

## **Capital Projects Group**

# **Electric Heating Cable and Control Specification**

Specification 23 83 13

Revision 1

Date: September 2018

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## Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
Various	Sept. 20, 2018	Revised to coordinate with corresponding specifications.

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## **1. GENERAL**

### **1.1. SCOPE OF WORK**

- 1.1.1. Provide electric heating cable and control as required, scheduled and specified herein.

### **1.2. DESIGN REQUIREMENTS**

- 1.2.1. Design requirements are based on Part 2 specified requirements of products.

### **1.3. RELATED WORKS**

- 1.3.1. Section 20 05 05 - Mechanical Work General Instructions.
- 1.3.2. Section 20 05 10 - Basic Mechanical Materials and Methods.
- 1.3.3. Section 20 05 40 - Mechanical Work Commissioning.

### **1.4. REFERENCE STANDARDS**

- 1.4.1. Standards and codes to be latest editions adopted by and enforced by local governing authorities.
- 1.4.2. API American Petroleum Institute RP500A for Area Classification.
- 1.4.3. CEC Canadian Electrical Code, Part I, (CSA C22.1) and Saskatchewan Amendments and including Ontario Electrical Safety Code.
- 1.4.4. CSA Standard C22.2 No. 130, Requirements for Electrical Resistance Trace Heating and Heating Device Sets - Class No: 2872 01, Heaters - Cable and Cable Sets.
- 1.4.5. NFPA National Fire Protection Association.
- 1.4.6. applicable other IEEE, ANSI, CSA and EEMAC standards for equipment.

### **1.5. TRAINING**

- 1.5.1. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- 1.5.2. Include for 3 training sessions of maximum 7 hours duration per session for 6 Metrolinx people per session.
- 1.5.3. Refer to Section 20 05 05 for additional general requirements.

### **1.6. SPARE PARTS**

- 1.6.1. Complete spare parts list.

- 1.6.2. List of priced spare parts that manufacturer recommends should be on hand during commissioning and first 2 year's operation.

**1.7. WARRANTY**

- 1.7.1. Products to be guaranteed by manufacturer, for a minimum of 5 years after acceptance by Metrolinx.

**1.8. DELIVERY, STORAGE AND HANDLING**

- 1.8.1. Handle and store products in accordance with manufacturer's instructions, in locations approved by Metrolinx. Include one copy of these instructions with product at time of shipment.

**1.9. SUBMITTALS**

- 1.9.1. Refer to submittal requirements in Section 20 05 05.
- 1.9.2. Submit a start-up certification letter from cable supplier as specified in Part 3 of this Section.
- 1.9.3. Submit certified cable megger test reports as specified in Part 3 of this Section.
- 1.9.4. Submit shop drawings/product data sheets as follows:
- a) to regulatory authority for review and approval prior to submitting to Consultant.
  - b) for all products specified in Part 2 of this Section;
  - c) copies of all calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing requirements.
- 1.9.5. Submit installation, operating and maintenance manuals in accordance with requirements specified herein this Section and Section 20 05 05.
- 1.9.6. Product Data
- a) Submit product data sheets indicating:
    - 1) technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;
    - 2) performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol;
    - 3) product transportation, storage, handling, and installation requirements;
    - 4) product identification in accordance with Metrolinx requirements.

1.9.7. Shop Drawings

- a) Submit shop drawings indicating:
  - 1) capacity and ratings;
  - 2) mounting details to suit locations shown, indicating methods and hardware to be used;
  - 3) installation drawings completely dimensioned in metric units, showing all components applicable and control wiring schematic of the electric tracing system and the layout and routing of the heating cable;
  - 4) heater circuit number;
  - 5) heater catalogue number;
  - 6) line number and dimensions;
  - 7) tag number where applicable;
  - 8) heater length;
  - 9) voltage required;
  - 10) maximum ampere load of heater;
  - 11) total output of heaters in watts;
  - 12) output of heater in watts per foot;
  - 13) spiral pitch (if applicable);
  - 14) design parameters (heat loss, insulation, temperature maintenance, etc.);
  - 15) startup current at lowest design temperature.

