Industrial Electrical Heat Tracing Systems

nVent RAYCHEM

CONNECT AND PROTECT

Engineering specification for industrial advanced electrical heat-management systems

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1 SCOPE

1.1 This specification together with the project line list, plans and elevation drawings, isometric drawings and P&ID's provide the requirements for the design, fabrication, insulation, installation QA/QC, commissioning and testing of the heat management system. Plan and detail drawings shall be provided for the following systems: cable tray/conduit, power, control, grounding and instrumentation.

1.2 The heat management system shall include power transformers, control panels, heat tracing cables and components, temperature sensors, temperature controllers, contactors/SSR's, circuit breakers, pre-fabricated instrument enclosures, conduit, cable tray and support, wire, insulation with jacketing and all necessary monitoring equipment.

1.3 It is recommended that all parts of the Heat Management System, as detailed in Section 1.2, be installed, commissioned, and documented by a single Heat Management System Integrator to obtain the "warm pipe" warranty described herein.

1.4 When possible, electric heat-trace control panels, power transformers and power distribution equipment shall be centrally located in the operating units to minimize the lengths of the secondary power distribution cables and conduit in the area they serve.

1.5 The control panels, power transformers, and power distribution equipment shall be suitable for use in the area classification in which they are installed. Whenever possible, they shall be installed in non-classified areas. In general, the control panels and transformers shall be installed in optimized locations to reduce the cost of the ingress and egress of power distribution to and from the panel.

1.6 When there is a large density of heat trace circuits in one area, a pre-fabricated control and power distribution building or switch rack assembly should be considered.

1.7 For projects utilizing 3D modeling software, it recommended the nVent TRACERLYNX program be used for EHT designs.

2 CONDITIONS

2.1 Conformance

2.1.1 The design, drawings, equipment, and materials supplied shall be in conformance with all conditions and instructions in the purchase order or sub contract and this specification. It is the responsibility of the Heat Management System Integrator to comply with all requirements.

2.2 Exceptions

2.2.1 If total compliance is not possible, each exception shall be clearly stated to in writing and submitted with the quotation. Specific section references to the specification requirements shall be included with the list and titled "Exceptions to Specification". Any apparent discrepancies in this specification or in the supplements or attachments shall be clarified before proceeding with work.

2.3 Product Approvals

2.3.1 The freeze protection and heat tracing equipment, including materials, fittings, devices, apparatus, and the like shall be approved by and bear the mark of one of the following agencies:

Underwriters' Laboratories (UL), (c-UL) for Canada, or (c-UL-us) for both US and Canada; Intertek/ETL (ETL), (c-ETL) for Canada, or (c-ETL-us) for both US and Canada; Factory Mutual (FM), (c-FM) for Canada, or (c-FM-us) for both US and Canada; Canadian Standards Association (CSA), (c-CSA) for Canada, or (c-CSA-us) for both US and Canada; or IECEx for applications in the specified service conditions and area classification.

Where no such approval exists, the Heat Management System Integrator shall produce documentation, for approval by Owner, that the equipment meets the required service conditions.

2.4 Hazardous Area Approvals

2.4.1 All equipment shall be approved for use for the area in which it is installed.

2.5 Workmanship and Materials

2.5.1 All materials and components shall be suitable for continuous and reliable service in areas subject to the design parameters described in Section 3.0.

2.5.2 The equipment offered shall be of the same construction and materials as similar equipment now in satisfactory service for at least one year, unless approved by Owner.

3 DESIGN PARAMETERS

3.1 Environmental Conditions

3.1.1 The Heat Management System Integrator shall certify and warrant that the design and the equipment shall be suitable to deliver rated performance and service life when subjected to the project specific environmental data conditions provided by the client.

3.2 Design Safety Factors

3.2.1 All tracing design for pipes shall utilize a minimum of 25% safety factor in calculated heat input. All tracing designs for instruments, tanks and vessels shall utilize a minimum of 50% safety factor. Heat loss calculations shall be submitted to verify compliance.

3.3 Electrical Areas Classifications

3.3.1 The equipment, materials, and installation shall be suitable for the electrical classification of the area involved.

3.3.2 Area classification drawings should be available for identifying the boundaries of the areas.

3.3.3 The electric tracing design shall comply with IEC/IEEE 60079-30-1 for sheath temperature calculations and approvals within specified auto-ignition parameters per NFPA 497.

3.4 Available Power Supply

3.4.1 Owner will furnish a separate incoming power feeder to each heat trace power transformer.

A. Incoming voltage: 480 volts, 3-phase, 4-wire, 60 hertz “delta” or 480/277 volts, “wye”.

B. Heating cable design shall be suitable to deliver rated performance and service life when subjected to voltage variations from 90% to 110% of nominal distribution voltages. Nominal voltages for design are:

1. 120 volts
2. 208 volts
3. 240 volts
4. 277 volts
5. 480 volts

4 FREEZE PROTECTION SYSTEM

4.1 A completely coordinated and integrated electrical freeze protection system shall be provided for process, instrumentation and miscellaneous piping systems.

4.2 The purpose of the freeze protection system is to apply sufficient electric heat to the outside of liquid or vapor filled pipes and equipment to prevent freezing during exposure to minimum ambient temperatures and a no flow condition.

4.3 The freeze protection system shall possess the following sub-assemblies and/or options:

4.3.1 For freeze protection or group control process-temperature maintenance systems, distribution panels shall consist of an enclosure, 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 control. The panel shall be the nVent RAYCHEM HTPG or nVent RAYCHEM NGC-30, NGC-40 heat tracing panel. The nVent RAYCHEM Elexant 4010i, 4020i, Elexant 3500i or nVent RAYCHEM 920 heat-tracing controllers may be used for single or dual circuit freeze protection applications.

4.4 A separate 480-volt, 3-phase circuit breaker shall be provided by the owner for electrical service to each power transformer serving each heat tracing control panel. The owner shall also furnish and install conduit and wiring from the power supply to field mounted transformers. No feeders shall exceed 3% or 5% voltage drop (project specific).

4.5 Heater circuits shall be serviced from branch circuit breakers in the power distribution panel board located in the freeze protection control panel.

4.6 For freeze protection, multiple heating cables may be operated in parallel from the same power circuit with up to a maximum of five (5) pipes or instrument lines, etc., being serviced from the same branch circuit breaker.

4.7 Multiple loops may be connected to a single branch breaker and can be wired in series, permitting end-of-circuit continuity check.

4.8 Freeze protection for pipes shall include all in-line components. “Buffering” (i.e. inclusion of an insulation layer to protect the electric tracing cable from direct line contact exposure temperatures in excess of their rating) shall not be permitted under any circumstances. All flanges, pumps, valves, devices, supports and appurtenances shall be traced with appropriate additional lengths of heating cable as required by the pertinent installation details.

4.9 In general, instrument tap lines should be pre-traced and pre-insulated tubing bundle. "Buffered" (i.e. inclusion of an insulation layer to protect the electric tracing cable from direct line contact exposure temperatures in excess of their rating) tubing bundle shall not be permitted without permission from Engineering Manager and Management. The instrument tubing should be traced with the same type of heating cable as the tap line and removable insulating blankets or hard-insulated enclosures, type specified elsewhere in these bid documents, should be provided for each instrument. In addition, individual block heaters should be provided and should be powered from the instrument tubing heating cable for each remote transmitter.

