Where an electrode boiler is rated 50 kW or more, the conductors supplying the boiler electrode(s) shall be permitted to be sized at not less than 100 percent of the nameplate rating of the electrode boiler, provided all the following conditions are met:

(1) The electrode boiler is marked with a minimum conductor size.
(2) The conductors are not smaller than the marked minimum size.
(3) A temperature- or pressure-actuated switch controls the cyclic operation of the equipment.

425.83 Overtemperature Limit Control. Each boiler, designed so that in normal operation there is no change in state of the heat transfer medium, shall be equipped with a temperature-sensitive limiting means. It shall be installed to limit maximum liquid temperature and shall directly or indirectly interrupt all current flow through the electrodes. Such means shall be in addition to the temperature regulating system and other devices protecting the tank against excessive pressure.

425.84 Overpressure Limit Control. Each boiler, designed so that in normal operation there is a change in state of the heat transfer medium from liquid to vapor, shall be equipped with a pressure-sensitive limiting means. It shall be installed to limit maximum pressure and shall directly or indirectly interrupt all current flow through the electrodes. Such means shall be in addition to a pressure-regulating system and other devices protecting the tank against excessive pressure.

425.85 Grounding. Boilers designed such that fault currents do not pass through the pressure vessel, and the pressure vessel is electrically isolated from the electrodes, all exposed non–current-carrying metal parts, including the pressure vessel, supply, and return connecting piping, shall be connected to the equipment grounding conductor. For all other designs, the pressure vessel containing the electrodes shall be isolated and electrically insulated from ground.

425.86 Markings. All electrode-type boilers shall be marked to show the following:

(1) The manufacturer's name.
(2) The rating in volts, amperes, and kilowatts.
(3) The electrical supply required specifying frequency, number of phases, and number of wires.
(4) The marking "Electrode-Type Process Heating Boiler."
(5) A warning marking, "All Power Supplies Shall Be Disconnected Before Servicing, Including Servicing the Pressure Vessel."

A field-applied warning marking or label shall comply with 110.21(B). The markings shall be permanent and located so as to be visible after installation.

ARTICLE 426

Fixed Outdoor Electric Deicing and Snow-Melting Equipment

Part I. General

426.1 Scope. This article covers fixed outdoor electric deicing and snow-melting equipment and the installation of these systems.

Article 426 includes requirements for resistance heating elements, impedance heating systems, and skin-effect heating systems used for deicing and snow melting.

(A) Embedded. Embedded in driveways, walks, steps, and other areas.

(B) Exposed. Exposed on drainage systems, bridge structures, roofs, and other structures.

Informational Note: See ANSI/IEEE 515.1-2012, *Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications*, for further information. See IEEE 844/CSA 293 series of standards for fixed outdoor electric deicing and snow-melting equipment.

Δ **426.3 Other Articles.** Cord-and-plug-connected fixed outdoor electric deicing and snow-melting equipment shall additionally comply with Table 426.3.

N ***TABLE 426.3*** Other Articles

Equipment	Article
Appliances	422 (Parts I, II, III, IV, V)

426.4 Continuous Load. Fixed outdoor electric deicing and snow-melting equipment shall be considered a continuous load.

Fixed outdoor electric deicing and snow-melting equipment is considered a continuous load for the purpose of sizing branch circuits, feeders, service conductors, and overcurrent protective devices (OCPDs).

Part II. Installation

426.10 General. Equipment for outdoor electric deicing and snow melting shall be identified as suitable for the environment and installed in accordance with the manufacturer's instructions.

426.11 Use. Electric heating equipment shall be installed in such a manner as to be afforded protection from physical damage.

Underwriters Laboratories Inc. requires that manufacturers of UL-listed mat or cable deicing and snow-melting equipment provide specific installation instructions for their products. These

instructions supplement the requirements contained in Article 426. For example, if the equipment can be installed only in concrete that is double poured (poured in two parts), the installation instructions are to specifically require that installation technique. Where the instructions do not specify an installation process, the use of either a single- or double-pour installation method is acceptable.

See also

110.3(B) regarding the installation and use of listed or labeled equipment

426.12 Thermal Protection. External surfaces of outdoor electric deicing and snow-melting equipment that operate at temperatures exceeding 60°C (140°F) shall be physically guarded, isolated, or thermally insulated to protect against contact by personnel in the area.

426.13 Identification. The presence of outdoor electric deicing and snow-melting equipment shall be evident by the posting of appropriate caution signs or markings where clearly visible.

Part III. Resistance Heating Elements

426.20 Embedded Deicing and Snow-Melting Equipment.

(A) Watt Density. Panels or units shall not exceed 1300 watts/m^2 (120 watts/ft^2) of heated area.

(B) Spacing. The spacing between adjacent cable runs is dependent upon the rating of the cable and shall be not less than 25 mm (1 in.) on centers.

(C) Cover. Units, panels, or cables shall be installed as follows:

(1) On a substantial concrete, masonry, or asphalt base at least 50 mm (2 in.) thick and have at least 38 mm (1½ in.) of concrete, masonry, or asphalt applied over the units, panels, or cables; or
(2) They shall be permitted to be installed over other identified bases and embedded within 90 mm (3½ in.) of concrete, masonry, or asphalt but not less than 38 mm (1½ in.) from the top surface; or
(3) Equipment that has been listed for other forms of installation shall be installed only in the manner for which it has been identified.

