

Chapter E 665

INDUCTION AND DIELECTRIC HEATING EQUIPMENT

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A. SCOPE AND GENERAL

E 665.01 Scope. The provisions of this chapter shall apply to the construction and installation of induction and dielectric heating equipment and accessories for industrial, scientific and medical applications, but not for appliances.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.02 Definitions. (1) The term "heating equipment" as used in this chapter includes any equipment used for heating purposes whose heat is generated by induction or dielectric methods.

(2) Induction heating is the heating of a nominally conducting material due to its own i^2R losses when the material is placed in a varying electro-magnetic field.

(3) Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

(4) The term "therapeutic high frequency equipment" as used in this chapter shall be understood to mean generating equipment capable of producing alternating currents having frequencies greater than those frequencies which elicit neuromuscular response. In order to comply with the above, the output frequency of the therapeutic high frequency equipment shall not be less than 2 megacycles.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.03 Application of other chapters. Wiring from the source of power to the heating equipment shall comply with Wis. Adm. Code chapters E 100 to E 400 inclusive. Circuits and equipment operating on a supply circuit of more than 600 volts shall comply with the provisions of chapter E 710.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.04 Hazardous locations. Induction and dielectric heating equipment shall not be installed in hazardous locations as defined in chapter E 500 unless the equipment and wiring is designed and approved for the locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. MOTOR-GENERATOR EQUIPMENT

E 665.05 Scope. Motor generator equipment shall include all rotating equipment designed to operate from an AC or DC motor, or by mechanical drive from a prime mover, producing an alternating current of any frequency for induction and/or dielectric heating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.06 Ampacities of supply conductors. Ampacities of supply conductors shall be determined by Wis. Adm. Code chapter E 430.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.07 Overcurrent protection. Overcurrent protection shall be provided as specified in chapter 430 of this code for the electrical supply circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.08 Disconnecting means. The disconnecting means shall be provided as specified in chapter E 430 of this code. (1) A readily accessible disconnecting means shall be provided by which each heating equipment can be isolated from the supplying circuit. The ampacity of this disconnecting means shall be not less than the nameplate current rating of the equipment. The supply circuit disconnect means may be used as a heating equipment disconnecting means where the circuit supplies only one equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.09 Output circuit definition. The output circuit shall include all high frequency output components external to the generator, including contactors, transformers, bus-bars, and transmission lines. The same definition shall apply to all off line frequencies obtained from motor generators, or generators used with induction heating loads.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.10 Output circuits. Output circuits shall conform to the following: (1) **GENERATOR OUTPUT.** (a) The output circuit shall be isolated from ground, except for the capacitive coupling inherent in the generator, which, in effect causes the generator terminals to have voltages from terminal to ground that are equal.

(b) When rated at more than 500 volts, the output circuit shall incorporate a DC ground protector unit. The DC impressed on the output circuit shall not exceed 30 volts and shall not exceed a current capability of 5 milliamperes.

(c) An isolating transformer for matching the load and the source may be used in the output circuit wherein the secondary is not at DC ground potential.

(2) **COMPONENT INTERCONNECTIONS.** The various components required for a complete induction heating equipment installation shall

be connected by properly protected multiconductor cable, bus bar, or coaxial cable. Cables shall be installed in non-ferrous conduit raceways. Bus bar shall be protected where required by nonferrous enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.11 Control-enclosures. Low frequency AC or DC may be used in the control portion of the heating equipment. This shall be limited to a value of 150 volts. Solid or stranded wire, properly sized in No. 18 AWG or larger shall be used. Sixty cycle components may be used to control HF when properly rated by the induction heating equipment manufacturer. Electronic circuits utilizing solid state devices and tubes may use printed circuits or wire sizes, properly sized smaller than No. 18 AWG.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.12 Remote control. (1) When remote controls are used for applying power, a "Local-Remote" switch shall be provided and interlocked so as to prevent the possibility of applying power from other than one selected control point or points.

(2) Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. EQUIPMENT OTHER THAN MOTOR GENERATOR

E 665.13 Scope. Equipment other than motor generator includes all static multipliers and oscillator type units utilizing vacuum tubes and/or solid state devices. The equipment shall be capable of converting AC, or DC to a frequency suitable for induction and/or dielectric heating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.14 Ampacities of supply conductors. Ampacities of supply conductors shall be determined as follows: (1) the ampacity of the circuit, shall be not less than the nameplate current rating of the equipment.

(2) The ampacities of conductors supplying 2 or more equipments shall be not less than the sum of nameplate current ratings on all equipment except as follows: Where, when supplying 2 or more equipments from the same feeder, simultaneous operation of said equipments is not possible, the ampacity of the feeder shall be not less than the sum of the nameplate currents for the largest group of machines capable of simultaneous operation, plus 100% of the standby currents of the remaining machines supplied.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.15 Overcurrent protection. Overcurrent protection shall be provided as specified in chapter E 430 for the equipment as a whole. This overcurrent protection shall be provided separately or as a part of the equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.16 Disconnecting means. A readily accessible disconnecting means shall be provided by which each heating equipment can be

isolated from the supplying circuit. The ampacity of this disconnecting means shall not be less than the nameplate current rating of the equipment. The supply circuit disconnect means may be used for disconnecting the heating equipment where the circuit supplies only one equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.17 Output circuit definition. The output circuit shall include all high frequency output components external to the converting device including contactors, transformers, bus-bars, and transmission lines. The same definition shall apply to all off line frequencies obtained from the converting device, or devices used with induction and/or dielectric heating loads.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.18 Output circuits. Output circuits shall conform to the following: (1) CONVERTER OUTPUT. The output circuit (direct or coupled) shall be at DC ground potential.