1.9.8. Commissioning Package

- a) Submit the following in accordance with Sections 20 05 05 and 20 05 40:
  - 1) Commissioning Plan;
  - 2) Commissioning Procedures;
  - 3) Certificate of Readiness;
  - 4) complete test sheets specified in Section 20 05 40 and attach them to the Certificate of Readiness;

- 5) Source Quality Control inspection and test results and attach to the Certificate of Readiness.

1.9.9. Commissioning Closeout Package

- a) Submit the following in accordance with Section 20 05 05:
  - 1) Deficiency Report;
  - 2) Commissioning Closeout Report;
  - 3) submit the following for each Product for incorporation into the Operation and Maintenance Manuals in accordance with Section 20 05 05:
    - i) Identification: manufacturer's name, type, year, serial number, number of units, capacity, and identification to related systems;
    - ii) functional description detailing operation and control of components;
    - iii) performance criteria and maintenance data;
    - iv) safety precautions;
    - v) installation instructions;
    - vi) operating instructions and precautions;
    - vii) component parts availability, including names and addresses of spare part suppliers;
    - viii) maintenance and troubleshooting guidelines/protocol;
    - ix) product storage, preparation, handling, and installation requirements;
    - x) Commissioning Report.
  - 4) Installation Requirements:
    - i) Installation drawings.
    - ii) Field testing and checkout procedure including acceptable testing values.
    - iii) Cable arrangement drawings.



## 1.10. QUALITY ASSURANCE

- 1.10.1. Products are to comply with codes, regulations and standards listed above and applicable local codes and regulations.
- 1.10.2. All electric heat tracing materials are to be tested at the factory using the manufacturer's standards which must be in accordance with the latest CSA Standard C22.2 No 130.
- 1.10.3. Manufacturer to supply a competent field engineer to instruct and assist with installation of first 10% of heaters to assure that installers are familiar with installation requirements. All components and tracing cabling shall be installed according to manufacturer's instructions.
- 1.10.4. Site personnel are to be licensed in jurisdiction of the work and under continuous supervision of a foreman who is an experienced system installer.
- 1.10.5. Manufacturers Qualifications
  - a) Manufacturer shall be ISO 9000, 9001 or 9002 certified. Manufacturer of product shall have produced similar product for a minimum period of five years. When requested by Consultant, an acceptable list of installations with similar product shall be provided demonstrating compliance with this requirement.
  - b) Where manufacturers provide after installation onsite inspection of product installations, include for manufacturer's authorized representative to perform onsite inspection and certificate of approvals.
- 1.10.6. Installers Qualifications
  - a) Installers for work under Mechanical Division to be performed by or work under licensed Mechanical Contractor.
  - b) Installers for electrical work to be performed by or work under licensed Electrical Contractor.
  - c) Where manufacturers provide training sessions to installers and certificates upon successful completion, installers to have obtained such certificates and submit copies with shop drawings.
- 1.10.7. Regulatory Requirements
  - a) Products and work to comply with applicable local governing authority regulations, bylaws and directives.
  - b) Include for required inspections and certificate of approvals of installation work from local governing authorities.

## 2. PRODUCTS

### 2.1. DOMESTIC HOT WATER TEMPERATURE MAINTENANCE CABLE

2.1.1. ULC listed, CSA approved, heating cable sets to maintain temperature in domestic hot water piping, each set as specified/scheduled on drawings and include but not be limited to provision of following:

- a) electrical heat tracing cable:
  - 1) required lengths of heating cable type;
  - 2) installed to withstand EMI/EMC interference;
  - 3) typical a metallic sheath with stainless steel braid or tinned copper braid with a corrosive resistant jacket;
  - 4) sheath able to supply a continuous path to the ground;
  - 5) operate on line voltages as required and noted on drawings, without the use of transformer.
- b) thermostat set at required design temperature;
- c) power connection with end seal per circuit;
- d) tee connections with end seals as required for pipe branches;
- e) splice connections as required as per manufacturer's specifications and approved procedures typical;
- f) glass tape to secure cable on pipe, and "Electric Traced" adhesive labels to be secured to pipe insulation.