4.10 Plants with extensive winter conditions freeze protection systems may require the design to be completed per Section 5.0. Operation of lock-out/tag-out procedures may dictate the use of external panel boards in cold climates. Ground-fault protection must be utilized in all cases.

5 PROCESS HEAT TRACING SYSTEM

5.1 A completely coordinated and integrated electrical process heat tracing system shall be provided for process, instrumentation and miscellaneous piping systems, etc.

5.2 The purpose of the process heat tracing system is to maintain the temperature of process pipes, instrumentation and equipment within a specified range during exposure to the environmental conditions described in Section 3.1. In addition, the heating system may be required to provide heat up and thaw out capabilities as required and defined during the design effort.

5.3 Process heat tracing systems may consist of the following options:

5.3.1 For control process temperature maintenance systems, distribution panels shall consist of an enclosure, including a panel board with ground-fault protection devices (30-mA trip level) through either the circuit breaker or the controller. The panels shall provide ground-fault trip and alarm capabilities. Circuits shall be switched by individual contactors operated by line-sensing controllers. The panel shall be the nVent RAYCHEM HTPI, nVent RAYCHEM NGC-30, NGC-40 heat tracing panel. The nVent RAYCHEM Elexant 4010i, 4020i, Elexant 3500i or nVent RAYCHEM 920 heat tracing controllers may be used for single or dual circuit process heating applications.

A. Each process heat trace control panel shall be housed in a wall/rack mount or free standing enclosure and shall contain the following equipment:

1. Independent single-point temperature controllers (with dual RTD input capability.)
2. Contactors or solid state relays (one per controller)
3. "LOSS OF PURGE" indicating light (if required)
4. Terminal blocks
5. Space heater (if required per the environment)
6. Control power transformers
7. Electric heaters (if required)
8. Main circuit breaker
9. Power distribution panel boards (internal to panel or external)
10. 1 Panel cooling system (if required)

5.4 For the incoming power distribution requirements, see Section 3.4.

5.5 The process heat trace system shall provide heat to the outside of process piping, instrumentation and equipment; and each heating circuit shall be automatically controlled by means of an individual temperature controller connected to a single or dual RTD sensors located on the outside wall of the pipe or equipment. This process control panel shall also be capable of housing freeze protection heat trace circuits with an ambient sensing master temperature controller.

5.6 Each independent temperature controller shall operate an individual contactor or solid-state relay for energizing and de-energizing the heating circuit. Each contactor or relay shall "break" all live legs of the circuit in the de-energized mode and its associated controller shall be protected by a separate branch circuit breaker located in the power distribution panel board.

5.7 For process heat tracing, each process line shall be provided with an individually controlled heating cable. Individual flow and no flow conditions shall be separately traced and controlled. Each line size variation within a flow condition may also require a separate control circuit. Pumps must be removable without affecting the suction and discharge circuit integrity.

5.8 Process heat tracing for pipes shall include all in-line components. "Buffering" (i.e. inclusion of an insulation layer to protect the electric tracing cable from direct line contact exposure temperatures in excess of their rating) shall not be permitted under any circumstances without approval from the Engineering Manager and Management. All flanges, pumps, valves, devices, supports and appurtenances shall be traced with appropriate additional lengths of heating cable as required by pertinent installation details.

5.9 In general, process instrument tap lines shall be pre-traced and pre-insulated bundle. "Buffered" (i.e. inclusion of an insulation layer to protect the electric tracing cable from direct line contact exposure temperatures in excess of their rating) tubing bundle shall not be permitted under any circumstances without approval from the Engineering Manager and Management.

The instrument tubing should be traced with the same type heating cable as the tap line, and instrument enclosures should be provided for each instrument. In addition, individual block heaters should be provided and separately powered and controlled for each remote transmitter.

5.10 Tanks, bins, drums, filters, vessels and other such equipment, which may be identified as requiring process heat tracing, shall be considered as part of the system requirements. Where not identified as being furnished by others, the heating and insulation of this equipment shall be as recommended and designed by the heat management system integrator. Either heating cable or flexible pad type heaters approved by the owner shall be employed, and the heaters for each item of equipment shall be from an individually controlled power circuit. Additionally, canned motor pumps, loading arms and other special applications shall be designed and recommended by the Heat Management System Integrator and approved by Owner.

5.11 Where the heat tracing and insulation for the equipment described in 5.10 is identified as being furnished by others, the heating for each item of equipment shall be powered and controlled from a separate circuit in the process heat trace panel. Providing power and controls for these items shall be considered as a part of the system requirements.

6 ELECTRIC HEAT TRACE SYSTEM MATERIALS

6.1 Self-Regulating Heating Cable Systems

All heat-tracing applications with continuous operating (maintain) temperatures up to 400°F (205°C) or intermittent exposure temperatures up to 500°F (260°C) shall use self-regulating cables as per each cable's applicable ratings.

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. An extended warranty against manufacturing defects for a period of 10 years shall be available.

C. All cables shall be capable of passing a 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).

6.1.1 Freeze-protection and low operating temperature 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 semi-conductive 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. Self-regulating heating cable shall be designed for a useful life of 20 years or more when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 20 years of usage at maximum continuous operating temperature.

D. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

E. 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 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.

F. 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 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.

G. The heating cable shall be nVent RAYCHEM BTV-CT or BTV-CR self-regulating heater, with continuous operating (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

6.1.2 Freeze protection and medium operating temperature 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 semi-conductive 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. Self-regulating heating cable shall be designed for a useful life of 20 years or more when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 20 years of usage at maximum continuous operating temperature.

D. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

E. The heating cable shall be nVent RAYCHEM QTVR-CT self-regulating heater, for continuous and intermittent exposure capability up to 225°F (110°C).

6.1.3 Freeze protection and high operating temperature 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 semi-conductive core that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T3A (356°F/180°C) up to 8 W/ft and T3 (392°F or 200°C) for 10, 12, 15 W/ft (240 V), 10 W/ft (120 V) versions and T2D (419°F or 215°C) for 15, 20 W/ft (120V), 20 W/ft version 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. Self-regulating heating cable shall be designed for a useful life of 30 years or more when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 30 years of usage at maximum continuous operating temperature.

D. Self-regulating heating cable shall have minimum 95% power retention after 10 years at maximum operating temperature.

E. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

F. The heating cable shall be nVent RAYCHEM XTVR-CT self-regulating heater, for continuous operating maintain capability up to 302°F (150°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam).

6.1.4 Freeze protection and very high operating temperature with steam exposure

A. The heating cable shall consist of two 14 AWG nickel-plated copper bus wires, separated by a solid self-regulating semi-conductive core including pressure extruded electrical insulation that controls power output so that the cable has an unconditional temperature identification number (T-rating) of T3 (392°F or 200°C up to 15 W/ft, T2D (419°F or 215°C) for 20 W/ft and T2B (464°F or 240°C) for 28 W/ft without use of thermostats.

B. The cable wattage range should include 3, 5, 8, 10, 12, 15 and 20 W/ft rated at 120 V and 3, 5, 8, 10,12, 15, 20 and 28 W/ft rated at 240 V and 240 V to closely match the heat loss in various operating conditions.

C. Self-regulating heating cable shall be designed for a useful life of 30 years when operated within its parameters. The design life of the cable is defined as power retention of minimum 75% of rated power, after simulated 30 years of usage at maximum continuous operating temperature.

