

This is an nVent RAYCHEM specification. A qualified design professional should review and edit the document to suit project requirements.

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SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING FLOW MAINTENANCE FOR ABOVEGROUND, FUEL OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes plumbing piping heat tracing for pipe freeze prevention and grease waste flow maintenance with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.
- B. Related Requirements:

Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 220719 "Plumbing Piping Insulation."
- 2. Section 210533 "Heat Tracing for Fire-Suppression Piping."
- 3. Section 230533 "Heat Tracing for HVAC Piping."
- 4. Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 5. Section 260526 "Grounding and Bonding for Electrical Systems."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include the following:
 - a. Heating cable data sheet.
 - b. Plumbing piping freeze protection design guide.
 - c. System installation and operation manual.
 - d. System installation details.

- e. Connection kits and accessories data sheet.
 - f. Controller data sheet.
 - g. Controller wiring diagram.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 3. Schedule heating capacity, length of cable, and electrical power requirement for each electric heating cable required.
 4. Include heat loss calculations for each pipe including pipe and insulation characteristics, heat loss, and watts per foot supplied by the heating cable.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.
3. Manufacturer to produce detailed design as described below.

RAYCHEM offers detailed design services. For information contact local representative, at www.nvent.com/RAYCHEM or RAYCHEM Technical Support at (800) 545-6258.

With this service, RAYCHEM provides the following: Heat Trace Circuit Layout Drawings, Heat Trace Isometric Drawings, Detail Drawings, Control Panel Drawings, System Wiring Diagram, and Controller Setpoint Schedule.

"Delegated-Design Submittal" Paragraph below is defined in Section 013300 "Submittal Procedures as a Delegated Design Submittal." Retain paragraph below only if applicable for your region.

- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Delegated design submittals include the following:
 1. Heat Trace Circuit Layout Drawings, including:
 - a. Location/identification of area to be traced.
 - b. Heater circuit number.
 - c. Electrical load.
 - d. Heater catalog numbers.
 - e. Heater termination points.
 - f. Start-up temperature.
 - g. Location of all components.
 - h. Material list and quantities of all components.
 - i. Heating cable layout.
 2. Heat Trace Isometric, including the following:
 - a. Location of line.
 - b. Piping line numbers
 - c. Valves, pumps, flanges, fittings, and instruments.
 - d. Heat loss and heater output.

- e. Electrical load.
 - f. Heater catalog number.
 - g. Heater termination points.
 - h. Design parameters.
 - i. Insulation type and thickness.
 - j. Position of all components.
 - k. Material schedule listing all components and quantities used.
 - l. Panel ID number.
3. Pipe Freeze Protection Detail Drawings: Project-specific Detail Drawings, including details showing 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.
4. Control Panel Drawings: Drawings for each control panel shall include the following:
- a. Physical arrangement and structural detail drawings.
 - b. Complete power and control wiring diagrams showing all internal wiring connections for electrical and instrument components in each control panel. All wires, terminals, and devices shall be numbered and tagged in accordance with system elementary diagrams.
5. System Wiring Diagram: Project-specific Drawings (if applicable) including:
- a. Interconnect of all major components.
 - b. Assignment of circuiting.
 - c. Connection of circuit wiring in terminal blocks.
 - d. Connection of sensor wiring.
 - e. Connection of external alarm wiring.
6. Controller Setpoint Schedule (if applicable) showing the following:
- a. Circuit addresses.
 - b. Circuit set points,
 - c. Circuit alarms and settings.
- D. Testing Instructions and Reporting Form: Provide documentation for use in preinstallation testing of heat-tracing system.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- B. Testing: Completed system test report.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. ISO-09001 registered.
 - 2. Provide products consistent with UL 515, CSA 22.2 No 130-16, and IEEE 515.1 requirements.
- B. Installer Qualifications:
 - 1. System Installer to have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
 - 2. Electrical connections to be performed by licensed electrician.
- C. Certification - System (Heating Cable and Connection Kits): c-UL-us Listed, CSA Certified, or FM Approved for freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, and Fire Suppression systems.
- D. Testing: Self-regulating heating cable for pipe freeze protection/flow maintenance to be qualified and tested to demonstrate a useful lifetime in excess of 20 years; for hot-water-temperature maintenance to be qualified and tested to demonstrate a useful lifetime in excess of 40 years.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
 - 1. Product and manufacturer.
 - 2. Length/quantity.
 - 3. Lot number.
 - 4. Installation and operation manual.
 - 5. Material safety data sheet (MSDS).
- B. Store heating cable in clean, dry location with a temperature range of 0 to 140 deg F (-18 to 60 deg C).
- C. Protect heating cable ends from moisture ingress until final termination of the heating cable is complete.