2.1.2. Heating cable which will be installed in concrete foundations or slabs (if applicable) must be approved for this type of application.

2.1.3. Components exposed to elements to be weatherproof and corrosion resistant. Component enclosures to be NEMA 4X rated.

2.1.4. Standard of quality assurance manufacturers are:

- a) nVent - Raychem;
- b) 3M;
- c) Thermon;
- d) Chromalox;

- e) or approved equivalent.

## 2.2. PIPE FREEZE PROTECTION HEATING CABLE

2.2.1. ULC listed, CSA certified, self-regulating piping freeze protection cable sets as specified and/or scheduled on drawings, each set complete with:

- a) electrical heat tracing cable:
  - 1) required lengths of self-regulating heating cable;
  - 2) consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two - 16 AWG nickel-plated copper bus wires that varies its power output in response to pipe temperature changes;
  - 3) with a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness;
  - 4) have fluoropolymer outer jacket, to suit application;
  - 5) be compatible with piping being heated, as verified by independent testing company;
  - 6) cable to operate at voltages shown, without use of transformers.
- b) power connection with end seal per circuit;
- c) tee connections with end seals as required for pipe branches;
- d) splice connections as required;
- e) glass tape to secure cable on pipe, and "Electric Traced" adhesive labels to be secured to pipe insulation;
- f) pipe temperature sensing thermostat.

2.2.2. Heating cable which will be installed in concrete foundations or slabs (if applicable) must be approved for this type of application.

2.2.3. Components exposed to elements to be weatherproof and corrosion resistant. Component enclosures to be NEMA 4X rated.

2.2.4. Standard of quality assurance manufacturers are:

- a) nVent - Raychem;
- b) 3M;
- c) Thermon;

- d) Chromalox;
- e) or approved equivalent.

### **2.3. ELECTRIC SNOW MELTING CABLE (SELF -REGULATING)**

2.3.1. ULC listed, CSA certified, self-regulating snow melting cable sets as specified and/or scheduled on drawings, each set complete with:

- a) electrical heat tracing cable:
  - 1) required lengths of self-regulating heating cable;
  - 2) parallel circuit construction, self-regulating cable consisting of 2 #14 gauge nickel coated copper bus wires embedded in a parallel self-regulating polymer core;
  - 3) covered by a crosslinked dielectric jacket, protected by a tinned-copper braid and a 70 mm (2-3/4") thick modified polyolefin outer jacket;
  - 4) cable to operate at voltages shown, without use of transformers.
- b) junction boxes for power connections and end seal terminations;
- c) expansion joint kits to permit cable to cross heated surface expansion joints;
- d) splice kits to permit splicing or repairing cable;
- e) for each snow melting area, an anodized aluminum snow melting area caution sign for flush with grade installation.

2.3.2. Heating cable which will be installed in concrete foundations or slabs (if applicable) must be approved for this type of application.

2.3.3. Components exposed to elements to be weatherproof and corrosion resistant. Component enclosures to be NEMA 4X rated.

2.3.4. Standard of quality assurance manufacturers are:

- a) nVent - Raychem;
- b) 3M;
- c) Thermon;
- d) Chromalox;
- e) or approved equivalent.

