Appendix J: Engineering Specification for Electrical Heat-Tracing Systems

Contents

1 Scope

This specification covers the requirements of materials and support services for heat-tracing systems supplied by the vendor. Neither the supply of the materials related to the connection of the power supply nor the installation of the entire system is part of this specification.

2 Codes, Approvals, and Standards

The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured, and tested in accordance with the applicable requirements of the latest edition of the following codes and standards.

FM	Factory Mutual Research Corporation
IEEE 515	Institute Of Electrical and Electronics Engineers
NEC	U.S. National Electric Code (NFPA 70)
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
UL 746B	Underwriters' Laboratories, Inc.
ANSI	American National Standards Institute
IEC 216	International Electro-Mechanical Commission
BS6351	British Standard for Electrical Surface Heating
CSA	CSA International

3 Electric Heat Trace System Materials

3.1 Self-Regulating Heating Cables

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters can use fewer runs due to higher power output at higher temperatures.

A. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

B. Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:

1. Retention of at least 75 percent of rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
2. Retention of at least 90 percent of rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 7468, IEC 216-1 Part 1.

C. A warranty against manufacturing defects for a period of 10 years shall be available.

D. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

3.1.1 FREEZE-PROTECTION SYSTEMS

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

D. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

Table G.1 Minimum Self-Regulating Indices

Heating Cable	S.R. Index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

E. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.

F. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 5O°F (10°C) and 210°F (99°C), allowing at least six minutes of dwell time at each temperature.

G. The heating cable shall be Raychem BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

3.1.2 PROCESS-TEMPERATURE MAINTENANCE WITH NO STEAM EXPOSURE

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable has a temperature identification number (T-rating) of T4 (275°F or 135°C) without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

D. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 300°F (110°C), allowing at least six minutes of dwell time at each temperature.

E. The heating cable shall be Raychem QTVR-CT self-regulating heater, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by Tyco Thermal Controls.

3.1.3 FREEZE PROTECTION AND PROCESS TEMPERATURE MAINTENANCE WITH STEAM EXPOSURE

A. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires, separated by a fluoropolymer spacer and helically wrapped with a self-regulating fluoropolymer fiber that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T2C (446°F or 230°C) or lower without use of thermostats.

B. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

D. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 450°F (232°C), allowing at least six minutes of dwell time at each temperature.

E. The heating cable shall be Raychem XTV-CT self-regulating heater, for continuous exposure (maintain) capability up to 250°F (121°C) and intermittent exposure capability up to 420°F (215°C or 250 psi steam), as manufactured by Tyco Thermal Controls.

3.1.4 SYSTEMS FOR DIVISION 1 HAZARDOUS (CLASSIFIED) LOCATIONS

The following requirements shall apply in addition to the criteria specified in paragraph 3.1.1, 3.1.2, or 3.1.3.

A. The self-regulating heating cable shall be specifically FM-approved or CSA-certified for use in Division 1 locations.

B. A ground fault protection device set at 30 mA, with a nominal 100 ms response time, shall be used to protect each circuit.

C. The temperature identification number (T-rating) of the cable used shall comply with FM and CSA requirements as applicable.

D. Connection methods used with the cable shall be compatible and approved as a part of the system manufactured and supplied by the heating cable vendor for use in the Division 1 location.

E. For plastic pipe and vessel applications, the heating cable shall be Raychem HBTV-CT self-regulating heater, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

F. The heating cable shall be Raychem HQTV-CT self-regulating heater, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by Tyco Thermal Controls.

G. The heating cable shall be Raychem HXTV-CT self-regulating heater, for continuous exposure (maintain) capability up to 250°F (121°C) and intermittent exposure capability up to 420°F (215°C or 250 psi steam), as manufactured by Tyco Thermal Controls.

3.2 Power-Limiting Heating Cables

All heat-tracing applications with continuous exposure (maintain) temperatures to 455°F (230°C) or power-off exposure temperatures to 482ºF (250ºC) shall use power-limiting cables cables. Continuous exposure (maintain) temperatures are based on wattage and voltage used, consult with vendor for specific cable temperature limits. Applications below 482ºF (250ºC) continuous exposure, power-off, shall consider power-limiting cables if more than one run of self-regulating heating cable is required.