D. Self-regulating heating cable shall have minimum 95% power retention after 10 years at maximum operating temperature.

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

F. The heating cable shall have a nickel copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.

G. The cable shall have a minimum installation temperature of –76°F (–60°C) with minimum bend radius of 1 inch at that temperature.

H. The heating cable shall be nVent RAYCHEM HTV-CT self-regulating heater, for continuous operating (maintain) capability up to 400°F (205°C) and intermittent exposure capability up to 500°F (260°C).

6.1.5 Systems for Division 1 hazardous locations

The following requirements shall apply in addition to the criteria specified in paragraph 6.1.1, 6.1.2, 6.1.3 or 6.1.4.

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 nVent RAYCHEM BTV-CT self- regulating heaters, with continuous operating capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).
F. The heating cable shall be nVent RAYCHEM QTVR-CT self-regulating heaters, for continuous and intermittent exposure capability up to 225°F (110°C).
G. The heating cable shall be nVent RAYCHEM XTVR-CT self-regulating heaters, for continuous operating (maintain) capability up to 302°F (150°C) and intermittent exposure capability up to 482°F (250°C or 250 psi steam).
H. The heating cable shall be nVent RAYCHEM HTV-CT self-regulating heaters, for continuous operating (maintain) capability up to 400°F (205°C) and intermittent exposure capability up to 500°F (260°C).

6.1.6 Terminations for nonhazardous and hazardous locations

A. All connection kits 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 as this voids the approvals and warranty.
B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four 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. Connection kits shall be rated to a minimum installation temperature of –67°F (–55°C), maximum ambient temperatures of 132°F (56°C), and maximum pipe temperature of 500°F (260°C). The connection kits with integral LED lights should have the ambient temperature range of –40°F (–40°C) to 104°F (40°C).
E. The connection kit system shall be nVent RAYCHEM JBS-100-L-A, E-100-L-A, or JBM-100-L-A complete with integral LED power indicating light. The JBM-100-L-A connection kit shall serve as complete power, splice, or tee connection for up to three BTV, QTVR, XTVR or HTV industrial parallel heating cables.

6.2 Power-Limiting Heating Cable Systems

Heat-tracing applications with continuous operating (maintain) temperatures up to 455°F (235°C) or power-off exposure temperatures up to 500°F (260°C) shall use power-limiting cables. Continuous operating (maintain) temperatures are based on wattage and voltage used; consult with vendor for specific cable temperature limits. Applications below 500°F (260°C) 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 may require using 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. The cable shall be designed such that it can be crossed over itself one time and cut to length in the field.
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 12 AWG 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 2.2 kV dielectric test for one minute after undergoing a 1.0 kg-0.7 m impact (IEC/IEEE 60079-30-1:2015, clause 5.1.5.1).
G. The heating cable shall be nVent RAYCHEM VPL-CT power-limiting heater, with continuous operating (maintain) capability of up to 455°F (235°C), depending on power output required, and intermittent exposure capability up to 500°F (260°C).

6.2.1 Terminations for nonhazardous and hazardous locations

A. All connection kits 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 as this voids the approvals and warranty.

B. In order to keep connections dry and corrosion resistant, connection kits shall be constructed of nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated TYPE 4X. The connection kit stand shall allow for up to four inches (100 mm) of thermal insulation.

C. Terminals shall be the 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. Connection kits shall be rated to a minimum installation temperature of 67°F (55°C), maximum ambient temperatures of 132°F (56°C), and maximum pipe temperature of 500°F (260°C). The connection kits with integral LED lights should have the ambient temperature range of 40°F (40°C) to 104°F (40°C).

F. The connection kit system shall be nVent RAYCHEM JBS-100-L-A, E-100-L-A, or JBM-100-L-A complete with integral LED power indicating light. The JBM-100-L-A connection kit shall serve as complete power, splice, or tee connection for up to three VPL industrial parallel heating cables.

6.3 Mineral Insulated Heating Cable Systems

All heat-tracing applications with continuous operating (maintain) temperatures above 300°F (150°C) to 455°F (230°C), depending on power output required, or intermittent exposure temperatures above 500°F (260°C) shall use factory-terminated, mineral insulated (MI) cables.

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

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.

Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.

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.

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

The heating cable shall be nVent RAYCHEM (Alloy 825), mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C).

6.4 Longline Systems

A. Self-Regulating, two-wire geometry, freeze protection for circuit lengths 500–2000 feet. For freeze protection applications, without high temperature exposure, up to 2000 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 the use of thermostats.
  2. The heating cable shall have a tinned copper braid wire with a cross-sectional area being equal to or greater than conductor cross-sectional area. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
  3. The heating cable shall be nVent RAYCHEM LBTV2-CT for circuit lengths of 500–1125 feet, with continuous operating temperature up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

B. Constant-Wattage Series Resistance, Freeze Protection and Process Temperature Maintenance up to 482°F (250°C) with Steam Exposure for circuit lengths 500–12,000 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, two or three 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 to provide a ground path. The braid shall be protected from chemical attack and mechanical abuse by a fluoropolymer outer jacket.
  3. The heating cable shall be constant wattage nVent RAYCHEM SC, with continuous exposure capability up to 400°F (204°C), nVent RAYCHEM SC/H with continuous exposure capability up to 482°F (250°C), or SC/F with continuous exposure capabilities up to 195°F (90°C).

C. Constant-Wattage, Mineral Insulated (MI), Series Resistance, Freeze Protection and Process Temperature Maintenance from 482°F (250°C) to 1022°F (550°C) with Steam Exposure with circuit lengths 5,000-10,000 feet. A constant wattage Alloy 825 series resistance heater is often the best choice for high temperature, longline, and corrosion resistant applications.

1. MI cable shall be magnesium oxide insulated, with copper or alloy conductors and seamless Alloy 825 sheath. The heating section of the cable shall be joined to a cold lead also made of Alloy 825.
2. 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.
3. Maximum heating cable sheath temperature, per approved engineering design software, shall be submitted with the bid or design for all Division 1 (Zone 1) and Division 2 (Zone 2) applications.
4. 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.
5. A warranty against manufacturing defects for a period of 10 years shall be available.
6. The heating cable shall be nVent RAYCHEM XMI (Alloy 825) MI mineral insulated heating cable with a maximum application temperature for the heating units of 1022°F (550°C) and a maximum exposure temperature for the heating cable of 1200°F (650°C).

D. Skin-Effect Heat-Tracing Systems, Circuit Lengths up to 31 miles (50 km), Freeze Protection and Process Temperature Maintenance, and exposure up to 500°F (260°C). For very long lines, skin- effect tracing is required in order to minimize power connection locations.

1. The heating system shall consist of an electrically insulated, temperature-resistant conductor with high-temperature, heavy- walled 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 completed by the system manufacturer.
4. The system manufacturer should perform the installation.
5. The heat-tracing system shall be nVent RAYCHEM STS (Skin-Effect Heat-Tracing System).

6.5 Heat-Trace Power Distribution Panels

6.5.1 Group heat-tracing circuit control

A. For freeze protection or group control process-temperature maintenance systems, power distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30 mA trip level).
B. The panels shall provide ground-fault alarm capabilities.
C. If more than one circuit is required, a main contactor shall be used.
D. The panels shall be capable of operating with ambient-sensing or proportional ambient-sensing controllers.
E. The panels shall be capable of alarming of individual heat-tracing circuits.
F. The panels shall be approved for use in nonhazardous or hazardous locations as required by the installation environment.
G. The panels shall be capable of providing audible and visible alarms.
H. The panel shall be the nVent RAYCHEM HTPG heat-tracing power distribution panel.