## 2.4. ELECTRIC SNOW MELTING CABLE (MINERAL INSULATED)

2.4.1. ULC listed, CSA certified, mineral insulated (MI) snow melting cable sets as specified and/or scheduled on drawings, each set complete with:

a) Electrical Heat Tracing Cable:

- 1) magnesium oxide insulated, with copper or resistance alloy conductor and a seamless copper sheath.
- 2) constructed in a manner that no combustible materials are allowed between resistance alloy conductor and outer metal sheath.
- 3) heater core materials are inorganic and will not deteriorate with age.
- 4) heated section joined to a PVC jacketed copper sheath cold lead section by a factory-made joint.
- 5) complete heater assembly to have a protective high density polyethylene jacket.
- 6) designed for operation on supply voltages up to 600 VAC.
- 7) heat output to not decrease as temperature of slab increases.
- 8) factory-fabricated to length required and not be altered on site.
- 9) cable to operate at voltages shown, without use of transformers.

b) Mounting Hardware:

- 1) Corrosion resistant mesh or stainless steel pre-punched strapping to hold snow melting cables in place and to maintain desired spacing for application.

c) Junction Boxes:

- 1) Cast aluminum flush and surface mounting junction boxes complete with gasketed lid and entries suitable for entries required at each location. Junction boxes to not be in heated surface or below grade or in a location where moisture will enter box.

d) Warning Signage:

- 1) Anodized aluminum plaque that identifies an embedded heating cable system.

2.4.2. System to be controlled by automatic controllers and sensors, as specified later in this Section. Include for manual override switch of type recommended by system manufacturer to deactivate system power.

- 2.4.3. Heating cable which will be installed in concrete foundations or slabs (if applicable) must be approved for this type of application.
- 2.4.4. Components exposed to elements to be weatherproof and corrosion resistant. Component enclosures to be NEMA 4X rated.
- 2.4.5. Standard of quality assurance manufacturers are:
  - a) nVent - Raychem;
  - b) 3M;
  - c) Thermon;
  - d) Chromalox;
  - e) or approved equivalent.

## **2.5. SNOW MELTING CABLE CONTROLS**

- 2.5.1. Controllers to suit specific applications as follows:
  - a) 24 volt AC, roof or mast mounting, solid-state, microcontroller design aerial snow sensor to detect falling or blowing precipitation at 3.37 °C (38 °F) before snow or ice begins to accumulate;
  - b) Single Circuit Controller: surface wall mounting, microprocessor snow controller with contactor and integral 30 mA ground fault circuit interrupter, test/reset facility, a relay interface for connection to a building management system, and an adjustable high temperature sensor to protect heating cable from excessive temperature.
  - c) Multi-Circuit Controller: similar to single circuit controller but with pre-programmed parameters to provide concurrent control for heating cables. Controller includes ground fault protection, configurable alarm settings and remote annunciation of various operating parameters. Include required auxiliary contacts (form C type) for third party interface.
- 2.5.2. Standard of quality assurance manufacturers are:
  - a) nVent - Raychem;
  - b) Environmental Technology Inc;
  - c) 3M;
  - d) Thermon;
  - e) Chromalox;

- f) or approved equivalent.

## **2.6. SYSTEM TESTING AND VERIFICATION:**

- 2.6.1. Include for manufacturer's authorized representative to inspect system installation, test system, and verify system.
- 2.6.2. Manufacturer's authorized technician to prepare and sign verification report letter that states system has passed manufacturer's testing and performs to manufacturer's requirements for application.

## **2.7. INSULATION**

- 2.7.1. Refer to Section 20 05 25 for insulation requirements.

## **3. EXECUTION**

### **3.1. GENERAL INSTALLATION REQUIREMENTS**

- 3.1.1. Engage system manufacturer to review documents to ensure that requirements are included for proper operation and functionality of system for specific application in compliance with drawings parameters and specification. Confirm type materials be heated, area, length and diameter as applicable, insulation as applicable, and design temperature parameters and include in design and selection of system. Provide required components suitable for operation at voltages and for connection to breakers as noted on drawings and as required.
- 3.1.2. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.1.3. Install electric heating cables in strict accordance with manufacturer's requirements and installation instructions.
- 3.1.4. Lay cables out at spacing as per system manufacturer's recommendations.
- 3.1.5. Where traced pipe enters a building, extend heater minimum of 300 mm (1') inside building.
- 3.1.6. Locate junction boxes in accessible areas. Locate junction boxes above grade level, not in heated slab. Covers boxes at all times when not working therein.
- 3.1.7. Protect terminations from weather and from physical damage. Bond gland assembly to system ground.
- 3.1.8. Provide alarm/communications circuits as required to monitor system controller status and alarms. Connect to fire alarm system as required by local governing codes or to building automation system.