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters can use fewer runs due to higher power output at higher temperatures.

A. Power-limiting heating cable shall use a metallic heating element that varies its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be a parallel-zoned heating cable with a positive temperature coefficient heating element spirally wound around a flexible glass fiber core.

B. A ground fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

C. Maximum heating cable sheath temperature, per either the FM or CSA method of calculation, shall be submitted with the bid or design for all Division 1 and Division 2 applications.

D. The power-limiting heating cable shall have 12AWG copper bus wires.

E. A warranty against manufacturing defects for a period of 10 years shall be available.

F. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

G. The heating cable shall be Raychem VPL-CT power-limiting heater, with continuous exposure (maintain) capability of 300ºF (150ºC) and intermittent exposure capability up to 482ºF (250ºC), as manufactured by Tyco Thermal Controls.

3.3 Mineral Insulated Heating Cable Systems

All heat-tracing applications with continuous exposure (maintain) temperatures above 300°F (150°C) 455°F (230°C) or intermittent exposure temperatures above 482°F (250°C) shall use factory-terminated, mineral insulated (MI) cables.

A. MI cable shall be magnesium oxide insulated, with copper or alloy conductors and an Incoloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Incoloy 825.

B. Each cable shall be factory-terminated to the required length, consisting of the lengths required for the pipe or equipment, plus an allowance for areas of additional heat loss such as valves flanges fittings, supports, and the like, plus a reasonable excess to allow for field variations. The cold lead section shall be seven feet long unless otherwise specified.

C. Maximum heating cable sheath temperature, per either the FM or CSA method of calculation, shall be submitted with the bid or design for all Division 1 and Division 2 applications.

D. Each cable shall be shipped with the catalog number marked on the outside of the package, and a permanent metallic cable tag containing the heating cable length, wattage, voltage, and current draw. If the cable has been designed for a hazardous location, the tag shall also indicate the area classification and heat-tracing circuit number.

E. The heating cable shall be Pyrotenax brand Alloy 825 MI, mineral insulated heating cable with a maximum application temperature for the heating units of 1022ºF (550ºC) and a maximum exposure temperature for the heating cable of 1238ºF (670ºC), as manufactured by Tyco Thermal Controls.

3.4 Long-Line Systems

A. Self-Regulating, Two-Wire geometry, Freeze Protection (500-1250 feet). For freeze protection applications, without high temperature exposure, up to 1250 feet, a two-wire self-regulating heater is often the best choice.

1. The heating cable shall consist of two 10 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. The cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.
2. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
3. The heating cable shall be Raychem LBTV2-CT self-regulating heater, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

B. Self-Regulating, VL geometry, Freeze Protection (1000-12,000 feet). For freeze protection applications, without steam exposure, above 1250 feet up to 12,000 feet a self-regulating freeze protection heater in a VL geometry is often the best choice.

1. The heating cable shall consist of two 10 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core, plus three additional 10 AWG nickel-plated copper bus wires. The cable shall be able to be connected directly to a 3-phase, 4-wire, 480 Vac or 600 Vac source.
2. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from mechanical abuse by a modified polyolefin outer jacket or from mechanical abuse and chemical attack by a fluoropolymer outer jacket.
3. The heating cable shall be Raychem VLBTV2-CT self-regulating heater, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), manufactured Tyco Thermal Controls.

C. Self-Regulating, VL geometry, Freeze Protection and Process Temperature Maintenance with Steam Exposure (1000-6000 feet). For process temperature maintenance and freeze protection with steam exposure a self-regulating process temperature maintenance heater in a VL geometry is often the best choice.

1. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires embedded in a self-regulating polymeric core, plus three additional 14 AWG nickel-plated copper bus wires. The cable shall be able to be connected directly to a 3-phase, 4-wire, 480 Vac or 600 Vac source.
2. The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
3. The heating cable shall be Raychem VLKTV2-CT self-regulating heater, with continuous exposure capability up to 250°F (121°C) and intermittent exposure capability up to 420°F (215°C or 250 psi steam) as manufactured by Tyco Thermal Controls.

D. Constant-wattage Series Resistance, Freeze Protection and Process Temperature Maintenance up to 250ºF with Steam Exposure (500-8,000 feet). For process temperature maintenance and freeze protection with steam exposure a constant wattage series resistance heater is often the best choice, particularly when more than one run of self-regulating heater is needed.

1. The heating cable shall be a series resistance constant wattage heater. It shall consist of one or two copper conductors or copper alloy conductors insulated with high temperature heavy-walled fluoropolymer.
2. The heating cable shall have a tinned or nickel-plated copper braid with a resistance less than the heating cable bus wire resistance as determined in a type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
3. The heating cable shall be constant wattage Raychem SC, with continuous exposure capability up to 400°F (204°C) and Raychem SCH with continuous exposure capability up to 482 °F (250°C) as manufactured by Tyco Thermal Controls.

E. Skin-effect Tracing Systems, Circuit lengths up to 15 miles, Freeze Protection and Process Temperature Maintenance up to 392ºF (200ºC), with or without Steam Exposure. For very long lines, process-temperature maintenance and freeze-protection skin-effect tracing is usually the best choice.

1. The heating system shall consist of an electrically insulated, temperature-resistant conductor with high temperature heavy walled fluoropolymer insulation installed inside a heat tube and connected to the tube at the far end.
2. The heat tube shall be ferromagnetic and thermally coupled to the carrier pipe that is being traced.
3. The design must be done by the manufacturer
4. The installation should be done under the supervision of the manufacturer.
5. The heat-tracing system system shall be Tracer STS (Skin-effect Tracing System) long-line heating system as manufactured by Tyco Thermal Controls.

3.5 Termination for Self-Regulating and Power Limiting Heating Cables

A. All connection components used to terminate heating cables, including power connectors, splices, tees, and connectors, shall be approved for the respective area classification and approved as a system with the particular type of heating cable in use. Under no circumstances shall terminations be used which are manufactured by a vendor other than the cable manufacturer.

B. In order to keep connections dry and corrosion resistant, components shall be constructed of non-metallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The component stand shall allow for up to 4 inches (100 mm) of thermal insulation.

C. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance-free operation and ease of reentry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of a heat gun, torch or hot work permit for installation.

E. Components shall be rated to a minimum installation temperature of –40ºF (–40ºC), minimum usage temperature of –75ºF (–60ºC) and maximum pipe temperature of 482ºF (250ºC).

F. The component system shall be Raychem JBM-100-A-L connection kit complete with integral LED power indicating light to serve as complete power, splice or tee connection for up to three Raychem BTV, QTVR, XTV, or VPL industrial parallel heating cables as manufactured by Tyco Thermal Controls.

3.6 Thermostats and Contactors

A. Freeze protection systems shall operate using self-regulating control or with the Digitrace Digitrace AMC-1A or Digitrace AMC-F5 thermostat and the Digitrace E104-100A or Digitrace E304-40A contactor in ordinary areas, and Digitrace AMC-1H thermostat with Digitrace E307-40A contactor in hazardous locations, as supplied by Tyco Thermal Controls.

B. Process temperature maintenance systems shall operate using self-regulating control or with Digitrace AMC-1B thermostat and Digitrace E104-100A or Digitrace E304-40A contactor in ordinary areas and Digitrace E507S-LS or Digitrace RAYSTAT-EX-03-A thermostats and Digitrace E307-40A contactor in hazardous locations, as supplied by Tyco Thermal Controls.

3.7 Heat-Trace Panels

A. For freeze protection or group control process-temperature maintenance systems, distribution panels shall be wall-mounted enclosures, including a panel board with ground fault protection devices (30 mA trip level). The panels shall provide ground fault alarm capabilities. If more than one circuit is required, a main contactor shall be used. The panels shall operate with ambient-sensing or proportional ambient-sensing controllers. The panel shall be the Tracer HTPG heat tracing panel as manufactured by Tyco Thermal Controls.