1.8 WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

For more detailed information on RAYCHEM's Limited Product Warranty, see www.nvent.comwww.nvent.com/[RAYCHEM](http://www.nvent.com).

- A. Manufacturer's Limited Warranty: Manufacturer agrees to repair or replace heat tracing products listed below that fail in materials or workmanship within specified warranty period, when such goods are properly installed, operated, and maintained in accordance with product documentation.
1. Covered Products include the following:
 - a. Heating cables, connection kits, and accessories.
 - b. Thermostats, controllers, panels, contactors, sensors, and accessories.

Verify available warranties and warranty periods for electric heating cable.

2. Warranty Period: Two years from date of Substantial Completion.

As a demonstration of quality, RAYCHEM, a brand of nVent offers an extended warranty on all heating cable and components manufactured. Extended warranty is free to Owner. Contractor (or RAYCHEM field technician) must perform a system test as outlined in RAYCHEM's installation manual. Whereas some manufacturers do not offer an extended warranty due to variations in product quality, they may make an exception on certain projects to meet specification. For this is the reason, you should require that the extended warranty being offered is published on the manufacturer's website.

- B. Manufacturer's Extended Warranty: Provide Owner an extended product warranty for heat tracing products described below.
1. Contractor must complete and forward to Owner the Installation, Inspection, or Commissioning Record(s), and complete manufacturer's online warranty registration form within 30 days from date of installation, otherwise only standard limited warranty applies.
 2. Heating Cable Warranty Period: 10 years from date of Substantial Completion.
 3. Heating cables, connection kits, and accessories not automatically offered with a 10-year manufacturer's warranty, as a standard matter of course, will not be allowed. Warranty information must be published on manufacturer's website.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Complete pipe freeze protection system for [**insulated pipes exposed to the risk of freezing**] [**flow maintenance**] [**grease waste**] [**fuel oil lines**]. System consists of a self-regulating heating cable, connection kits, accessories, and energy-efficient control, monitoring, and Building Management System (BMS) communication capabilities. The heating cable shall have a

polyolefin jacket for above ground, water piping, and a fluoropolymer jacket for below ground grease waste or fuel piping.

1. Pipe freeze protection of above ground water piping.
2. Pipe freeze protection of below ground water piping.
3. Grease flow maintenance of above ground, sanitary grease waste piping.
4. Grease flow maintenance of below ground, sanitary grease waste piping.
5. Fuel flow maintenance of above ground fuel piping.

2.2 PERFORMANCE REQUIREMENTS

Retain "Delegated Design" Paragraph below if RAYCHEM is contracted to provide design services.

- A. Delegated Design: Engage manufacturer to design complete and functional heat-tracing system as required by Project documents.

2.3 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES FOR PIPE FREEZE PROTECTION AND GREASE WASTE FLOW MAINTENANCE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide RAYCHEM, a brand of nVent; XL-Trace Edge Pipe Freeze/Flow Maintenance or comparable product by one of the following:
 1. **<Insert manufacturer's name>**.
- B. Source Limitations: Obtain heat-tracing components and controllers from single manufacturer. To ensure system integrity and meet warranty requirements, only components and controllers supplied by cable manufacturer are to be used.
- C. Heating cable and connection kit shall be included in a c-UL-us Listed system.
- D. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end with a watertight end seal. Cable shall be capable of crossing over itself without overheating.
- E. Electrical Insulating Jacket: Flame-retardant modified polyolefin.
- F. Ground Braid: Tinned-copper braid. Minimum 70 percent for ground path and mechanical ruggedness.

To specify polyolefin (rubber) outer jacket, add suffix "-CR" to RAYCHEM model number. To specify fluoropolymer (Teflon) outer jacket, add suffix "-CT" to RAYCHEM model number.