Individual Heat-Tracing Circuit Control

A. For individual control process temperature maintenance systems, power distribution panels shall consist of an enclosure, including a panelboard with ground-fault protection devices (30 mA trip level).
B. The panels shall provide ground-fault alarm capabilities.
C. Circuits shall be switched by individual contactors capable of being operated by line-sensing controllers.
D. The panels shall be capable of monitoring and alarming of individual heat-tracing circuits.
E. The panels shall be approved for use in nonhazardous and hazardous locations as required by the installation environment.
F. The panels shall be capable of providing audible and visible alarms.
G. The panel shall be the nVent RAYCHEM HTPI heat-tracing power distribution panel.

6.6 Thermostats and Contactors

Freeze protection systems shall operate using self-regulating control or with the nVent RAYCHEM AMC-1A, nVent RAYCHEM AMC-F5 thermostat and the nVent RAYCHEM Elexant 3500i Electronic Thermostat in nonhazardous locations, and nVent RAYCHEM AMC-1H thermostat or nVent RAYCHEM Elexant 3500i Electronic Thermostat in hazardous locations, as supplied by nVent.

Process temperature maintenance systems shall operate using self-regulating control or with nVent RAYCHEM AMC-1B thermostat or nVent RAYCHEM Elexant 3500i Electronic Thermostat in nonhazardous locations and nVent RAYCHEM E507S-LS or nVent RAYCHEM Elexant 3500i Electronic thermostats in hazardous locations.

6.7 Control and Monitoring Systems

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

A. Alarm limits and setpoint temperatures shall be programmable from the central monitoring and control panel in °F and °C. The system shall include multi-language support and password protection to prevent unauthorized access to the system.

B. The heat tracing load shall be switched by solid-state or mechanical relays with a minimum rating of 30 Amps at 104°F (40°C), and have the option of single, dual, or 3-pole switching without de-rating due to ambient temperatures up to 104°F (40°C).

C. The system shall be capable of assigning one or more RTDs to a circuit to monitor temperature.

D. The system shall provide high temperature cut-out capability when using multiple RTDs.

E. The system shall monitor temperature, and load current to the systems.

F. The system shall monitor ground-fault current and offer the option of alarm only or alarm and trip if the ground fault exceeds the selectable level. Separate ground fault alarm and trip settings shall be supported.

6.7.1 Multipoint Control and Monitoring Systems for Single Circuit and Multi-Circuit Applications General

A. The system shall have UL, CSA, ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching devices or using electromechanical relays with either a Z-purge system, or encapsulated circuit breakers rated for hazardous areas..

B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, fiberglass, outdoor installation) as required by project specification.

C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. Power distribution and control components may also be integrated into a common panel. The entire switch rack shall be factory assembled, tested, and approved by UL, CSA, ETL (or equivalent).

D. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs), or temperatures derived from 4-20 mA sources for temperature sensing.

E. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

F. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional Control with configurable power and/or current limiting shall also be available.

G. The controllers shall be available to support single or 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

H. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

I. For controllers utilizing SSRs, a soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

J. The controller shall be capable of testing the heating circuit at a user-defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

K. The system shall be compatible with all types of heating cables and capable of performing the following functions:

   1. Controlling and monitoring pipe temperatures.
   2. Providing real-time temperature and alarm log readouts.
   3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.

4. Providing remote alarm annunciation.
5. Interfacing with personal computers and DCS systems.

L. The system shall support a touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if available if locating the user interface remotely from the panel is desired.
M. The UI shall have programmable form-C alarm relay.
N. The system shall be capable of updating UI operating software in the field.
O. The system shall support Modbus RTU and Modbus/TCP communications protocols and be supplied complete with RS-485 and Ethernet communications interface capabilities. Fiber-optic interfaces, pre-packaged communications converters, repeaters, and wireless interfaces shall be available as options.
P. Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.
Q. The heat trace vendor shall offer supervisory software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a multi-user architecture allowing multiple simultaneous users and/or workstations, and be capable of integrating all system data into a central database or distributed repository. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

Single/Dual Circuit Controllers

A. The single and dual-point controllers shall allow at least two hardwired RTD inputs per circuit.
B. The controller shall monitor heater voltage and support high and low voltage alarming.
C. The controller shall monitor control temperature and support high temperature cut-off.
D. The system shall be the nVent RAYCHEM Elexant 4010i, 4020i, Elexant 3500i or nVent RAYCHEM 920 heat-tracing control systems.

Multi-Circuit Panels

A. The multi-point panels shall have the option to include integral power distribution.
B. The multi-point panels shall be capable of using RTDs that are wired directly to the internal control or expansion modules. The system shall allow up to four RTD inputs to be assigned to any circuit within the control panel. Expansion of the number of RTDs shall not result in a loss of the number of available heating circuits in the panel.
C. The multi-point panels shall support external field mounted RTD multiplexing modules and allow the temperatures to be assigned to any circuit within the control panel. RTD multiplexing modules shall be capable of being installed at a distance of up to 1200 m (4000 ft) from the control panel without additional equipment.
D. The multi-point control modules shall provide programmable dry contact alarm relays.
E. The controller shall have the option to monitor system voltage and support high and low voltage alarming.
F. The system shall be the nVent RAYCHEM NGC-30 heat-tracing control system.

6.7.2 Single point control and monitoring systems for single circuit and multi-circuit applications general

A. The system shall have ETL (or equivalent) approval for Class I, Division 2, Groups A, B, C, D and Class I, Zone 2, Group IIB+H2 when using a solid-state switching device or using electromechanical relays with either a Z-purge system, or encapsulated circuit breakers rated for hazardous areas.
B. Enclosure types shall be TYPE 12 (painted steel, indoor installation), TYPE 4/3R (painted steel, outdoor installation), or TYPE 4X/3RX (stainless steel, fiberglass, outdoor installation) as required by project specification.
C. Field mounted switch racks (skid assemblies) shall be available in various configurations. They shall integrate a distribution transformer dedicated to the heating system, a power distribution panel board suitable for the area classification and a heat trace control panel. Power distribution and control components may also be integrated into a common panel. The entire switch rack shall be factory assembled, tested, and approved by UL, CSA, ETL (or equivalent).
D. The control solution shall provide single, dedicated, independent control modules for each heat tracing circuit to deliver the highest level of heat management system reliability.
E. The system shall use 3-wire 100-ohm platinum Resistance Temperature Detectors (RTDs) for temperature sensing.
F. The system shall allow multiple RTD temperature inputs per heat tracing circuit for monitoring, control and fault indication. Each sensor shall be configurable for control, monitoring or high temperature cut-out or combinations thereof.

G. The system shall provide the following control mode options: On/Off Control with a user selectable dead band, Proportional Ambient Sensing Control (PASC), Always On and Always Off. For controllers utilizing Solid State output Relays (SSRs), Proportional (PID) Control with adaptive power limiting shall also be available.

H. Each control module shall provide one digital input that may be configured for various functions such as forcing the controller output on or off.

I. The controllers shall support single and 3-phase heating loads of up to 60 Amps and 600 VAC with ground-fault detection.

J. For controllers utilizing SSRs, Circuit Breaker Limiting and Switch Limiting features for protection of circuit breakers and SSR relay outputs shall be available.

K. Each control module shall provide an individual fail-safe dry-contact alarm relay that may be connected to an external annunciator.

