



HEAT MANAGEMENT SYSTEM INDUSTRIAL SPECIFICATION

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1. SCOPE

- 1.1. This specification together with the attached line list, plans and elevation drawings, isometric drawings and P&ID's cover 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, power, control, grounding and instrumentation.
- 1.2. The heat management system shall include power transformers, control panels, heat tracing cables, 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 components 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 heating 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.

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 entitled "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 IEEE-515 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, 3-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 heat tracing panel as manufactured by nVent. The nVent RAYCHEM 910 or 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. All feeders shall not 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 shall be pre-traced and 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 under any circumstances. The instrument tubing shall 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, shall be provided for each instrument. Also, individual block heaters shall be provided and shall 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.
- 4.11 Safety showers and eyewash systems requiring freeze protection shall be designed per ANSI Z358.1 standard. These types of devices require more concise temperature control to maintain a narrow range of water temperatures, unlike most pipe heating systems. Application of controls and monitoring for safety showers is guided by the temperature requirements outlined in ANSI Z358.1. Controls for safety shower and emergency eyewash equipment heating devices shall include a Type III temperature controller (Per IEEE-515 2011).

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) either through 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, NGC-30 or NGC-40 heat tracing panel, as manufactured by nVent. The nVent RAYCHEM 910 or 920 heat tracing controllers may be used for single or dual circuit freeze protection 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. 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. Each heat tracing circuit must be capable of being energized, for test purposes, without panel entry.
- 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. 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 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. A separately controlled heating cable shall be used for each instrument line. The instrument tubing shall be traced with the same type heating cable as the tap line, and instrument enclosures shall be

provided for each instrument. Also, individual block heaters shall 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 to be a 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 4.10 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 to be a part of the system requirements.
- 5.12 Horizontal pipe lines that are 8" diameter and smaller shall use a clamp-on pipe support such as the Tracer Interlock™ pipe shoe. The shoe shall allow for optimum pipe rack utilization, higher quality insulation systems, reduce pipe corrosion and reduce heat loss. Refer to the attached details for more information.

6. ELECTRIC HEATING CABLES AND PADS

6.1 SELF REGULATING HEATING CABLES

- 6.1.1 All heat-tracing applications with continuous exposure (maintain) temperatures from 150°F (65°C) to 250°F (121°C) or intermittent exposure temperatures from 185°F (85°C) to 420°F (215°C) shall use self-regulating cables.
 - 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 nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
 - 2. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 216-1 Part 1.
 - c. A warranty against manufacturing defects for a period of 10 years shall be available.
 - d. All heating cables shall be capable of passing the dielectric test outlined in IEEE 515-2011 clause 4.1.1/ CSA C22.2 No.130-03 clause 6.2.1, when immersed in tap water at room temperature, after being subjected to the Impact of 13.6 J as per IEEE 515-2011 clause 4.1.8/ CSA C22.2 No.130-03 clause 6.2.10.2, at the minimum installation temperature of -40°C (-40°F).
- 6.1.2 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:

Minimum Self-Regulating Indices

Heating cable	S.R. index (W/°F)	S.R. Index (W/°F)
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 50°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 nVent 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 nVent.

6.1.3 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 (150°C), allowing at least six minutes of dwell time at each temperature.
- 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), as manufactured by nVent.

6.1.4 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 nVent 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 nVent.

6.1.5 Systems for Division 1 Hazardous Locations

The following requirements shall apply in addition to the criteria specified in paragraph 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 HBTV-CT or nVent RAYCHEM BTV-CT self-regulating heaters, with continuous exposure capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by nVent.
- f. The heating cable shall be nVent RAYCHEM HQTV-CT or nVent RAYCHEM QTVR-CT self-regulating heaters, for continuous and intermittent exposure capability up to 225°F (110°C), as manufactured by nVent.
- g. The heating cable shall be nVent RAYCHEM HXTV-CT or nVent RAYCHEM XTV-CT self-regulating heaters, 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 nVent.