- G. Outer Jacket Requirements.
 1. For aboveground freeze protection of water lines where fuel oil or aqueous chemicals are not present, use a modified polyolefin with ultraviolet inhibitor. Outer jacket to be printed

- with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).
2. For below-grade applications, grease waste, or where fuel oil and aqueous chemicals are present, use fluoropolymer with ultraviolet inhibitor. Outer jacket to be printed with cable model number, agency listings, batch number, and meter marks (for ease of installation within maximum circuit length).
- H. Maximum Operating Temperature (Power On): [**154 deg F (68 deg C) for 3 W/ft. (9.8 W/m), 5 W/ft. (16.4 W/m), and 8 W/ft. (26 W/m)**] [**150 deg F (65 deg C) for 12 W/ft. (39.4 W/m)**].

Verify temperature of circulated media in freeze-protected piping in "Maximum Exposure Temperature (Power Off)" Paragraph below.

- I. Maximum Exposure Temperature (Power Off): **185 deg F (85 deg C)**.
- J. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

If Project has more than one type or configuration of electric heating cable, delete "Capacities and Characteristics" Paragraph below and schedule on Drawings. See the Evaluations for a sample schedule.

- K. Capacities and Characteristics:

Retain first option in first subparagraph below for RAYCHEM models 5XL1-CR and 5XL2-CR. Retain second option for RAYCHEM models 8XL1-CR and 8XL2-CR, and third option for RAYCHEM model 12XL2-CR.

1. Nominal Heat Output at **50 deg F (10 deg C)**: [**3 W/ft. (9.8 W/m)**] [**5 W/ft. (16.4 W/m)**] [**8 W/ft. (26 W/m)**] [**12 W/ft. (39.4 W/m)**].
2. Piping Diameter: **<Insert NPS (DN)>**.
3. Number of Parallel Cables: **<Insert number>**.
4. Electrical Characteristics for Single-Circuit Connection:

Verify available voltages and heat-output ratings with manufacturer.

For nVent RAYCHEM pipe heat-tracing systems design assistance and information, see, "TraceCalc Pro for Buildings" at <https://www.nvent.com/RAYCHEM/design-tools/online-tools/trace-calc-pro-for-buildings/index.aspx><https://www.nvent.com/RAYCHEM/design-tools/online-tools/trace-calc-pro-for-buildings/index.aspx>.

- a. Volts: [**120**] [**208**] [**240**] [**277**].
- b. Phase: Single.
- c. Full-Load Amperes: **<Insert value>**.
- d. Maximum Overcurrent Protection: **<Insert amperage>**.

2.4 CONTROLS

- A. Single Circuit Local Digital Controller for Freeze Protection and Flow Maintenance.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

1. Basis-of Design Product: RAYCHEM; C910-485.
2. Control self-regulating heating cable via an energy-saving, programmable single-circuit controller to provide adjustable maintained temperatures in the range of **-40 to 140 deg F (-40 to 60 deg C)**.
3. Provide one controller for each heat-tracing circuit[, **as indicated on heat tracing schedule**].
4. Controller to include self-test function to verify heat-tracing integrity at least once every 24 hours.
5. Controller Capabilities:
 - a. Supply Voltage: 100 to 277 V ac.
 - b. Enclosure: NEMA 4X FRP.
 - c. Operating Temperature Range: **-40 to 140 deg F (-40 to 60 deg C)**.
 - d. Display: Six-character, alphanumeric LED.
 - e. Control: DP mechanical relay type.

Ambient control will energize the heat-trace circuit whenever ambient temperature drops below set point of controller. Proportional Ambient Sensing Control (PASC) is a cost/energy saving algorithm that calculates required run time of heating cable to ensure it provides sufficient heat output at a given ambient temperature. If the system is designed for -10 deg F (-23 C), the system will run continuously at -10 deg F (-23 C), but will only run partially at 20 deg F (-6.7 C).

- f. Control Algorithms: On/Off. PASC for energy savings.
- g. Monitoring:
 - 1) Temperature:
 - a) Low Alarm: **0 to 180 deg F (-18 to 82 deg C)**.
 - b) High Alarm: **0 to 200 deg F (-18 to 93 deg C)**.
 - 2) Ground Fault:
 - a) Alarm Range: 20 to 100 mA.
 - b) Trip Range: 20 to 100 mA
 - 3) Current:
 - a) Low Alarm Range: 3. to 20 A, or off.
 - 4) Autocycle Test: Interval of 1 to 240 minutes or 1 to 240 hours.
- h. Temperature Sensor Inputs:
 - 1) Quantity: Two.
 - 2) Type: 100 ohm, platinum, 3-wire, shielded.
- i. Alarm Outputs:
 - 1) AC Relay: Isolated solid state triac, SPST, 0.75 A maximum, 100 to 277 V ac nominal.
 - 2) Dry Contact Relay: Pilot duty, 48 V ac/dc, 500mA maximum, 10 V maximum resistive switching.

