (OSHA)
Institute of Electrical Engineers (IEEE)
American National Standards Institute (ANSI)
Local codes and requirements

4.0 THERMAL DESIGN

4.1 Heat loss calculations shall conform to the guidelines stated in IEEE Publication 515-1997.

4.2 A 10% safety factor shall be used for all freeze protection heat loss calculations. A 25% safety factor shall be used for all temperature maintenance applications.

4.3 The following worst case ambient conditions shall be used in the heat loss determination.

Minimum Ambient Temperature = ?? °F (?? °C)
Maximum Wind Speed = 20 MPH (32 Km/hr)

4.4 THERMAL INSULATION

4.4.1 All heat traced pipes and vessels shall be installed with a dry thermal insulation with weather barrier. For determination of pipe heat losses, the following insulation thickness schedule shall be used based on maintain temperatures.

Insulation Thickness (inch / mm) at Maintain Temp							
Pipe Size		40 - 100°F (4 - 38°C)		101 - 200°F (39 - 93°C)		> 200°F (93°C)	
Inch	mm	Inch	mm	Inch	mm	Inch	mm
1/2	12	1	25	1	251	25	
3/4	18	1	25	1	25	1	25
1	25	1	25	1	25	1	25
2	50	1	25	1	25	2	50
3	75	1	25	2	50	2	50
4	100	2	50	2	50	2	50
6	150	2	50	2	50	3	75
8	200	3	75	3	75	3	75
10	250	3	75	3	75	3	75
12	300	3	75	3	75	4	100
16	400	3	75	3	75	4	100
18	450	3	75	3	75	4	100
20	500	3	75	4	100	4	100
24	600	3	75	4	100	4	100

4.4.2 Unless specified otherwise all insulated lines will be covered with a metallic weather barrier. Its functions are to secure the basic insulation and jacket during normal operations and adverse weather, protecting the insulation from moisture.

The weather barrier shall be installed in a neat and attractive manner to prevent moisture ingress at seams and penetrations. Band seals shall be used on vertical lap joints. Horizontal lap joints shall have higher piece overlapping lower piece. Penetrations shall be caulked with a silicone or other long life caulk that will not shrink and crack.

4.4.3 Insulating materials shall be protected from the environment at all times. All insulation applied in one day shall have the weather barriers, band seals and penetration caulk applied the same day and all the exposed ends shall be temporarily protected.

Insulation shall not be applied to lines or equipment until after completion of pressure testing. If it is necessary to apply insulation before testing, all welds and flanges shall be left exposed (exposed insulation ends protected from moisture) until testing is complete.

All surfaces to be insulated must be primed or thoroughly cleaned and free of dirt, oil, grease, loose paint, scale or rust and must be dry before insulation is applied. Any surface not cleaned in this manner shall be brought to the attention of customer and approved before proceeding.

4.4.4 Frequently maintained equipment, such as pumps shall be insulated with a two part rigid structure that can be quickly separated for maintenance.

4.4.5 Insulation blanket packs used for valves shall have all air gaps sealed to prevent excessive loss of heat.

4.4.6 Pipe thermal insulation shall be selected based on maximum exposure temperature

	°F	°C
Glass Fiber	500	260
Calcium Silicate	1800	985
Cellular Glass	800	425
Rigid Urethane	230	110
Foamed Elastomer	200	95
Mineral Wool	500	260
Expanded Perlite	1500	815

4.4.7 Vessel thermal insulation type and thickness will be specified on the "Vessel Schedule".

5.0 ELECTRICAL CONDUIT

Electrical conduit shall comply with project electrical specifications as well as referenced codes.

5.1 Conduit shall be installed in a manner to prevent moisture entry or accumulation due to condensation. This should include bottom entry into enclosures where possible, low point conduit drains and drip loops on entry/exit wiring.

5.2 Equipment enclosures, conduit fittings, connection boxes, etc. should be closed or temporarily protected from moisture (rain, snow, hosing) at the end of each day.

5.3 Heater cable power connection points shall not be the low point in a conduit run. If at the end of a run, a low point drain should be installed below the power connection box and the conduit teed over and up to the power connection box.

6.0 ELECTRICAL HEAT TRACING SELECTION

The selection of the appropriate heat tracing family shall be based on the maximum maintain temperature and maximum exposure temperature. Selection of specific heaters within a family will be based on the heater power output being equal to or greater than the worst case heat loss as calculated in Section 4.0. Additional factors such as required maintain temperature and maximum system design temperatures, i.e. maximum and minimum allowable product temperature and maximum allowable material temperature, must also be considered.

