

Chapter E 710

OVER 600 VOLTS; GENERAL

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A. GENERAL

E 710.01 Scope. This chapter applies in general to all circuits and equipment operated at more than 600 volts. For specific installation see the chapters referred to in section E 710.02.

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

E 710.02 Installations covered in other chapters. Provisions applicable to specific types of installations are included in Wis. Adm. Code chapter E 230, Services; chapter E 346, Rigid Metal Conduit; chapter E 347, Rigid Nonmetallic Conduit; chapter E 430, Motors, Motor Circuits and Controllers; chapter E 450, Transformers and Transformer Vaults; chapter E 460, Capacitors; chapter E 730, Outside Branch Circuits and Feeders; chapter E 410, Lighting Fixtures, Lamp-holders, Lamps, Receptacles and Rosettes; chapter E 600, Electric Signs and Outline Lighting; chapter E 660, X-ray Equipment, and chapter E 665, Inductive and Dielectric Heat Generating Equipment.

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

E 710.03 Wiring methods. Circuit conductors shall be suitable for the voltage and the conditions under which they are installed. They shall be installed in rigid metal conduit, in raceways or ducts or as open runs of metal armored cable suitable for the use and purpose.

(1) **EXCEPTION.** In locations accessible to qualified persons only, open runs of non-metallic sheathed cable, bare conductors and bare bus bars may also be used.

(2) When installed in the ground they shall be suitable for the purpose and buried at least 36 inches deep. An approved concentric neutral type of direct burial multiple or single conductor cable may be buried to a minimum depth of 30 inches. Where these methods are impractical the cable may be not less than 24 inches deep provided they are installed in suitable raceways or encased in 2 inches of concrete. See chapters E 346 and E 347.

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

E 710.04 Braid-covered insulated conductors; open installation. Open runs of braid-covered insulated conductors shall have a flame-retardant braid. When the conductors used do not have this protection a flame-retardant saturant shall be applied to the braid covering after installation. This treated braid covering shall be stripped back a safe distance at conductor terminals, according to the operating voltage. This distance should be not less than one inch for each kilovolt of the conductor-to-ground voltage of the circuit, where practicable.

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

E 710.05 Shielding of rubber-insulated conductors. Where rubber-insulated conductors for permanent installations operate at voltages higher than those indicated in table E 710.05 and under the conditions mentioned, they shall be of a type having metallic shielding for the purpose of confining their dielectric field.

**TABLE E 710.05
SHIELDING OF RUBBER-INSULATED CONDUCTORS**

Method of Installation	Voltage in Kv (L-L) Above which Shielding is Required			
	Neutral Grounded		Neutral Ungrounded	
	Fibrous Covered	Ozone Resistant Jacket Covering	Fibrous Covered	Ozone Resistant Jacket Covering
In metallic conduit or trough above grade located indoors and in dry locations				
Single conductor	2	5*	2	3
Multi-conductor	2	5	2	5
Underground ducts and conduits and other wet locations				
Single conductor	2	3**	2	3
Multi-conductor	2	5	2	5
On insulators—				
Only multi-conductor	Not required under 5 Kv.		3	5
Directly in soil—				
Single conductor		3		3
Multi-conductor		5		5

*It is presumed that installation conditions will be such as to maintain a high level of jacket surface resistivity and so minimize the possibility of destructive discharge. Pulling dry or the use of insulating type pulling lubricants will help attain these conditions. Where surface contamination cannot be prevented and high surface resistivity cannot be maintained, metallic shielding shall be used at over 3 kv.

**For 3 single conductor cables, cabled together without overall outer covering, the value is 5 kv.

Note: Metallic sheathed single or 3-conductor cables require no metallic shielding for voltages 5 kv and less. In the case of portable equipment cables it is good practice to specify shielding for all voltages above 2 kv.

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

E 710.06 Grounding of shielding tape. The metallic shielding or any other static voltage shields on shielded cable shall be stripped back to a safe distance according to the circuit voltage, at all terminations of the shielding, as in potheads and joints. At such points, suitable meth-

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ods such as the use of potheads, terminators, stress cones or similar devices shall be employed for stress reduction and the metallic shielding tape shall be grounded.

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

E 710.07 Grounding. Wiring and equipment installations shall conform with the applicable provisions of chapter E 250.

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

E 710.08 Moisture or mechanical protection for metal sheathed cables. Where cable conductors emerge from a metal sheath and where protection against moisture or mechanical injury is necessary, the insulation of the conductors shall be protected by a pothead or other approved means.

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

B. EQUIPMENT—GENERAL PROVISIONS

E 710.10 Indoor installations. Indoor electrical equipment installations shall conform with subsections (1) and (2).