B. For individual control process temperature maintenance systems, distribution panels shall be wall-mounted enclosures, including a panel board with ground fault protection devices (30 mA trip level). The panels shall provide ground fault alarm capabilities. Circuits shall be switched by individual contactors operated by line-sensing controllers. The panel shall be the Tracer HTPI heat tracing panel as manufactured by Tyco Thermal Controls.

3.8 Control and Monitoring Systems.

All control and monitoring systems shall be capable of communicating with a host PC for central programming, status review and alarm annunciation. All systems shall include, but not be limited to, the following:

A. Alarm limits and set-point temperatures shall be programmable from the central monitoring and control panel in °F and °C. The system shall include an alphanumeric display with multi-language support and password protection or lockable cabinet to prevent unauthorized access to the system.

B. The system shall be switched by an external solid-state or mechanical relay with a minimum rating of 30 amps.

C. The system shall be capable of assigning one or more RTDs to a circuit to monitor temperature. The controller shall be capable of one RTD to control the heater circuit and a second RTD for another control point or to measure sheath temperature of a heater for high temperature cutout.

D. The system shall monitor temperature, voltage and line current to the systems

E. The system shall monitor ground-fault current and offer the option of alarm or trip if the ground fault exceeds the selectable level.

3.8.1 SINGLE- OR DUAL-CIRCUIT CONTROL AND MONITORING DEVICES.

A. The system shall be field-mounted and shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D when using a solid state switching device.

B. The system shall provide user with the option of line-sensing control with a user- selectable dead band, ambient sensing, proportional ambient sensing (PASC), and power limiting control modes.

C. The system shall provide an isolated triac alarm relay or a dry contact relay for alarm annunciation back to a Distributed Control System (DCS).

D. Electrical code approved ground fault detection equipment shall be integral to the controller to simplify installation and reduce total cost.

E. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP) or stainless steel for corrosion resistance and protection from moisture.

F. DigiTrace units may be network ready to provide communication to a host PC running Windows based Supervisor software for central programming, status review and alarm annunciation. DigiTrace units shall support the Modbus RTU or ASCII/HTCBus communications protocol and be supplied complete with RS-485 communications interface capability.

G. The system shall be DigiTrace 910 or DigiTrace 920 heat-tracing control systems, as manufactured by Tyco Thermal Controls.

3.8.2 MULTICIRCUIT HARD-WIRED CONTROL AND MONITORING SYSTEMS - RACK MOUNTED

H. The system shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D. when using a solid state switching device or using electromechanical relays and a Z-purge system.

I. The system shall provide an isolated triac alarm relay for alarm annunciation back to a Distributed Control System (DCS).

J. Electrical code approved ground fault detection equipment shall be integral to the controller to simplify installation and reduce total cost.

K. Multicircuit hard-wired control and monitoring systems shall be rack mounted complete with integral power distribution panels.

L. The panel shall be complete with individual control contactors, circuit breakers, power transformers (adjacent to each panel), space heaters or panel cooling system as required.

M. Units shall be network ready to provide communication to a host PC running Windows based Supervisor software for central programming, status review and alarm annunciation. DigiTrace units shall support the Modbus RTU or ASCII/HTCBus communications protocol and be supplied complete with RS-485 communications interface capability.

N. The system shall be DigiTrace T2000 heat-tracing control systems, as manufactured by Tyco Thermal Controls.

3.8.3 MULTICIRCUIT DISTRIBUTED-ARCHITECTURE CONTROL AND MONITORING SYSTEM

A. The control and monitoring system shall be capable of controlling heat-tracing circuits with line-sensing control, ambient-sensing control, or proportional ambient-sensing control (PASC). The system shall be capable of using resistance temperature detectors (RTDs) which are wired directly to the central monitoring systems, to a remote module that communicates with the central monitoring system over a twisted pair, or to a temperature transmitter that communicates to a remote module over the bus wires of the heater (Power-line carrier technology).