6.1 LOW TEMPERATURE, FREEZE PROTECTION

Maximum Maintain Temperature = 65°C (150°F)
Maximum Exposure Temperature = 85°C (185°F)

6.1.1 The electric heating cable shall be a parallel, self regulating heater such that it can be cut to length in the field without effecting power output per unit length. Initial design shall not exceed 75% of maximum rated circuit length, allowing for added field changes.

6.1.2 The heating element shall be a radiation cross linked, semi-conductive core extruded over two parallel, stranded 16 ga bus wires. The heating element shall vary its power output inversely with pipe temperature at every point along its entire length such that power output is reduced as temperature increases.

6.1.3 The heating cable shall operate at _____volts without the use of special transformers. (110, 120, 208, 220, 240, 277).

6.1.4 The heating cable shall have an unconditional temperature rating of 100°C (212°F) or better per the T5 rating in the National Electrical Code.

6.1.5 The base heater shall have two jackets. The first will be a thermoplastic jacket extruded over and thermally bonded to the heating core to prevent moisture penetration and wicking along the core. The second jacket shall be extruded over the first jacket and will provide dielectric protection.

6.1.6 A continuous tinned-copper braid shall be installed over the heater to provide an electrical ground path.

6.1.7 For installations where the heater can be exposed to aqueous solutions of inorganic chemicals, or to protect against mechanical abuse, a continuos polyolefin jacket shall be extruded over the braid to provide additional protection.

6.1.8 For heater installations in corrosive environments, a continuous fluoropolymer jacket shall be extruded over the braid to provide additional protection.

6.1.9 The heater shall be manufactured and tested for a design life of 20 years based on accelerated aging techniques specified in IEEE Standards 1, 98, & 99 and UL Standard 746B.

6.1.10 The heat tracing cable shall be warranted against manufacturing defects for 10 years from date of shipment.

6.2 MEDIUM TEMPERATURE, STEAM CLEANED SYSTEMS

Maximum Maintain Temperature = 121°C (250°F)
Maximum Exposure Temperature = 191°C (375°F)

6.2.1 The electric heating cable shall be a parallel, self regulating heater such that it can be cut to length in the field without effecting power output per unit length. Initial design shall not exceed 75% of maximum rated circuit length, allowing for added field changes.

6.2.2 The heating element shall be a semi-conductive fluoropolymer core extruded over two parallel, stranded 16 ga bus wires. The heating element shall vary its power output inversely with pipe temperature at every point along its entire length such that power output is reduced as temperature increases.

6.2.3 The heating cable shall operate at _____volts without the use of special transformers. (110, 120, 208, 220, 240, 277)

6.2.4 The heating cable shall have an unconditional temperature rating of 446°F or lower per the T3 rating.

6.2.5 The base heater shall have a continuous fluoropolymer jacket extruded tightly over the core to provide dielectric protection and to provide a moisture barrier.

6.2.6 A continuous tinned copper braid shall be installed over the heater.

6.2.7 For heater installations in corrosive environments, a continuous fluoropolymer jacket shall be extruded over the braid to provide additional protection.

6.2.8 The heater shall be manufactured and tested for a design life of 20 years based on accelerated aging techniques specified in IEEE Standards 1, 98, & 99 and UL Standard 746B.

6.2.9 The heat tracing cable shall be warranted against manufacturing defects for 10 years from date of shipment.

6.3 HIGH TEMPERATURE MAINTENANCE, HIGH TEMPERATURE EXPOSURE

Maximum Maintain Temperature = 371°C (700°F)
Maximum Exposure Temperature = 593°C (1100°F)

6.3.1 The electric heating cable shall be a series resistance mineral insulated cable consisting of a heating (hot) section of a specified length joined to a power lead (cold) section of sufficient length to reach a junction box or a thermostat box.

6.3.2 The heating section shall be constructed with two high performance alloy conductors insulated with inorganic magnesium oxide and covered with a fully annealed Incoloy 825 sheath.

6.3.3 The heating cable shall operate at _____volts. (110, 120, 208, 220, 240, 277, 300, 347, 440, 480, 550, 600)

6.3.4 The cold section shall consist of copper conductors encased with the same material used in the heating section and will have a current carrying capacity in accordance the with National Electrical Code.