6.1.6 Terminations for Nonhazardous and Hazardous Class 1, Division 2 Locations

- 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 nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The component 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. 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 -40°F (-40°C), minimum usage temperature of -75°F (-60°C), and maximum pipe temperature of 500°F (260°C).
- f. The component system shall be nVent RAYCHEM JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three nVent RAYCHEM BTV, QTVR, or XTV industrial parallel heating cables as manufactured by nVent.

6.2 POWER-LIMITING HEATING CABLES

- 6.2.1 Heat-tracing applications with continuous exposure (maintain) temperatures from 250°F (121°C) to 455°F (235°C) or power-off exposure temperatures from 420°F (216°C) to 500°F (260°C) shall use power-limiting cables. Continuous exposure (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.
- 6.2.2 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. 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 heating cables shall be capable of passing the dielectric test outlined in IEEE 515-2011 clause 4.1.1/ CSA C22.2 No.130-03 clause 6.2.1, when immersed in tap water at room temperature, after being subjected to the Impact of 13.6 J as per IEEE 515-2011 clause 4.1.8/ CSA C22.2 No.130-03 clause 6.2.10.2, at the minimum installation temperature of -40°C (-40°F).
 - g. The heating cable shall be nVent RAYCHEM VPL-CT power-limiting heater, with continuous exposure (maintain) capability of 300°F (150°C) to 455°F (235°C), depending on power output required, and intermittent exposure capability up to 500°F (260°C), as manufactured by nVent.

6.2.3 Terminations for Nonhazardous and Hazardous Class 1, Division 2 Locations

- 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 nonmetallic, electrostatic, charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The component 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. 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 -40°F (-40°C), minimum usage temperature of -75°F (-60°C), and maximum pipe temperature of 500°F (260°C).
- f. The component system shall be nVent RAYCHEM JBM-100-L-A connection kit complete with integral LED power indicating light to serve as complete power, splice, or tee connection for up to three nVent RAYCHEM VPL industrial parallel heating cables as manufactured by nVent.

6.3 CONSTANT WATTAGE (MI HEATING CABLES)

- 6.3.1 Mineral insulated (MI) heating cable shall be two conductor types with copper or alloy heating wire, magnesium oxide insulation and an Incoloy 825 sheath. Heating cable shall have proper resistance to develop the required watt density with operating voltages of either 120, 208, 240 or 277 volts. Complete heater assembly shall be FM, CSA or UL approved for use in the hazardous areas defined in Section 3.3.
- 6.3.2 Each MI heating cable shall be factory fabricated to required lengths with cold junctions for connection to power or where splices are required. Cold sections shall be 7 ft long with 12" long THW insulated leads. Cold sections shall have gland type fitting for termination in threaded hub junction boxes. Cables shall be factory terminated and sealed.
- 6.3.3 Cable circuits exceeding 200 ft in length shall be broken into sections of 200 ft or less. Cable sections shall be interconnected in external splice boxes.
- 6.3.4 MI heating cables shall be attached to pipes on maximum one-foot centers by means of 16 gauge stainless steel wire.
- 6.3.5 Each MI heating cable shall have a stainless steel tag connected to the cold sections with stainless steel wire. The tag shall show the circuit number to which it is connected, FM, CSA and/or UL approval, catalog number approval, catalog number and heater electrical and physical characteristics such as voltage, watt/ft, heat output, resistance and cable diameter.