L. For controllers utilizing SSRs, an adaptive soft-start feature shall be available to ramp the output from 0-100% over time to reduce heater inrush currents.

M. The controller shall be capable of testing the heating circuit at a user-defined interval. The test shall terminate immediately upon detection of any unsafe condition (GF, High Temperature) and generate the appropriate alarms.

N. The system shall be compatible with all types of heating cables and capable of performing the following functions:

1. Controlling and monitoring pipe temperatures.
2. Providing real-time temperature and alarm log readouts.
3. Providing alarms in the event of low or high pipe temperature, low or high heater current, high ground-fault current, ground-fault trip, relay failure, and sensor failure.
4. Providing remote alarm annunciation.
5. Interfacing with personal computers and DCS systems.

The system shall support an optional touch screen user interface (UI) mounted on the panel to display circuit status, monitoring data and fault information as well as provide heat-tracing circuit configuration capability. A version of the UI shall be approved for use in Class I Division 2/Zone 2 environments as required. A remote mountable version of the UI shall be available if locating the user interface remotely from the panel is desired.

The UI shall not be used for heat trace control. All heat trace control shall be performed independently by the control modules.

The system shall be capable of updating UI operating software and controller firmware in the field.

The system shall support Modbus RTU and Modbus/TCP communications protocols and be supplied complete with RS-485 and Ethernet communications interface capability. Fiber-optic interfaces, pre-packaged communications converters, repeaters, and wireless interfaces shall be available as options.

Devices with multiple communications ports shall support simultaneous connections to external devices and automatically synchronize status and configuration information across all ports.

The heat trace vendor shall offer supervisory software for central programming, monitoring, and alarm annunciation. The supervisory software shall support a multi-user architecture allowing multiple simultaneous users and/or workstations, and be capable of integrating all system data into a central database or distributed repository. All information shall be available from any workstation and the software shall provide full user permissions and grouped access features.

The system shall provide load shedding capabilities that may be initiated by external devices. Multiple load shedding zones shall be supported, allowing select groups of controllers to be put into load shedding mode.

The load shedding command shall be periodically broadcast on the network. The controller shall manage the load shedding mode and automatically revert to normal operation should the load shedding commands fail to be broadcast.

The Controllers shall provide a fail-safe load shedding mode to ensure that pipe temperatures do not drop below acceptable levels even during load shedding events.

7.1 Secondary Power and Control Wire

7.1.1 Power and control wire may be stranded copper with type THHN or XHHW 90°C, 600-volt insulation. Control wire shall be #16 AWG, and power wire shall be minimum #12 AWG. (#10 AWG is recommended)

7.1.2 Power and control wire may be either single conductor or multiconductor. Multiconductor controller cables shall be type TC tray cable with a PVC jacket. Multiconductor power cables shall be phased with phase tape to indicate ground as well as neutral in a 120 VAC system.

7.1.3 All wiring shall be marked and tagged as described in Section 7.1.2.

7.1.4 All wire shall be sized with a maximum 5% voltage drop and derated per National Electrical Code Article 310 and be designed per UL 2250.

7.1.5 RTD's shall be wired with (300 volt in conduit & 600 volt in tray), stranded copper, twisted triad, shielded instrument cable with 90 deg. FR-PVC outer jacket. Shields shall be aluminum-Mylar with a stranded, tinned copper drain wire.

7.1.6 Splices in TC wires are unacceptable unless approved by the owner.

7.1.7 Single triad instrument cables shall have #16 AWG conductors with #18 AWG drain wire and drain wires are terminated at one end only. Multi triad instrument cables shall have #18 AWG conductors with #20 AWG drain wire and drain wires are terminated at one end only.

7.2 Communications Wire

7.2.1 Communications wire should be a minimum of 22 AWG, PVC jacketed, Stranded, Tinned Copper wire. Each cable will contain a minimum of two (2) pairs of Shielded, Twisted Pair wires, a Drain wire, overall Tinned Copper Braid, all within a PVC jacket. Additional jacketing may be utilized to comply with Tray and/or armoring requirements.

7.2.2 Wire characteristics regarding Nominal Capacitance, Characteristic Impedance, Frequency Range, Insertion Loss, and Nominal Velocity of Propagation shall be such that they are suitable for RS-485 and /or Ethernet based applications.

7.2.3 All wiring shall be marked and tagged to include source and destination identifiers.

7.3 Conduit/Tray

7.3.1 The plant cable tray system shall be considered for routing of power, control or other instrument circuits associated with the heating cables.

7.3.2 If tray cable is not utilized, all field wiring for the heating systems shall be routed in RGS, aluminum or Plasti-Bond conduit per the specific project requirements. Minimum conduit size shall be ¾" and the maximum size shall be 2". The maximum conduit fill shall be per National Electrical Code section 310.16. All conduit fitting covers shall face down or out to prevent the ingress of water and shall be Cooper Crouse-Hinds or Appleton Form 7, 8 or Mark 9 and contain an integral urethane gasket. (IEG, FG or GSA series)

7.3.3 A ¾" Liquid tight flexible conduit may be used when convenient for connections to field junction boxes and enclosures. Flexible conduit connections shall not exceed 3' 0" in length with connection at the conduit being made through a “tee” conduit fitting with low point drain and the device being the highest point of the conduit system. Per IEEE 515 Section 7.H.

7.3.4 When explosion proof seals are required they shall utilize the Copper Crouse-Hinds Chico Speed Seal compound or equal and shall be per NEC 501.15.C.6; the fill shall not exceed 25%.

7.3.5 Expansion fittings shall be installed in the conduit and cable tray when required by NEC article 30B. When adjustable splice fittings are utilized for the cable tray, the tray must be supported within 2' of each side of the fitting.

7.3.6 Structural supports for conduit or tray systems shall be fabricated from steel and hot dipped galvanized after fabrication or fabricated from aluminum. Tray systems shall be assembled and installed with stainless steel hardware (300 series). All hot dipped galvanized steel, which is drilled, cut or damaged during the installation, shall be immediately restored by the application of cold galvanizing compound.

8 GROUNDING

8.1 Each power circuit conduit shall contain a green insulated ground wire for grounding of all heating circuits. The ground wire shall be sized per NEC requirements, and shall be grounded to the control panel ground bus.

8.2 Where screw type connections are used, ground wires shall be provided with ring tongue or forked lugs.

8.3 The tinned copper braid on the self-regulating heating cables shall be grounded by connecting to the ground terminal inside the heater power connection and splice boxes.

8.4 RTD enclosures shall be grounded by means of the metallic conduit connections.

8.5 All conduit entries into control panel enclosures shall be bonded and grounded to control panel ground bus in accordance with the specifications.

9 THERMAL INSULATION FOR HEAT MANAGEMENT SYSTEMS

9.1 Specification Guide

9.1.1 The owner supplied isometric drawings, models, or line list for the pipe or equipment to be insulated shall be the controlling document for the insulation system. They shall be identified with standard owner nomenclature.

9.1.2 The Handbook of Thermal Insulation Design Economics for Pipes and Equipment should be used to determine the suggested insulated thickness.

9.1.3 "Notes and Exceptions" shall provide data for site areas or processes where special insulation systems may be required.

9.1.4 The owner supplied piping drawings shall verify all heat traced pipe and equipment which must be insulated, as well as pipe and equipment which require insulation "only", if applicable.