6.3.5 Heater cable assembly shall be accomplished by butting the conductors of the hot and cold sections together and silver soldering them. Then a metallic sleeve shall be soldered to the sheath of the hot and cold sections. A splice splint shall be mechanically attached over the sleeve area for physical protection of the joint. An end cap shall be silver soldered to the sheath at the end of the hot section. The power termination at the end of the cold section shall consist of 12 inch long XLPE or THHN insulated stranded pigtail wires butted to cold section conductors and silver soldered. A potted metallic pigtail sleeve shall be silver soldered to the sheath of the cold section making the entire assembly hermetically sealed.

6.3.6 All heating cables shall be tested before shipment. Each cable shall be immersed in a 100 PSI pressurized water bath for one hour prior to the following tests:

- High potential test for one minute using a 60 Hertz supply between conductors and sheath.
- 500 volt DC megger insulation test
- Heating element resistance test to confirm element resistance is within 10% of specified values.

6.3.7 Each heater unit shall have a permanently affixed stainless steel tag giving required identification data.

6.3.8 Hot-cold junctions shall be mounted outside of the thermal insulation on all high exposure temperature (over 316°C/ 600°F) applications. High wattage or high maintain temperature applications shall have the heating section heat sinked as it penetrates the thermal insulation with a special high temperature adaptor.

6.3.9 The heat tracing cable shall be warranted against manufacturing defects for 10 years from date of shipment.

6.4 VESSEL HEATING PANELS

Maximum maintain temperature = 79°C (175°F)
Maximum exposure temperature = 220°C (428°F)

6.4.1 Heat tracing of insulated vessels shall be accomplished with flexible, silicone insulated heating panels approved for use on metallic vessels.

6.4.2 The heating panels shall be capable of maintaining 79°C (175°F) with a maximum exposure temperature of 220°C (428°F).

6.4.3 The heating panels shall be equipped with a continuous stainless steel metallic sheath, providing physical protection and a protective ground plane over the exposed surface of the heater.

6.4.4 Heat transfer contact cement shall not be allowed.

7.0 DISTRIBUTION PANEL

7.1 The power distribution panels shall be located close to the physical location of the heat trace cables as the branch circuit breakers shall serve as local disconnect means for each heat trace circuit. Wherever practical the panels shall be located in unclassified, non-corrosive areas.

7.2 A hard wired ground shall be provided between the distribution panel and each heater circuits ground braid.

7.3 Critical process circuits shall be protected by a separate branch circuit breaker. Multiple cable segments may be grouped on a single breaker for non-critical processes.

7.4 Ground fault detection or circuit breakers shall be used on all circuits. All electrical connections shall be moisture proofed to eliminate nuisance tripping from condensation in connection enclosures.

7.5 Breakers shall be oversized for self regulating heater cables to prevent tripping from cold start up inrush currents where applicable.

8.0 TEMPERATURE CONTROL

Heat tracing circuit control shall be provided in accordance with the following guidelines.

8.1 Freeze Protection

Freeze protection circuits with maximum exposure temperatures 65°C (150°F) or less shall be controlled with an ambient sensing thermostat and properly sized contactor for each power distribution panel. Circuits shall be energized when ambient temperature drops to 4°C (40°F).

8.2 Temperature Maintenance

Heat tracing circuits for pipes and vessels having maintain temperatures above 4°C (40°F) and/or exposure temperatures above 65°C (150°F) shall be individually controlled.

8.2.1 Local temperature control shall be provided by mechanical, bulb and capillary thermostats or electronic controller approved for the area classification. Each heat tracing circuit shall be energized when pipe or vessel temperature drops below the desired maintain temperature as specified on the line list or vessel schedule. Thermostats shall be selected in accordance with electrical switching requirements provided in the heat tracing manufacturer's technical documentation.

8.2.2 Control of critical heat tracing circuits shall be accomplished with the use of a solid state distributed control system providing individual circuit temperature control, temperature monitoring, and alarm functions. The controller shall have the following features:

1. 40 channel microprocessor based system with temperature control and system monitoring, mounted in a NEMA ___ (12, 4, 4X) cabinet. Unit shall be failsafe, include a self calibrating feature, large two line twenty character display and security codes to control access. Power switching relays shall be rated to handle ____ (120, 240, 277, 347, 480, 550, 600).

2. Temperature control features must be selectable per channel and include: maintain temperature, low temperature alarm, high temperature alarm, deadband of control, failure mode (heater on or off), circuit active or off, and Centigrade or Fahrenheit display units. Temperature sensor inputs must be three wire 100 ohm RTD or type J thermocouple inputs and be field selectable. Up to four different programs must be able to be stored to allow rapid variable change for different chemical processes.