(D) Secured. Cables, units, and panels shall be secured in place by frames or spreaders or other approved means while the concrete, masonry, or asphalt finish is applied.

(E) Expansion and Contraction. Cables, units, and panels shall not be installed where they bridge expansion joints unless provision is made for expansion and contraction.

426.21 Exposed Deicing and Snow-Melting Equipment.

(A) Secured. Heating element assemblies shall be secured to the surface being heated by identified means.

(B) Overtemperature. Where the heating element is not in direct contact with the surface being heated, the design of the heater assembly shall be such that its temperature limitations shall not be exceeded.

(C) Expansion and Contraction. Heating elements and assemblies shall not be installed where they bridge expansion joints unless provision is made for expansion and contraction.

(D) Flexural Capability. Where installed on flexible structures, the heating elements and assemblies shall have a flexural capability that is compatible with the structure.

426.22 Installation of Nonheating Leads for Embedded Equipment.

(A) Grounding Sheath or Braid. Except as permitted under 426.22(B), nonheating leads installed in concrete, masonry, or asphalt shall be provided with a grounding sheath or braid in accordance with 426.27 or shall be enclosed in rigid metal conduit, electrical metallic tubing, intermediate metal conduit, or other metal raceways.

(B) Splice Connections. The splice connection between the nonheating lead and heating element, within concrete, masonry, or asphalt, shall be located no less than 25 mm (1 in.) and no more than 150 mm (6 in.) from the metal raceway. The length of the nonheating lead from the metal raceway to the splice assembly shall be permitted to be provided without a grounding sheath or braid. Grounding continuity shall be maintained.

(C) Bushings. Insulating bushings shall be used in the concrete, masonry, or asphalt where the leads enter a metal raceway.

See also

300.4(G) and its commentary for more information on insulating bushings

(D) Expansion and Contraction. Leads shall be protected in expansion joints in accordance with 300.4(H) or installed in accordance with the manufacturer's instructions.

(E) Emerging from Grade. Exposed nonheating leads shall be protected by raceways or other identified means.

(F) Leads in Junction Boxes. Not less than 150 mm (6 in.) of free nonheating lead shall be within the junction box.

426.23 Installation of Nonheating Leads for Exposed Equipment.

(A) Nonheating Leads. Power supply nonheating leads (cold leads) for resistance elements shall be identified for the temperature encountered. Not less than 150 mm (6 in.) of nonheating leads shall be provided within the junction box. Preassembled factory-supplied and field-assembled nonheating leads on approved heaters shall be permitted to be shortened if the markings specified in 426.25 are retained.

(B) Protection. Nonheating power supply leads shall be enclosed in a rigid conduit, intermediate metal conduit, electrical metallic tubing, or other approved means.

426.24 Electrical Connection.

(A) Heating Element Connections. Electrical connections, other than factory connections of heating elements to nonheating elements embedded in concrete, masonry, or asphalt or on exposed surfaces, shall be made with insulated connectors identified for the use.

(B) Circuit Connections. Splices and terminations at the end of the nonheating leads, other than the heating element end, shall be installed in a box or fitting in accordance with 110.14 and 300.15.

426.25 Marking. Each factory-assembled heating unit shall be legibly marked within 75 mm (3 in.) of each end of the nonheating leads with the permanent identification symbol, catalog number, and ratings in volts and watts or in volts and amperes.

426.26 Corrosion Protection. Ferrous and nonferrous metal raceways, cable armor, cable sheaths, boxes, fittings, supports, and support hardware shall be permitted to be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition.

426.27 Grounding Braid or Sheath. Grounding means, such as copper braid, metal sheath, or other approved means, shall be provided as part of the heated section of the cable, panel, or unit.

Δ **426.28 Ground-Fault Protection.** Ground-fault protection shall be provided for fixed outdoor electric deicing and snow-melting equipment. The trip level of ground-fault protection shall be as specified by the manufacturer.

Rather than protecting the entire branch circuit, the ground-fault protection requirement is focused on protecting just the equipment itself. The manufacturer and the user have an option of providing both circuit and equipment protection or just the required equipment protection. This required protection can be accomplished by the use of circuit breakers equipped with equipment ground-fault protection or an integral device supplied as part of the deicing or snow-melting equipment that is sensitive to leakage currents of 6 milliamperes to 50 milliamperes. These protection devices, if applied properly, will substantially reduce the risk of a fire being started by low-level electrical arcing.

Note that the required equipment protection is not the same as a GFCI used for personal protection that trips at 5 milliamperes (±1 milliamperes).

Part IV. Impedance Heating

426.30 Personnel Protection. Exposed elements of impedance heating systems shall be physically guarded, isolated, or thermally insulated with a weatherproof jacket to protect against contact by personnel in the area.

426.31 Isolation Transformer. An isolation transformer with a grounded shield between the primary and secondary windings shall be used to isolate the distribution system from the heating system.