9.1.5 The approved insulation materials shall be provided by owner and meet the criteria of this specification.

9.1.6 Areas of primary concern for determining the type of insulation and cladding to utilize:

A. Thermal requirements
B. Moisture requirements
C. Physical requirements
D. Chemical requirements
E. Flammability requirements
F. Personnel requirements

9.1.7 K-Factor (Thermal conductivity Factor) is the measure of heat in BTUs that pass through one square foot of homogeneous substance, 1 inch thick, in one hour, for each degree F temperature difference. The lower the K-value, the higher the insulating value.

9.2 Traced Pipe

9.2.1 General

This category covers requirements for installing thermal insulation systems on traced pipe. If the sheath temperature of the tracer is higher than the operating temperature of the process, the tracer temperature must be used for determining the insulation material type and thickness. Coding on diagrams should reflect the higher temperature.

9.2.2 Insulation specifications

A. Urethane – Standard specification for unfaced preformed rigid cellular Polyisocyanurate thermal insulation ASTM C591-13:

1. This specification covers the types, physical properties, and dimensions of unfaced, preformed rigid cellular Polyisocyanurate plastic material intended for use as thermal insulation on surfaces from –297°F (–183°C) to 300°F (150°C). For specific applications, the actual temperature limits shall be agreed upon by the manufacturer and purchaser.
2. This specification only covers "polyurethane modified polyisocyanurate" thermal insulation, which is commonly referred to as "polyisocyanurate" thermal insulation. This standard does not encompass all polyurethane modified materials. Polyurethane modified polyisocyanurate and other polyurethane materials are similar, but the materials will perform differently under some service conditions.
3. This standard is designed as a material specification, not a design document. Physical property requirements vary by application and temperature. At temperatures below –70°F

4. (–51°C) the physical properties of the polyisocyanurate insulation at the service temperature are of particular importance. Below –70°F (–51°C), the manufacturer and the purchaser must agree on what additional cold temperature performance properties, may be required to determine if the material can function adequately for the particular application.
5. Materials and Manufacture – Unfaced, preformed rigid cellular polyisocyanurate thermal insulation is produced by the polymerization of polymeric polyisocyanurates in the presence of polyhydroxyl compounds, catalysts, cell stabilizers, and blowing agents.
6. The material covered by this specification may be supplied in finished board stock or special shapes.

B. Calcium silicate – Standard specification for Calcium silicate thermal insulation ASTM C533-13:

1. Calcium silicate shall consist principally of hydrous calcium silicate usually with the incorporation of fibrous reinforcement. Asbestos shall not be used as a component in the manufacture of the material.
2. Standard shapes, sizes, and dimensions – Calcium silicate block-type thermal insulation shall be supplied in the form of pipe insulation, flat block or curved blocks as specified. Standard sizes of the block type insulation shall be as follows:
3. Flat Block- flat block shall be furnished in lengths of 36" (458 or 914 mm), widths of 6" to 18" (152 to 914 mm), and thickness from 1" to 6" (25 to 152 mm) in ½" (13 mm) increments. Thicknesses greater than 3" (76 mm) shall be furnished in one or more layers as agreed upon by purchaser and manufacturer.
4. Curved Block – curved block shall be furnished in lengths of 36" (914 mm), widths of approximately 6" to 12" (152 or 305 mm), thicknesses of 1 ½" to 4" (38 to 101 mm) in ½" (13 mm) increments, and curved to inside radii of over 16 ½" (419 mm). Individual dimensions shall conform to those specified by the manufacturer.
5. Grooved Block – Grooved block shall be furnished in lengths of 36" (914 mm), widths of 12" or 18" (305 or 458 mm), and thicknesses from 1" to 6" (25 to 152 mm) in ½" (13 mm) increments. Size and spacing of grooves shall be as specified by the manufacturer.
6. Calcium Silicate Pipe Insulation – calcium silicate pipe insulation shall be supplied either as hollow cylindrical shapes split in half lengthwise (in a plane including the cylindrical axis) or as curved segments. The pipe insulation shall be furnished in sections or segments in a length of 36" (914 mm), unless otherwise agreed upon by the Purchaser, to fit standard sizes of pipe and tubing, and in nominal wall thicknesses from 1" to 6" (25 to 152 mm), in ½" (13 mm) increments. Thicknesses greater than 3" (76 mm) shall be furnished in one or more layers as agreed upon by between the purchaser and the manufacturer. Inner and outer diameters shall be in accordance with those standard dimensions specified in Practice C 585.

C. Mineral Wool – Std. specification for Mineral Fiber Pipe Insulation ASTM C547-15:
Materials and Manufacturer:

1. Composition – the mineral fiber insulation for pipes shall be manufactured from mineral substance such as rock, slag, or glass, processed from a molten state into fibrous form with binder. Asbestos shall not be used as an ingredient or component part. Some products may also contain adhesive.
2. Jackets (Facings) – The owner of this specification has the option to specify that the insulation be jacketed.
3. Standard Shapes, Sizes, and Dimensions – the basic shape of mineral fiber pipe insulation forms a right annular cylinder, which is radially slit on at least one side of the cylinder axis. It is furnished in sections or segments designed to fit standard sizes of pipe and tubing.
4. Typical available thicknesses range from nominal ½" (13 mm) to nominal 6" (152 mm), single or double layer, in ½” increments for most pipe and tubing sizes.
5. Individual dimensions for inner diameter and wall thickness shall conform to Practice C585. Standard section or segment length shall be 3' (0.91m) or as agreed upon between the buyer and seller.

D. Cellular Glass – Std. spec. for Cellular Glass Thermal Insulation ASTM C552-15:

1. This specification covers the composition, sizes, dimensions, and physical properties of cellular glass thermal insulation intended for use on surfaces operating at temperatures between –450°F and 800°F (–268°C and 427°C). Special fabrication or techniques for pipe insulation, or both, may be required for application in the temperature range from 250°F to 800°F (121°C to 427°C). Contact the manufacturer for recommendations regarding fabrication and application procedures for use in this temperature range. For specific applications, the actual temperature limits shall be agreed upon between the manufacturer and the purchaser.
2. Materials and Manufacture – the block material shall consist of a glass composition that has been foamed or cellulated under molten conditions, annealed, and set to form a rigid noncombustible material with hermetically sealed cells. The material shall be trimmed into blocks of standard dimensions that may be rectangular or tapered.
3. Special shapes and pipe covering shall be fabricated from blocks in accordance with Practices C450 and C585.
4. Board, tapered or flat, shall be fabricated from blocks.

E. Expanded Perlite – Standard specification for Molded Expanded Perlite block and Pipe Thermal Insulation ASTM C610-15:

1. This specification covers molded expanded Perlite block, fittings, and pipe thermal insulation intended for use on surfaces with temperatures between 80°F to 1,200°F (27°C to 649°C).
2. The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.
3. When the installation or use of thermal insulation materials, accessories, and systems may pose safety or health problems, the manufacturer shall provide the owner appropriate current information regarding any known problems associated with the recommended use of the company's products and shall also recommend protective measures to be employed in their safe utilization. The following safety caveat applies only to the test methods portions of this specification:
4. These standards do not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the owner to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
5. Insulation thickness:
   Consultant Heat Management System Integrator for optimized insulation thicknesses.
6. Insulation jacket materials for Pipe and Equipment:
   Aluminum .016", .020", or .024" thick with a moisture barrier
   Stainless steel .010", .016", or .020" thick with a moisture barrier
   Finish types for both aluminum and stainless steel:
   Smooth
   3/16" corrugated (standard and rib-corrugated)
   Stucco embossed
7. Irregular surfaces:
   Utilize a reinforced mastic system. Apply a tack coat of mastic and in bed open weave cloth over and overlay reinforcing material by a minimum of 2". Apply a second coat of mastic (must be applied) the same day to a minimum .010" thick.
8. Application Specification:
   See product piping drawings submitted by owner

9.3 General Conditions

Keep the insulation dry at all times during storage and installation. No wet insulation shall be installed. If the insulation becomes wet during or after installation, it shall be removed and replaced with new dry insulation.