3. Heater monitoring features must include adjustable ground fault alarm, adjustable ground fault trip, deactivation of ground fault trip, heater current, loss of voltage, low heater current alarm, and high heater current alarm. Unit shall be equipped with an adjustable auto test cycle to periodically turn heaters on and verify their performance.

4. Controllers shall have communications capability- shall utilize Modbus protocols for communicating with other systems. The controller must also communicate with PC host communications software. The PC communications software shall include the ability to monitor each channel's status and alarms. Controller settings must be able to be changed from the PC host software.

5. Display shall show status of following functions: channel number, actual pipe temperature, heater status (on or off), alarms, if alarms have been acknowledged, circuit status (active or turned off), and program in operation.

9.0 CIRCUIT MONITORING FOR MECHANICAL THERMOSTAT AND AMBIENT CONTROL SYSTEMS

Each electrical heat tracing circuit shall be independently monitored for: (1) Heater continuity, (2) Heater voltage (85-300 VAC), and (3) Heater current (50mA-30A).

9.1 Each monitoring panel shall have the capacity for ____(12,24,48) heater circuits with a minimum of 4 circuits. Additional circuits shall be installed in modules of 4 circuits each such that a total of _____(3,6,12) 4-circuit sensing cards are installed for the full circuit capacity.

9.2 The monitoring system shall be microprocessor based and shall continuously scan all circuits.

9.3 The monitoring system shall be useable for any heater type (series or parallel) and for any manufacturer's heater.

9.4 The monitoring system shall be compatible with a standard one or two conductor heating cable. No additional monitoring wires shall be permitted. The monitoring system, therefore, shall be retrofittable to any existing heater installation without requiring the heater to be replaced.

9.5 The monitoring system shall have the following alarm features: Loss of bus wire continuity, loss of circuit voltage, low heater current, alarm silence, programmable alarm delay, programmable scan speed, programmable circuits to be scanned, and auto fault reset.

9.6 The monitoring system shall be suitable for installation in Division 2 hazardous areas. It shall be passive such that the system does not interfere with and is not effected by other electrical or electronic equipment.

9.7 Monitoring system shall have communications capability - shall utilize Modbus protocols for communicating with other systems. The controller must also communicate with PC host communications software. The PC communications software shall include the ability to monitor each channel's status and alarms. Monitor settings must be able to be changed from the PC host software.

10.0 INSTALLATION

Heater installation and electrical design shall conform to the manufacturer's published specifications and guidelines.

10.1 All electrical heat tracing components, power connections, splices, tees and end seals shall be by the same manufacturer as the heat tracing cable and shall be approved by a Certifying Agency for installation in the designated areas.

10.2 Heating cable shall be installed to allow easy removal in maintenance items such as pumps, valves, strainers and filters.

10.3 Heater cables shall not be installed before completion of hydro tests and any piping rework to avert possible physical damage to the cables.

10.4 All terminations and electrical connections shall be waterproofed to prevent moisture tracking electrical faults.

10.5 Self-regulating heaters shall be attached to the pipe with adhesive backed glass fiber tape at 1-foot (30 cm) intervals.

10.6 MI cable shall be attached to the pipe with stainless steel tie wire at 1-foot intervals.

10.7 Vessel heating panels shall be attached to the vessel wall with adhesive backed aluminum tape.

10.8 NO HEAT TRANSFER CEMENT of any type shall be permitted.

10.9 Caution signs shall be installed at 10-foot (300 cm) intervals along the pipe or around the vessel.

11.0 START UP/CHECK OUT

11.1 Upon completion of thermal insulation installation the heater cable shall be meggered to verify no damage has occurred. Tests should use at least a 500 VDC megger. Do not use a megger with an excess of 2500 VDC for polymer heater cables and 1000 VDC for mineral insulated heater cables. Minimum acceptable readings should be 20 megohms per circuit, regardless of length.

11.2 Each circuit shall be energized and voltage and current measured and documented to verify the installation is properly functioning.

11.3 Temperature controls should be operated to verify functioning.

12.0 DOCUMENTATION

12.1 The installed system documentation shall include cables/controls/accessories installed on each circuit, electrical parameters and panelboard (breaker, control, alarm) circuit assignments.

12.2 Test documentation shall be maintained of installation and start up test values and turned over to plant maintenance upon completion of the project to assist in future maintenance.