B. For temperature monitoring without power-line carrier technology the system shall use resistance temperature detectors (RTDs) which are wired to the central monitoring and control panel or to a remote module that communicates with the central monitoring and control system via a twisted pair. For temperature control the system shall use on-off control methods with contactors addressed through the central monitoring and control panel.

C. The non-power-line carrier part of the system shall be compatible with all types of heating cables and capable of performing the following functions:

1. Monitoring and controlling pipe temperatures.
2. Providing real-time temperature and alarm log readouts.
3. Providing alarms in the event of low or high pipe temperature, or in case of sensor failure.
4. Providing remote alarm annunciation.
5. Interfacing with personal computers and DCS systems.

D. The system shall be capable of utilizing power line carrier technology that uses the heating cable bus wires and power distribution wiring for communication, thus eliminating additional field instrument/sensor wiring. Temperature transmitters shall monitor heating cable continuity and temperature at any point along the heat-tracing circuit, including teed-off heating segments and the end of the circuit. The temperature monitoring the system shall use resistance temperature detectors (RTDs) wired directly to the temperature transmitters. Electrical isolation between the plant environment and the system shall be provided by dedicated, shielded, heat-tracing isolation transformers and filters.

E. The system shall use on-off control methods to maintain temperatures of heat-tracing circuits. Process temperature control shall be accomplished using contactors addressed through the central monitoring and control panel. The contactors shall be grouped into a common NEMA 12, 4 or 4X-rated enclosure. Ambient temperature control and proportional ambient sensing control (PACS) shall be accomplished using dry contacts in the central monitoring and control panel to switch an auxiliary contactor, which in turn energizes or de-energizes heat-tracing circuits.

F. The power-line carrier part of the system shall be compatible with all types of parallel heating cables and capable of performing the following functions:

1. Monitoring and controlling pipe temperatures.
2. Monitoring heating cable continuity and ground leakage current if GFPDs are used.
3. Providing alarms in the event of low or high pipe temperatures, loss of heating cable continuity, loss of panel power, loss of service voltage to the heating cable, sensor failure, or microprocessor failure.
4. Providing time-stamped temperature and alarm log readouts.
5. Performing self-diagnostic routines for commissioning and troubleshooting.
6. Interfacing with DCS systems.

G. The monitoring and control system shall be the DigiTrace 200N monitoring and control system as manufactured by Tyco Thermal Controls.

4 Engineering

A. The vendor shall be given a line list from which to design and estimate a complete heat-tracing system. The bid package shall also include area layout and orthographic drawings.

B. The vendor shall provide a detailed design utilizing standard heat-tracing design software, such as Tyco Thermal Controls TraceCalc Pro software or iequal. At minimum, the design must provide the following:

1. Circuit identification number.
2. Maintain temperature.
3. Line size and insulation.
4. Heat loss for pipe, valves, and supports.
5. Amount and type of heating cable required.
6. Spiral requirements.
7. Heating cable service voltage.
8. Heating cable power output at the maintain temperature.
9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures.
10. Circuit breaker and transformer sizing.

C. The vendor shall provide heat-tracing isometric drawings at the buyer's request, using either hard copy or machine-readable CAD inputs.

5 Testing

A. Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (M.I.) heater cables shall include but are not limited to the following:

1. Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer's standards.
2. In the field, all heater cables shall be meggered. The following separate field megger readings shall be taken on each self-regulating and each M.I. heater cable:
   a. Heater cable shall be meggered when received at jobsite before installation.
   b. Heater cable shall be meggered after installation, but before insulation is applied.
   c. Heater cable shall be meggered after insulation has been installed.
3. All three of the above field megger readings shall be greater than 20 megohms. Otherwise, the heater cable is not acceptable and shall be replaced.
4. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to User.

Tyco Thermal Controls
300 Constitution Drive
Menlo Park, CA 94025-1164
Tel (800) 545-6258
Fax (800) 527-570