3.1.9. After installation, conduct recommended tests under supervision of cable manufacturer's representative and subject self-regulating heating cable to insulation resistance testing using Megger. Minimum insulation resistance to be 1000 megohms or greater. All heating cables are to be field tested to assure correct operation before and after installation. The cables shall be tested for ground resistance and continuity after installation. Perform insulation resistance test and continuity test as recommended by manufacturer. Heating-cable circuit capacitance to also be recorded as a means of verifying continuous cable lengths. Submit completed test form to Consultant and Metrolinx as work progresses.

3.1.10. Replace any cable that fails testing.

### **3.2. INSTALLATION OF DOMESTIC WATER TEMPERATURE MAINTENANCE CABLE**

3.2.1. Supply electric tracing cable sets to maintain temperature of domestic hot water piping.

3.2.2. Hand cable sets and accessories and cable manufacturer's installation instructions to electrical trade at site for installation on piping. Clearly identify piping to be traced. Ensure piping has been pressure tested prior to cable installation and manufacturer's installation instructions are observed.

3.2.3. After cable installation but before application of piping insulation, megger test and commission cable in presence of Consultant and in accordance with cable manufacturer's installation and operation manual. Replace any damaged or faulty cable, and when satisfactory results have been obtained, submit signed test reports to Consultant.

3.2.4. When traced piping has been insulated, install "Electrically Traced" labels on opposite sides of pipe at 3 m (10') intervals and in accordance with requirements specified in Section 20 05 10.

### **3.3. INSTALLATION OF FREEZE PROTECTION HEATING CABLE**

3.3.1. Supply electric tracing cable sets to prevent piping from freezing.

3.3.2. Hand cable sets and accessories and cable manufacturer's installation instructions to electrical trade at site for installation on piping. Clearly identify piping to be traced. Ensure piping has been pressure tested prior to cable installation and manufacturer's installation instructions are observed.

3.3.3. After cable installation but before application of piping insulation, megger test and commission cable in presence of Consultant and in accordance with cable manufacturer's installation and operation manual. Replace any damaged or faulty cable, and when satisfactory results have been obtained, submit signed test reports to Consultant.



- 3.3.4. When traced piping has been insulated, install "Electrically Traced" labels on opposite sides of pipe at 3 m (10') intervals and in accordance with requirements specified in Section 20 05 10.
- 3.3.5. When cable installations are complete, check and test operation of each cable set with heater manufacturer's representative, make any required adjustments, and have cable manufacturer certify in writing that cable sets have been properly installed and operate as intended.