6.4 ELECTRICAL TANK HEATING PADS

- 6.4.1 The tank wall, to which the panel is to be fixed, shall be prepared according to panel manufacturer's instructions.
- 6.4.2 Panels shall be flexible so that they are easily fastened to the surface of the tank to be heated.
- 6.4.3 Panels shall be suitable for maintaining the tank wall temperature at specified temperature continuously without degrading or changing output characteristics of the panel.
- 6.4.4 Resistance heating elements shall be between flexible insulating layers, with a continuous operating rating of at least 200°F (93°C) and a short-term withstand rating of at least 366°F (186°C), to insulate electrically and provide mechanical protection for the heating elements. Elements shall be constant resistance.
- 6.4.5 Panels shall have an integrated thermostat to be used for over-temperature protection, but an additional primary control thermostat must be used.
- 6.4.6 A ground-fault protection device per Section 6.1.6 shall be used to protect each circuit.
- 6.4.7 For metallic tanks, the supplied watt density (at 240 volts) shall be 1.9 watts/sq inch with a T-rating of T2C.
- 6.4.8 For plastic tanks or plastic lined tanks, the supplied watt density (at 240 volts) shall be 0.6 watts/sq inch with a T-rating of T4A.
- 6.4.9 A stainless steel ground plane on the external surface of the panel shall be supplied to provide a ground path as required by the National Electrical Code section 427-22.
- 6.4.10 Heat Management System Integrator shall supply a stainless steel junction box. Cold leads shall be Teflon-coated 14 AWG copper leads contained within liquid-tight, flexible conduit for added protection.
- 6.4.11 Mounting instructions and all required materials for fastening panels to the tank wall are to be furnished. Means other than thermal insulation are to be provided to hold panels in position. In addition to the specified tank heater the following materials are required: nVent RAYCHEM RHS Installation Kit (P/N 844869) or equivalent, Thomas and Betts 5232 conduit fitting, and 5302 sealing ring or agency approved equivalent.

- 6.4.12 Non hazardous and hazardous location approvals for Class I, Division 2 Groups B, C, D, Class II Division 1 and 2 Groups E, F, G and Class III shall exist on all heating elements.
- 6.4.13 Installation and operation instructions shall be provided in hard copy and available on a 24-hour accessible internet site. Installation instructions shall be nVent RAYCHEM Tank Heater (H55207) instructions.
- 6.4.14 All heating pads should be tested annually and shall be capable of passing a 2.5 KV test for one minute.
- 6.4.15 The panels shall be nVent RAYCHEM RHS tank heaters as supplied by nVent.

7. WIRE AND CONDUIT/TRAY

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 Paragraphs 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 CONDUIT/TRAY

- 7.2.1 The plant cable tray system shall be considered for routing of power, control or other instrument circuits associated with the heating cables.
- 7.2.2 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 3/4" 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)
- 7.2.3 3/4" 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 7.4.1 H.
- 7.2.4 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%.
- 7.2.5 Expansion fittings shall be installed in the conduit and cable tray when required by NEC article 300.7 B. When adjustable splice fittings are utilized for the cable tray, the tray must be supported within 2' of each side of the fitting.
- 7.2.6 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 power junction boxes, heater power connection boxes, and heater splice boxes. The ground wire shall be sized per NEC requirements, and shall be grounded to the control panel ground bus.
- 8.2 A separate grounding connection shall be provided inside each box. Ground connections shall be made with either a servit post type connector or by means of a screw tapped into the metal frame or enclosure. Ground connections shall not penetrate or weaken sealed enclosures approved for hazardous location and shall not compromise the specified NEMA enclosure standards.
- 8.3 Where screw type connections are used, ground wires shall be provided with ring tongue or forked lugs.

- 8.4 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.
- 8.5 RTD enclosures shall be grounded by means of the metallic conduit connections.
- 8.6 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 C591-05:

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.

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.

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 (-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.

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.

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 C533-04:

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.

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:

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.

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.

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.

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 C547-03:

Materials and Manufacturer

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.

Jackets (Facings) – The owner of this specification has the option to specify that the insulation be jacketed.

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.

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.

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 C552-03:

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.

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.

Special shapes and pipe covering shall be fabricated from blocks in accordance with Practices C450 and C585.

Board, tapered or flat, shall be fabricated from blocks.

e. Expanded Perlite – Standard specification for Molded Expanded Perlite block and Pipe Thermal Insulation ASTM C610-05:

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).

The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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:

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.

1. Insulation thickness:

Consultant Heat Management System Integrator for optimized insulation thicknesses.

2. 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

3. Irregular surfaces:

Utilize a reinforced mastic system. Apply a tack coat of mastic and inbed 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.