3) Outputs: Normally open or normally closed.

j. Stored Parameters:

- 1) Minimum temperature.
- 2) Maximum temperature.
- 3) Maximum ground fault current.
- 4) Maximum heater current.
- 5) Contactor cycle count.
- 6) Time in use.

k. Alarm Conditions:

- 1) Low and high temperature.
- 2) Low current.
- 3) Ground fault alarm and trip.
- 4) RTD failure.
- 5) Loss of programmed values.
- 6) EMR failure.

l. Communications:

- 1) Protocol: Modbus RTU.
- 2) Topology: Daisy Chain.
- 3) 26 AWG shielded twisted pair.

6. Temperature Sensors:

a. For each temperature sensing controller, provide at least one of the following:

- 1) One, 100 ohm, platinum 3-wire, shielded RTD for pipe temperature sensing.

[Retain "Basis-of-Design Product" Subparagraph below to require a specific product.](#)

a) Basis-of-Design Product: RAYCHEM; RTD-10CS.

- 2) One, 100 ohm, platinum 3-wire, shielded RTD for ambient temperature sensing.

[Retain "Basis-of-Design Product" Subparagraph below to require a specific product.](#)

a) Basis-of-Design Product: RAYCHEM; RTD-200.

7. Approval: Complete heat trace system (heating cable, connection kits, and controller) shall be listed by a nationally recognized testing laboratory (NRTL), and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, and Fire Suppression systems.

B. Single Circuit Local Digital Controller for Freeze Protection and Flow Maintenance. (Indoor use only)

[Retain "Basis-of-Design Product" Subparagraph below to require a specific product.](#)

1. Basis-of Design Product: RAYCHEM; 460.
2. Control self-regulating heating cable via an energy-saving, programmable single-circuit controller to provide adjustable maintained temperatures in the range of 32 to 176 deg F (0 to 80 deg C).
3. Contractor shall provide one (1) 460 controller for each heat tracing circuit as indicated on heat tracing schedule
4. Controller shall include a user defined self-test function to verify heat-tracing integrity daily, weekly or monthly.
5. Controller shall be able to use two temperature sensors per circuit with ability to assign any of them for high temperature cut-out function.
6. Controller shall include user-defined filters for temperature alarms to avoid nuisance alarms.
7. Controller shall have ground fault current sensing and relaying equipment that complies with UL1053 requirements. External ground fault devices are not allowed.
8. Controller shall have user-defined settings for ground fault alarm and trip levels.
9. Controller shall store at least 100 past events/alarms to aid maintenance
10. Controller Capabilities:
 - a. Supply Voltage: 120 to 277 V ac.
 - b. Enclosure: NEMA 12 (indoor use).
 - c. Operating Temperature Range: 32 to 105 deg F (0 to 40 deg C).
 - d. Display: 5" touchscreen color display.
 - e. Control: DP mechanical relay type.

Ambient control will energize the heat-trace circuit whenever ambient temperature drops below set point of controller. Proportional Ambient Sensing Control (PASC) is a cost/energy saving algorithm that calculates required run time of heating cable to ensure it provides sufficient heat output at a given ambient temperature. If the system is designed for -10 deg F (-23 C), the system will run continuously at -10 deg F (-23 C) but will only run partially at 20 deg F (-6.7 C).

- f. Control Algorithms: Ambient On/Off. Line Sensing. Proportional Ambient Sensing Control (PASC) for energy savings.
- g. Monitoring:
 - 1) Temperature:
 - a) Low Alarm: -40 to 190 deg F (-40 to 88 deg C).
 - b) High Alarm: 32 to 190 deg F (0 to 88 deg C).
 - 2) Ground Fault:
 - a) Alarm Range: 20 to 200 mA.
 - b) Trip Range: 20 to 200 mA
 - 3) Current:
 - a) Low Alarm: Built-in 0.25 A.
 - 4) Autocycle Diagnostics: Built-in (Daily).
- h. Temperature Sensor Inputs:

- 1) Quantity: Two.
- 2) Type: Thermistor 2 K-Ohm / 77°F (25°C), 2-wire.

i. Alarm Outputs:

- 1) AC Relay: Single pole double throw relay, volt-free; maximum switching capacity (resistive load only) 1 A/30 VDC, 0.5 A/125 VAC. Maximum 60 VDC/125 VAC.
- 2) Outputs: Normally open or normally closed.