#### **3.4. INSTALLATION OF SNOW MELTING SYSTEM CABLE**

- 3.4.1. Supply electric heating cable to prevent ice and snow formation on exterior surfaces. Ensure that selected cable type is recommended for specific applications and surfaces to be heated.
- 3.4.2. Hand cable and accessories and cable manufacturer's installation instructions to electrical trade at site for installation on the surfaces. Clearly identify areas to be heated. Ensure surfaces are cleaned and suitable for cable installation prior to cable installation, and manufacturer's installation instructions for specific type of cable are observed.
- 3.4.3. Install snow sensor and connect to snow controller with 24 volt wiring in conduit in accordance with sensor manufacturer's instructions and wiring standard of electrical work. Test operation of sensor and controller in presence of cable manufacturer's representative and adjust as required.
- 3.4.4. Do not proceed with any field alterations or deviations unless approved in writing by Metrolinx and reviewed with Consultant. Record changes accurately on as-builts.
- 3.4.5. Coordinate cable installation with type of surface toppings and with trades installing same. Supervise installation of toppings to ensure against cable damage. Replace damaged cables. Conduct recommended tests under supervision of a manufacturer's representative. Do not permit cables to be covered until tests are complete and accepted by Consultant. Engage manufacturer's technician to inspect installation, verify test, approve test results, and prepare an installation report.
- 3.4.6. Mineral insulation cables: Perform manufacturer's recommended cable testing, including field testing of insulation, 500 VDC meggering of cables and testing for continuity of cables. Conduct recommended tests under supervision of cable manufacturer's representative. Test MI cable to standards of IEEE Std.515 and applicable system manufacturer's instructions. Before installation of cables, apply 500 Vdc to cables and test cable to confirm readings in excess of 1000 megohms. Conduct recommended after installation tests under supervision of cable manufacturer's representative. Under applied 500 Vdc, measured megohmmeter readings to be greater than 20 megohms. Perform separate field megohmmeter readings of insulation resistance on each cable. Replace any cable with readings less than these values.

- 3.4.7. Self-regulating cables: After installation, conduct recommended tests under supervision of cable manufacturer's representative and subject self-regulating heating cable to insulation resistance testing using Megger. Minimum insulation resistance to be 1000 megohms or greater. All heating cables are to be field tested to assure correct operation before and after installation. The cables shall be tested for ground resistance and continuity after installation. Perform insulation resistance test and continuity test as recommended by manufacturer. Heating-cable circuit capacitance to also be recorded as a means of verifying continuous cable lengths. Submit completed test form to Consultant and Metrolinx as work progresses. Replace any cable that fails testing.
- 3.4.8. Carefully place an aluminum snow melting area caution sign flush with grade at each snow melting area, and coordinate placement with trade constructing finished surface.

### **3.5. INSTALLATION OF CONTROLS AND SENSORS**

- 3.5.1. Prior to submission of Bid, engage system manufacturer to review system controls and sensors to ensure that all requirements are included for proper operation of complete system and cables for each specific application. Provide specified required controller, control panel and snow/ice sensors in locations as shown on drawings and as reviewed with Consultant and system manufacturer. Mount devices and connect complete to control heating cables.
- 3.5.2. Obtain required training from manufacturer's representative on any special installation procedures. Install products in accordance with manufacturer's instructions to suit specific installation requirements.
- 3.5.3. If controller does not have ground fault detection protection, ensure that power to system is ground fault protected as per local governing code requirements.
- 3.5.4. Sensors to be suitable for installation in exposed, elevated locations, or for flush installation in pavement and ramps in accordance with system manufacturer's recommendations.
- 3.5.5. Pavement sensors controlling pavement snow/ice melting to function to incrementally ramp pavement temperature to minimize thermal stresses that may contribute to concrete cracking and maintain a maximum slab temperature of 3.3 °C (38 °F).
- 3.5.6. Where ambient sensors are not included with control panel, provide high limit thermostats with capillary end bulbs inserted into a metal conduit under surface being heated, to prevent operation of system in warm weather or over heating of panels. Include for means of manual override switch to power ON/OFF system.
- 3.5.7. Provide precipitation sensors in locations and of type to suit application, drawing requirements and site conditions, as per system manufacturer's recommendations.

- 3.5.8. Review with Metrolinx requirement for remote manual override switch. Install in single gang electrical outlet box complete with suitable faceplate, connect with required wiring.
- 3.5.9. Ground and bond system components as per system manufacturer's instructions.
- 3.5.10. Provide for system manufacturer authorized representative to program controller and to test and verify that automatic control system, in conjunction with snow melting cable is functioning in proper operation. Conduct recommended tests under supervision of manufacturer's representative.

**END OF SECTION**