9.3.1 Short tubing lines, less than 5 feet and limited to 180°F, can be covered with flexible insulation (Tetra Glass). Secure and seal the insulation with adhesive per the insulation manufacturer recommendation. All joints must be tightly fitted. The adhesive to secure the insulation must be dry prior to applying the finish. The insulation must be protected by coating the surface with insulation mastic (Code 734) 0.015" wet thickness (100 square feet per gallon). Specify white or gray (Apply with a soft bristle brush). Instrument tubing can be insulated as indicated in this paragraph, however where the tubing lines are over 5 feet and/or the service is critical, use the following systems.

9.3.2 For temperatures to 250°F, use pre-insulated tubing with transition fitting covers provided by the same vendor for all fitting connections. Wrap the fittings with fiberglass blanket or equal approximately 1" thick prior to installing the covers. Seal all terminations of pre-insulated insulation at fittings, and at the fitting cover joints with heat shrink boots.

9.3.3 For temperatures above 250°F (204°C), rigid insulation and cladding the same thickness as the adjacent pipe, is recommended.

9.3.4 All fittings are to be insulated with the same thickness as the adjacent piping.

All flanges and valves shall be insulated with permanent insulation unless removable/reusable insulation covers are specifically requested or noted on drawings. If removable blankets are used, the actual thickness may have to be modified depending on the efficiency of the blanket insulation material. All valves shall be insulated up to the packing glands and including the bonnet flange.

For all insulated ball and plug valves, use stem extension kits per industry standards.

At flanged joints, stop the insulation a minimum of 1 bolt length plus 1" to the back of each flange. For composite insulations, conductivities shall be averaged for the two insulating materials.

9.3.5 For rigid insulation, it is recommended that the insulation ID be sized for the next largest pipe. For non-rigid insulation, it is recommended that the insulation be over-sized on lines 4" diameter and less.

9.3.6 Stagger the insulation joints and utilize multiple layer for insulation thickness greater than 3".

9.3.7 Steam tracer jumpers will be installed outside of the insulation at all flanged joints.

9.3.8 Cover steam tracer jumpers with flexible insulation (Tetra Glass) 2" wide listing tape, spiral wrapped with 50 percent overlap. Secure and seal the insulation with adhesive per the manufacture recommendations.

9.3.9 Secure insulation thru 12" O.D. with filament tape on 9"centers. Above 12" O.D. and with heavier more dense insulations utilize SS tie wire for better security.

9.3.10 All cuts for protrusions such as hangers, nozzles or nipples must be tightly fitted and caulked with silicone. Protrusions should be through the bottom whenever possible. No gaps are permitted around these cutouts.

9.3.11 Removable blanket design will be sewn construction only. Hog-ring construction with mechanical fasteners is not permitted.

9.3.12 See all applicable customer specifications for insulation fireproofing requirements.

9.4 General Notes

9.4.1 The owner shall specify the location for the insulation inspection ports – and if required the Heat Management System Integrator will supply and install.

9.4.2 Lap jackets a minimum of 2" circumferentially and longitudinally. The metal shall be machine cut and rolled to provide a tight fit. Install in a watershed fashion with laps on horizontal pipe at the three or nine o’clock position. Jacketing for non-rigid insulation may include a 180° overlap.

9.4.3 Banding is the preferred method to secure all jacketing unless indicated otherwise. Provide ½" x 0.020" thick stainless steel bands on 9" centers with a band over each circumferential lap.

9.4.4 No screws are permitted on electrically traced lines or where the jacketing is installed over piping systems having a vapor barrier membrane.

9.4.5 Insulation on underground piping shall be installed per project specifications and standard details.

10 NAMEPLATES AND CIRCUIT TAGS

10.1 Nameplates

10.1.1 All major electrical components, instruments, control devices and junction boxes shall be labeled with embossed nameplates in accordance with the descriptions shown on the Heat management system integrator's drawings. Descriptions shall be coordinated with Owner's requirements.

10.1.2 Nameplates shall be made from three ply-laminated plastic consisting of two white polished surfaces with a black core. The nameplates shall be 1/16" thick, beveled on the face with black letters engraved on white background.

10.1.3 Nameplate engraving shall be with minimum 3/16" high letters for all nameplates on front or the exterior of equipment. ⅛" high letters may be used for engraving of nameplates, which are used for identifying interior components mounted inside an enclosure or box.

10.1.4 Except where otherwise noted, all engraved nameplates shall be permanently attached with stainless steel screws. Attachment of nameplates shall not compromise the required enclosure classification.

10.2 Circuit Tags

10.2.1 All power connection kits and all RTD circuits shall be identified with embossed stainless steel tags attached with stainless steel wire. The tags shall be fastened to the conduit at each junction box, each heater power connection box and each RTD enclosure. A separate tag shall be provided for each circuit entering the box or enclosure.

10.2.2 The information on the tags shall be arranged in accordance with the requirements of Owner.

10.2.3 Tags for power circuits shall include the following:

A. Part number

B. Panel and Circuit number

C. Heat Management System Integrator's job number

10.2.4 Tags for RTD circuits shall include the following:

A. RTD part number

B. Panel and controller number

C. Heat Management System Integrator's job number

10.2.5 Tags for MI heating cable shall be furnished in accordance with paragraph 6.3.5.

10.2.6 End seal and splice locations shall be labeled for future access.

11 QUALITY SURVEILLANCE

11.1 All materials and equipment shall be manufactured and tested in conformance with the manufacturer's published quality control and quality assurance manuals.

11.2 A copy of the Heat Management System Integrator's QA/QC manuals shall be submitted with the quotation.

11.3 Owner has the right to send an assigned Quality Representative to conduct an initial visit to review with the responsible Supplier Management the quality requirements of the purchase order and specification. Manufacturing is not to commence until this meeting is held unless this requirement is waived in writing by Owner.

12 INSPECTIONS AND TESTS

12.1 General

12.1.1 Each control panel assembly shall be inspected and tested per the manufacture's standard testing procedures.

12.1.2 Owner has the right to perform a pre-shipment inspection and to witness factory tests on each control panel assembly. The Heat Management System Integrator shall provide Owner with a minimum of seven (7) days advance notice for all inspection and testing dates.

12.1.3 Owner has the right, at its discretion, to perform inspections and witness factory tests on electric heating cables.

12.1.4 Owner's authorized representative shall be permitted to inspect the control panel assemblies and electric heating cables for compliance with the purchase order, this specification, industry standards, the manufacturer's standards and the Heat Management System Integrator's drawings.

12.2 Control Panels

12.2.1 Factory inspections and tests for the control panel assemblies shall be at a minimum, but not limited to the following:

A. Each electrical heat tracing control panel shall be complete with all components installed prior to shipment. Any discrepancies found as a result of inspection or tests shall be corrected by the Heat Management System Integrator at no cost to owner (including the cost of time for making the corrections and repeating the tests and/or inspections).