j. Stored Parameters:

- 1) Time stamp.
- 2) Warning.
- 3) Event description.
- 4) Device ID.
- 5) Language.
- 6) Country.
- 7) Control mode.
- 8) Cable type.
- 9) Supply voltage.
- 10) Sensor 1 and 2.
- 11) Setpoint.
- 12) Deadband.
- 13) Minimum expected ambient temperature.
- 14) Power adjustment.
- 15) GFCI current.
- 16) Load current.
- 17) Board temperature.

k. Alarm Conditions:

- 1) Low and high temperature.
- 2) Low current.
- 3) Ground fault alarm and trip.
- 4) RTD failure.
- 5) EMR failure.

l. Communications:

- 1) Alarm relay to fire alarm panel

11. Temperature Sensors: [**Select One**]

- a. Contractor shall use one sensor provided for ambient temperature sensing and second sensor provided for pipe temperature sensing for each 460 controller.
- b. Contractor shall be able to program the controller to keep the heating cable powered in case of temperature sensor failure.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

12. Approval: Complete heat trace system (heating cable, connection kits, and controller) shall be listed by a nationally recognized testing laboratory (NRTL), and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing.

Retain "Multi-Circuit Distributed Digital Control System" Paragraph below for total building control of all heat-tracing applications.

C. Multi-Circuit Distributed Digital Control System:

1. Control and monitor pipe freeze protection using a centralized control system with distributed power and control modules.

Retain "Basis-of-Design Product" Subparagraph below to require a specific product.

- a. Basis-of Design Product: RAYCHEM; ACS-30.
2. Multi-Application: Distributed digital control system shall be pre-programmed parameters to provide concurrent control for heating cables used for pipe freeze protection, flow maintenance, HVAC piping, hot-water-temperature maintenance, surface snow melting, roof and gutter de-icing, freezer frost heave prevention and floor heating applications.
3. Central User Interface Terminal: For all programming.
 - a. Basis-of Design Product: RAYCHEM; ACS-UIT3.
 - b. Certification: c-CSA-us Certified.
 - c. Terminal Display: Color LCD display with password protection to prevent unauthorized system access.
 - d. Capable of communicating with up to 52 power control panels, where each panel can control up to five circuits and accept up to five temperature inputs.
 - e. Digital control system shall be capable of assigning up to four temperature inputs per heat-tracing circuit.
 - f. Capable of communicating with up to 16 remote monitoring modules, where each module can accept up to eight temperature inputs.
 - g. USB port to allow for quick and easy software update.
 - h. Programmable Alarm Contacts: Three, including alarm light on enclosure cover.
 - i. Provide separate offline software tool to allow users to preprogram digital control system and transfer program via USB drive or Ethernet.
 - j. Enclosure: NEMA 4 for indoor or outdoor locations.
4. Power Control Panels:
 - a. Basis-of-Design Products: RAYCHEM; ACS-PCM2-5.
 - b. Certification: c-UL-us Listed.
 - c. Enclosure: NEMA 4/12 enclosure approved for nonhazardous indoor and outdoor locations.
 - d. Provide ground-fault and line current sensing alarming, switching and temperature inputs for five heat-tracing circuits.
 - e. Contactors: 3-pole, 30A contactors, EMR type. Quantity: Five.
 - f. Capable of operating at 120 to 277 V.
 - g. Alarm contact, including alarm light on panel cover.

5. Digital Controller:

- a. Integrated adjustable GFPD (10 to 200 mA).
- b. Capable of being configured for On/Off, ambient sensing, PASC, and timed duty cycle control modes based on application. PASC control proportionally energizes power to heating cable to minimize energy based on ambient sensed conditions.
- c. Upon communication loss with user interface terminal, panels shall control with the last downloaded set point.
- d. Include built-in self-test feature to verify proper functionality of heating cable system.

If selecting BACnet or Metasys protocol in "BMS Communication Protocol" Subparagraph below, include RAYCHEM ProtoNode RER multi-protocol gateway as an accessory.

- e. BMS Communication Protocol: By one of the following protocols: [Modbus] [BACnet or Metasys N2].
 - f. Variables monitored by digital controller and reported back to BMS include the following:
 - 1) Temperature.
 - 2) Ground-fault.
 - 3) Current draw.
 - 4) Power consumption.
 - 5) Associated alarms.
6. Approval: Complete heat trace system (heating cable, connection kits, and controller) shall be listed by an NRTL, and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, Domestic Hot-Water-Temperature Maintenance, and Fire Suppression systems.