4. Application Specification:

See product piping drawings submitted by owner

9.3 GENERAL CONDITIONS

- 9.3.1 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.
- 9.3.2 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.
- 9.3.3 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.
- 9.3.4 For temperatures above 250°F (204°C), rigid insulation and cladding the same thickness as the adjacent pipe, is recommended.
- 9.3.5 All fittings are to be insulated with the same thickness as the adjacent piping.
- 9.3.6 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.
- 9.3.7 For all insulated ball and plug valves, use stem extension kits per industry standards.
- 9.3.8 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.
- 9.3.9 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.
- 9.3.10 Stagger the insulation joints and utilize multiple layer for insulation thickness greater than 3".
- 9.3.11 Steam tracer jumpers will be installed outside of the insulation at all flanged joints.
- 9.3.12 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.

- 9.3.13 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.
- 9.3.14 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.
- 9.3.15 Removable blanket design will be sewn construction only. Hog-ring construction with mechanical fasteners is not permitted.
- 9.3.16 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 1/2" 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 name plates 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. 1/8" 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 manufacturer'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:
- 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).
 - Each control panel shall undergo complete operation and alarm testing at the factory.
 - All controllers shall be pre-programmed by the panel supplier.

12.3 SELF-REGULATING CABLES/MI CABLES

- 12.3.1 Factory inspections and tests for self-regulating and mineral insulated heating cables shall include but are not limited to the following:
- Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer's standards.
- 12.3.2 In the field, all heating cables shall be meggered with a minimum of 500 volts DC for MI cable and 2,500 volts DC for self regulating cable. The following separate field megger readings shall be taken on each self-regulating and each mineral insulated heating cable:
- Heating cable shall be meggered when received at jobsite before installation.
 - Heating cable shall be meggered after installation, but before insulation is applied.
 - Heating cable shall be meggered after insulation has been installed.
- 12.3.3 All three of the above field megger readings shall be greater than 50 megohms. Otherwise, the heating cable is not acceptable and shall be replaced.

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 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.

14.2 DRAWING REQUIREMENTS

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

- a. Drawing and schedules which 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 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.

14.2.2 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.
- b. Power distribution panel board schedules showing the following for each circuit:
 1. Circuit number
 2. Breaker size
 3. Heater type and length
 4. Voltage and wattage
 5. 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.

- 14.2.3 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.
- 14.2.4 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.
- Each isometric shall include the following information:
- a. Location of line
 - b. Piping line numbers and dimensions
 - c. Valves, pumps, flanges, fittings, instruments,
 - d. Heater circuit number
 - e. Heat loss and heater output
 - f. Electrical load
 - g. Heater catalog numbers
 - h. Heater termination points
 - i. Design parameters
 - j. Insulation type and thickness
 - k. Positions of all components
 - l. Material schedule listing all components and quantities used
 - m. Panel ID No
- 14.2.5 Nameplates and Tagging Schedules: Complete schedules shall be furnished for all system nameplates and circuit tags which are required per Section 10.0.
- 14.2.6 Bills of Material: Complete system bills of material shall be provided giving descriptions, quantities and ratings of all components used.

14.3 DATA AND DOCUMENT REQUIREMENTS

The following data and documentation shall be furnished:

- 14.3.1 Detailed literature covering all equipment furnished.
- 14.3.2 Electric heating cable description data including physical and electrical characteristics dimensions, weights, etc.
- 14.3.3 Recommended procedures for handling, installing, terminating and splicing of electric heating cable.
- 14.3.4 Complete installation, operating and maintenance manuals including components descriptive literature and information on handling, installing, operating, maintaining and troubleshooting the equipment.
- 14.3.5 Recommended spare parts list for start up and operation for one year.
- 14.3.6 Reports for tests performed in accordance with Section 12.0.
- 14.3.7 As built correction of drawings, data sheets, schedules and record isometrics to show changes made during the installation.
- 14.3.8 Log sheets detailing megger readings, current draw and voltage for each circuit installed.







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