(2) CONVERTER AND APPLICATOR CONNECTION. When the connections between the converter and the work applicator exceed 2 feet in length the connections shall be enclosed or guarded with noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.19 Line frequency in converter equipment output. Commercial frequencies of 25 to 60 cycle alternating current output may be coupled for control purposes, but shall be limited to a value of 150 volts available only during periods of circuit operation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.20 Keying. Where high-speed keying circuits dependent on the effect of "oscillator blocking" are employed, the peak R.F. output voltage during the blocked portion of the cycle shall not exceed 100 volts in units employing R.F. converters.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.21 Remote control. (1) When remote controls are used for applying power, a "Local Remote" switch shall be provided and interlocked so as to prevent the possibility of applying power from other than one selected control point or points.

(2) Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. GUARDING AND GROUNDING

E 665.22 Enclosures. The converting apparatus (including the DC line) and high frequency electrical circuits (excluding the output circuits and remote control circuits), shall be completely contained in an enclosure or enclosures of noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.23 Panel controls. All panel controls shall be of "dead front" construction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.24 Access to internal equipment. Doors or detachable panels may be employed for internal access. Where doors are used giving access to voltages from 500 to 1000 volts AC or DC, either door locks shall be provided or interlocking shall be installed with the choice of precaution optional. Where doors are used giving access to voltages above 1000 volts AC or DC, either mechanical lockouts, with a disconnect means to prevent access until voltage is removed from the cubicle, or both door interlocking and mechanical door locks shall be provided. Detachable panels not normally used for access to such parts shall be fastened in a manner which will make them inconvenient to remove.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.25 Warning labels. "Danger" labels shall be attached on the equipment, and shall be plainly visible even when doors are opened or panels are removed from compartments containing voltages above 250 volts AC or DC.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.26 Capacitors. (1) when capacitors in excess of 0.1 Mfd. are used in DC circuits, either as rectifier filter components, or suppressors, etc., having circuit voltages exceeding 230 volts above ground, bleeder resistors or grounding switches shall be used as grounding devices. The time of discharge shall be in accordance with section E 460.06 (1).

(2) Where auxiliary rectifiers are used with filter capacitors in the output for bias supplies, tube keyers, etc., bleeder resistors shall be used even though the DC voltage may not exceed 230 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.27 Work applicator shielding. Protective cages or adequate shielding shall be used to guard work applicators other than induction heating coils. Induction heating coils may be protected by insulation and/or refractory materials. Interlock switches shall be used on all hinged access doors, sliding panels or other easy access to the applicator. All interlock switches shall be connected in such a manner as to remove all power from the applicator when any one of the access doors or panels is open. Interlocks on access doors or panels are not required when the applicator is an induction heating coil at DC ground potential or operating at less than 150 volts AC.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.28 Grounding and bonding. Grounds and/or inter-unit bonding shall be used wherever required for circuit operation and for limiting to a safe value radio frequency potentials between all exposed noncurrent-carrying parts of the equipment and earth ground, also between all equipment parts and surrounding objects and between such objects and earth ground. Such grounding and bonding shall be installed in accordance with Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.29 Marking. Each heating equipment shall be provided with a nameplate, giving the manufacturer's name and model identification, and the following input data: line volts, frequency, number of phases, maximum current, full load KVA and full load power factor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. THERAPEUTIC EQUIPMENT

E 665.30 Installation. (1) Where portability is not essential, equipment shall be permanently installed in accordance with Wis. Adm. Code chapters E 100 to E 300 inclusive.

(2) Where portability is essential, the power supply cord shall be a three-conductor hard service type with an ampacity not less than the marked rating of the equipment. One conductor having a continuous green color or a continuous green color with a yellow stripe insulation shall be used solely for equipment grounding. The cord shall terminate in an approved grounding attachment-plug cap as described in section E 250.059 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.31 Applicators for therapeutic equipment. Application of the high frequency power to the patient may be made by means of an electric field or of an induction field. Current-carrying parts of applicators shall be so insulated or enclosed that reliable isolation of the patient shall be assured.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.32 Enclosure. The converting apparatus including the DC line, and high frequency electrical circuits, but excluding the line cord for portable units and the output circuits, shall be contained in an enclosure of noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665. 33 Panel controls. All panel controls shall be of "dead front" construction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.34 Access to internal equipment. Access shall be through panels not conveniently removable. Panels which need removal for access to fuses, tubes, adjustments, overload reset devices, internal top switches, and the like, shall be labeled to indicate danger if and when removed, or shall be provided with suitable electrical interlock devices.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.