2.5 HEATING CABLE CONNECTION KITS

- A. Basis-of-Design Product: RAYCHEM; RayClic.
- B. Provide power connections, splices/tees, and end seal kits to properly connect and terminate heating cable circuit along specified length of the piping.
- C. Install splices, tees, and crosses underneath the pipe insulation with service loops installed to allow for future service of piping.
- D. Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized and shall not require cutting into heating-cable core to expose bus wires.
- E. Certification: c-UL-us Listed, CSA Certified, and FM approved.
- F. Locate connection kits above grade for buried applications.

2.6 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, cable ties, connection kits, and end seals all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Identification: Provide and install "Electric Heat Traced" labels on exterior of pipe insulation every 10 ft. (3 m) on opposite sides of pipe, and on all splices, tees, crosses, and power connections for the entire length of heat traced piping.
- C. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."
- D. Thermal Pipe Insulation:
 - 1. Pipes to be thermally insulated in accordance with manufacturer's written requirements.
 - 2. Thermal Insulation: Flame retardant, [closed-cell] [or] [fiberglass] with waterproof covering.

2.7 SYSTEM APPROVAL

- A. Complete heat trace system (heating cable, connection kits, and controller) shall be listed by an NRTL, and marked for intended freeze protection of metallic and non-metallic piping associated with HVAC, Plumbing, and Fire Suppression systems.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Prior to installation of heating cable system, verify that all piping that will be heat traced has passed all hydrostatic/pressure test and is signed off by plumbing inspector.
 - 2. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Preinstallation Testing:
 - 1. Prior to installing heating cable on piping, an insulation resistance test shall be performed by installing contractor to ensure integrity of heating cable as described in the installation and maintenance manual.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect all heating cable ends from moisture ingress until cable is terminated with end seals.
 - 1. Basis-of-Design Product: RAYCHEM; RayClic-E end seals.

3.3 INSTALLATION

Indicate location of controls on Drawings.

- A. All heat-tracing components including power connections, splices, tees, crosses or end seal, must be installed above grade and protected from abuse or damage. In accordance with NEC and CEC, electrical connections are not permitted to be installed below grade.
- B. In the field, all heating cables shall be meggered with a minimum of 2,500 V dc for self-regulating cable. The following field megger readings shall be taken on each heating cable:
 - 1. Heating cable shall be meggered when received at Project site before installation.
 - 2. Heating cable shall be meggered after installation, but before insulation is installed.
 - 3. Heating cable shall be meggered after insulation is installed.
 - 4. Heating cable shall be meggered at final commissioning prior to being energized.
 - 5. Insulation resistance must exceed 1.000 megohms at 2,500 V dc.
 - 6. All results must meet manufacturer's specification.
- C. Electric Heating-Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables in accordance with IEEE 515.1.
 - 3. Install insulation over piping with electric heating cables in accordance with Section 220719 "Plumbing Piping Insulation."
- D. Install electric heating cables after piping has passed all hydrostatic pressure testing and before insulation is installed.
- E. Install electric heating cables in accordance with IEEE 515.1.
- F. Install warning labels on piping insulation where piping is equipped with electric heating cables.
- G. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

RAYCHEM offers initial start-up and field testing (commissioning) of the system as a service. For information, contact local representative at www.nvent.com/RAYCHEM or RAYCHEM Technical Support at (800) 545-6258.

- A. Manufacturer's Field Service: Initial start-up and field testing (commissioning) of system shall be performed by factory technician in accordance with Owner's requirements.
- B. Contractor to perform the following tests and inspections during installation:
 - 1. Heating cable shall be meggered when received at Project site before installation.
 - 2. Heating cable shall be meggered after installation, but before insulation is installed.
 - 3. Heating cable shall be meggered after insulation is installed.
 - 4. Insulation resistance must exceed 1,000 megohms at 2,500 V dc.
 - 5. All results must meet manufacturer's specification.
 - 6. Test cables for electrical continuity during installation.
 - 7. Test insulation integrity before energizing.
 - 8. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

- D. Cables will be considered defective if they do not pass tests and inspections in accordance with manufacturer's testing requirements.
- E. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage and moisture ingress during construction.
- B. Remove and replace damaged heat-tracing cables.

END OF SECTION 220533