B. Each control panel shall undergo complete operation an alarm testing at the factory.

C. All controllers shall be pre-programmed by the panel supplier.

12.3 Heating Cables

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

A. Testing shall be done per the latest IEEE /IEC 60079-30-2 standard test section and applicable manufacturer's standards. Insulation resistance shall be measured from heating device conductors to metallic braid, metallic sheath, or other equivalent electrically conductive material with a 500 Vdc test voltage. However, it is strongly recommended that higher test voltages be used—mineral insulated trace heaters should be tested at, but not exceed, 1000 Vdc, and polymeric insulated trace heaters should be tested at 2500 Vdc.

B. In the field, all heater cables shall be tested for insulation resistance. The following separate field megohmmeter readings shall be taken on each cable:
   1. When received at jobsite before installation
   2. After installation, but before insulation is applied
   3. After insulation has been installed

C. The readings obtained shall satisfy the minimum acceptable readings per IEEE/IEC 60079-30-2 standard, otherwise the heater cable is not acceptable and shall be replaced.

D. It is strongly recommended that the manufacturer's minimum recommended IR values be observed as tabulated below:

Source	Manufacturer			IEC/IEEE 60079-30-2
Cable Type	Self-Regulating/ Power- Limiting	Constant Wattage (Polymer)	Constant Wattage (MI)	All
IR Values (Megohms)	Recommended Minimum IR Value			Absolute Minimum Acceptable
On Receipt	1000	100	100	20
After Installation	1000	100	20	20
After Insulation	1000	100	20	20 (5 MI only)
Start Up/Commissioning	1000	100	10	20 (5 MI only)

Note: Insulation resistance readings should be recorded promptly at each of the different stages after the cable has been received, installed, insulated and commissioned.

E. Field megohmmeter tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.

F. Adverse weather conditions such as high humidity can influence measuring equipment/ test leads/ connections and appropriate steps should be taken to avoid false insulation resistance readings.

13 SHIPPING, HANDLING AND STORAGE

13.1 General

13.1.1 The method of preparation for shipment shall be in accordance with the Heat management system integrator's standard practices unless otherwise specified in the purchase order, giving adequate protection against breakage, dampness, pilfering and tampering during transportation, handling and storage.

13.1.2 Each shipping section shall be provided with suitable steel section supports, lifting eyes, etc., to maintain alignment of parts during shipping, handling, hoisting and installation. The location of lifting points shall be clearly identified on shipping containers and on drawings. Each shipping section shall have its weight clearly marked on the container.

13.1.3 Necessary wire jumpers, bolts, nuts, washers, etc., shall be furnished suitably packaged and marked to facilitate field assembly. Each shipping container shall be identified with the purchase order number, area number and equipment tag number where applicable.

13.1.4 All materials shall be crated with adequate protection to permit outside storage at jobsite. The Heat Management System Integrator shall indicate his recommendation for on-site storage and handling.

13.2 Heating Cables

13.2.1 Self-regulating heating cable shall be shipped on non-returnable reels. Each reel shall contain only one continuous length of cable. Reels shall be of substantial construction to withstand multiple handling during storage and transit. Each reel shall be shipped totally enclosed in suitable shipping cartons.

13.2.2 The reel and associated carton shall indicate the purchase order number, area number, heater type, voltage rating and actual length.

13.2.3 Mineral insulated heating cables shall be shipped totally enclosed in a suitable shipping carton. The carton shall indicate the purchase order number, area number, heater type, voltage rating and actual length.

14 DRAWINGS AND DATA

14.1 General Requirements

14.1.1 The Heat Management System Integrator shall provide a completely engineered and designed heat management system including all necessary calculations, drawings, details, data, instructions and literature for the complete installation.

14.1.2 The Heat management system integrator's drawings and data shall be provided in quantities as specified in the purchase documents.

14.1.3 Drawing presentations shall be in accordance with owner's standard requirements. Samples shall be provided as required.

14.1.4 Each drawing shall show the customer's purchase order number, job number and plant area number, as well as all necessary references, notes, etc.

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14.3 Drawing Requirements

14.3.1 Layout and Distribution Drawings: Power, control and instrumentation physical layout drawings shall be provided including:

A. Drawing and schedules that completely define the tracing system are required to evaluate the proposed designs. These drawings and schedules shall be reviewed by Owner prior to release for fabrication or Letter of Intent (LOI) for installation.

B. Plan drawings showing all equipment locations, non-detailed conduit/cable tray routings and connections to all system components. Background drawings will be provided by Owner for the Heat management system integrator's use.

C. Sections and details as required for clarification of plan drawings.

14.3.2 Control Panel Drawings: Drawings shall be provided for each control panel and shall include the following:

A. Physical arrangement and structural detail drawings showing:

1. Elevations, sections, floor plan and base layout.
2. Arrangement and mounting of all components on front of panel, swing door, back panel, etc.
3. Location of ground bus and lugs.
4. Location of terminal blocks.
5. Purge system location and details. (if applicable)
6. Location of conduit entries.
7. Overall weight
8. Tagging information

B. Power distribution panel board schedules showing the following for each circuit:

1. Circuit number
2. Breaker size
3. Voltage and wattage
4. Full load amps

C. Complete power and control wiring diagrams showing all internal wiring connections for all electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with the system elementary diagrams.

14.3.3 Typical Installation Details: Typical installation detail drawings shall be provided as required. Typical details shall show the following:

A. Installation and positioning of all components

B. Proper amounts of tracing for valves, pumps, flanges, fittings, instruments, etc.

C. Junction box layouts

D. Material schedule on each detail listing all components and quantities used.

14.3.4 Isometrics: A piping installation isometric layout drawings shall be provided by the Heat Management System Integrator for each line. Isometrics shall be sufficiently detailed to readily orient heaters, boxes, RTD's and any other equipment supplied.

A. Each isometric shall include the following information:

B. Location of line (Unit No., Work Area No., etc.)

C. Piping line numbers and dimensions

D. Valves, pumps, flanges, fittings, instruments,

E. Heater circuit number

F. Heat loss and heater output

G. Electrical load

H. Heater catalog numbers

I. Heater termination points

J. Design parameters

K. Insulation type and thickness

L. Positions and coordinates of all components

M. Material schedule listing all components and quantities used

N. Panel ID No

14.3.5 Nameplates and Tagging Schedules: Complete schedules shall be furnished for all system nameplates and circuit tags, which are required per Section 10.0.

14.3.6 Bills of Material: Complete system bills of material shall be provided giving descriptions, quantities and ratings of all components used.

14.4 Data and Document Requirements

The following data and documentation shall be furnished:

14.4.1 Detailed literature covering all equipment furnished.

14.4.2 Electric heating cable description data including physical and electrical characteristics dimensions, weights, etc.

14.4.3 Recommended procedures for handling, installing, terminating and splicing of electric heating cable.

14.4.4 Complete installation, operating and maintenance manuals including components descriptive literature and information on handling, installing, operating, maintaining and troubleshooting the equipment.

14.4.5 Recommended spare parts list for start-up and operation for one year.

14.4.6 Reports for tests performed in accordance with Section 12.0.

14.4.7 As built correction of drawings, data sheets, schedules and record isometrics to show changes made during the installation.

14.4.8 Log sheets detailing megger readings, current draw and voltage for each circuit installed.

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Our powerful portfolio of brands:

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