426.32 Voltage Limitations. The secondary winding of the isolation transformer connected to the impedance heating elements shall not have an output voltage greater than 30 volts ac.

426.33 Induced Currents. All current-carrying components shall be installed in accordance with 300.20.

Part V. Skin-Effect Heating

426.40 Conductor Ampacity. The current through the electrically insulated conductor inside the ferromagnetic envelope shall be permitted to exceed the ampacity values shown in Table 310.16, provided it is identified as suitable for this use.

426.41 Pull Boxes. Where pull boxes are used, they shall be accessible without excavation by location in suitable vaults or above grade. Outdoor pull boxes shall be of watertight construction.

426.42 Single Conductor in Enclosure. The provisions of 300.20 shall not apply to the installation of a single conductor in a ferromagnetic envelope (metal enclosure).

426.43 Corrosion Protection. Ferromagnetic envelopes, ferrous or nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed in concrete or in direct contact with the earth, or in areas subjected to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition. Corrosion protection shall maintain the original wall thickness of the ferromagnetic envelope.

426.44 Equipment Grounding Conductor. The ferromagnetic envelope shall be connected to an equipment grounding conductor at both ends; and, in addition, it shall be permitted to be connected to an equipment grounding conductor at intermediate points as required by its design.

Section 250.30 shall not apply to the installation of skin-effect heating systems.

Part VI. Control and Protection

426.50 Disconnecting Means.

(A) Disconnection. All fixed outdoor deicing and snow-melting equipment shall be provided with a means for simultaneous

disconnection from all ungrounded conductors. Where readily accessible to the user of the equipment, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means. The disconnecting means shall be of the indicating type and be capable of being locked in the open (off) position.

(B) Cord-and-Plug-Connected Equipment. The factory-installed attachment plug of cord-and-plug-connected equipment rated 20 amperes or less and 150 volts or less to ground shall be permitted to be the disconnecting means.

426.51 Controllers.

(A) Temperature Controller with "Off" Position. Temperature-controlled switching devices that indicate an "off" position and that interrupt line current shall open all ungrounded conductors when the control device is in the "off" position. These devices shall not be permitted to serve as the disconnecting means unless they are capable of being locked in the open position in compliance with 110.25.

(B) Temperature Controller Without "Off" Position. Temperature controlled switching devices that do not have an "off" position shall not be required to open all ungrounded conductors and shall not be permitted to serve as the disconnecting means.

(C) Remote Temperature Controller. Remote controlled temperature-actuated devices shall not be required to meet the requirements of 426.51(A). These devices shall not be permitted to serve as the disconnecting means.

(D) Combined Switching Devices. Switching devices consisting of combined temperature-actuated devices and manually controlled switches that serve both as the controller and the disconnecting means shall comply with all of the following conditions:

(1) Open all ungrounded conductors when manually placed in the "off" position
(2) Be so designed that the circuit cannot be energized automatically if the device has been manually placed in the "off" position
(3) Be capable of being locked in the open position in compliance with 110.25

426.54 Cord-and-Plug-Connected Deicing and Snow-Melting Equipment. Cord-and-plug-connected deicing and snow-melting equipment shall be listed.

According to the UL *Guide Information for Electrical Equipment*, which can be found at productspec.ul.com, category KOBQ deicing and snow-melting equipment is provided with means for permanent wiring connection, except for equipment rated 20 amperes or less and 150 volts or less to ground, which may be of cord-and-plug-connected construction.

See also

Article 100 for the definition of *listed*

ARTICLE 427

Fixed Electric Heating Equipment for Pipelines and Vessels

Part I. General

427.1 Scope. This article covers electrically energized heating systems and the installation of these systems used with pipelines and vessels.

Informational Note: See IEEE 515-2017, *Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Industrial Applications*, for further information.

Also see applicable sections of the IEEE 844/CSA 293 series of standards for alternate technologies for fixed electric heating equipment for pipelines and vessels.

Article 427 includes requirements for impedance heating, induction heating, and skin-effect heating, in addition to resistance heating elements, where used in pipeline and vessel applications.

Δ • **427.3 Other Articles.** Cord-connected pipe heating assemblies shall additionally comply with Table 427.3.

N ***TABLE 427.3*** Other Articles

Equipment	Article
Appliances	422 (Parts I, II, III, IV, V)

427.4 Continuous Load. Fixed electric heating equipment for pipelines and vessels shall be considered continuous load.

Fixed electric heating equipment is considered a continuous load for the purpose of sizing branch circuits, feeders, service conductors, and overcurrent protective devices (OCPDs).

Part II. Installation

427.10 General. Equipment for pipeline and vessel electric heating shall be identified as being suitable for (1) the chemical, thermal, and physical environment and (2) installation in accordance with the manufacturer's drawings and instructions.

427.11 Use. Electric heating equipment shall be installed in such a manner as to be afforded protection from physical damage.

427.12 Thermal Protection. External surfaces of pipeline and vessel heating equipment that operate at temperatures exceeding 60°C (140°F) shall be physically guarded, isolated, or thermally insulated to protect against contact by personnel in the area.