(1) IN PUBLIC PLACES OR PLACES FREQUENTED BY UNQUALIFIED PERSONS EMPLOYED ON THE PREMISES. Exposed live parts of electrical equipment shall be guarded against accidental contact by enclosure or by locating the equipment as follows:

(a) In a room or enclosure which is accessible only to qualified persons;

(b) On a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified persons;

(c) Elevated in accordance with clearances of Table E 710.34 (6).

Note 1: For the purposes of this chapter a qualified person is one who has been trained in the construction, operation and hazards of equipment operating in excess of 600 volts and who is regularly employed in the installation, operation or maintenance of such equipment.

Note 2: The term "guarded" requires specific guards around live parts and does not include building walls, railings or fences used to exclude the public.

(2) IN PLACES ACCESSIBLE TO QUALIFIED PERSONS ONLY. Electrical installations shall conform with sections E 710.31 and E 710.34, inclusive.

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

E 710.11 Outdoor installations. Outdoor installations having exposed live parts shall be accessible to qualified persons only. Installations are considered to be accessible to qualified persons only where enclosed as provided in section E 710.31 or when isolated by elevation. Live parts are deemed to be isolated by elevation (1) where the clearance to ground and to buildings conforms with chapter E 730 for outdoor installations, and (2) as provided in section E 710.34 (6) for locations accessible to qualified persons only.

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

E 710.12 Metal enclosed equipments. Installations consisting of metal enclosed equipments such as metal clad switchgear, transformers, and the like, which have no exposed live parts, need not comply with section E 710.31, Ventilating or similar openings in

equipment shall be so designed that foreign objects inserted through these openings will be deflected from energized parts. Where exposed to physical damage from vehicular traffic suitable guards shall be provided.

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

C. EQUIPMENT—SPECIFIC PROVISIONS

(See also references to specific types of installations
in section E 710.02)

E 710.21 Circuit interrupting devices. (1) **CIRCUIT BREAKERS.** (a) Indoor installations shall consist of metal-enclosed units or fire-resistant cell-mounted units except that open mounting of circuit breakers is permissible in locations accessible to qualified persons only.

(b) Circuit breakers shall be trip-free in all positions. In every installation the circuit breaker rating in respect to closing, carrying or interrupting capabilities shall not be less than the short circuit duty at the point of application.

(c) Circuit breakers used to control oil-filled transformers should be located outside the transformer vault.

(d) Circuit breakers shall have a means of indicating the open and closed position of the breaker at the point(s) from which they may be operated.

(e) Oil circuit breakers shall be so arranged or located that adjacent readily combustible structures or materials are safeguarded in an approved manner. Adequate space separation, fire-resistant barriers or enclosures, trenches containing sufficient coarse crushed stone and properly drained oil enclosures such as dikes or basins are recognized as suitable for this purpose.

(2) **FUSEHOLDERS AND FUSES.** (a) Fuses which expel flame in opening the circuit shall be so designed or arranged that they will function properly without hazard to persons or property.

(b) Fuseholders shall be designed so that they can be de-energized while replacing a fuse unless the fuse and fuseholder are designed to permit fuse replacement by qualified persons using equipment designed for the purpose without de-energizing the fuseholder.

(c) When high voltage fused cutouts are installed in a building or a transformer vault, they shall be of a type designed for use in buildings. Where such cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved switch or contactor shall be provided which is capable of interrupting the entire load. In addition, the cutouts shall be interlocked with the approved interrupter or bear a conspicuous sign reading "Do Not Open Cutout Under Load".

(d) The cutouts shall be so located that they may be readily and safely operated and re-fused. Fuses shall be accessible from a clear floor space.

(3) **LOAD INTERRUPTERS.** Load interrupter switches may be used providing suitable fuses or circuit-breakers are applied in conjunction with these devices to interrupt fault currents. When these devices are used in combination they shall be so coordinated electrically that they

will safely withstand the effects of closing, carrying or interrupting all possible currents up to the assigned maximum short-circuit rating.

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

E 710.22 Isolating means. Means shall be provided to completely isolate an item of equipment. The use of isolating switches is not necessary where there are other ways of deenergizing the equipment for inspection and repairs such as metal-enclosed switchgear units, and removable truck panels. Isolating switches should be interlocked with the associated circuit interrupting device to prevent their being opened under load; otherwise signs warning against opening them under load shall be provided. Barriers should be provided on both sides of each pole of indoor open-type isolating switches. A fuseholder and fuse, designed for the purpose, may be used as an isolating switch.

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

D. INSTALLATIONS ACCESSIBLE TO QUALIFIED PERSONS ONLY

E 710.31 Enclosure for electrical installations. Electrical installations in a vault, room, closet or in an area surrounded by a wall, screen or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only. The height of the wall, screen or fence shall not be less than 6 feet overall, unless designed to provide an equivalent degree of isolation. Fences shall be of a type that cannot be readily climbed and the six foot minimum height is excluding any barbed wire. The type of enclosure used in a given case shall be designed and constructed according to the nature and degree of the hazard(s) associated with the installation. Chapter E 450 covers minimum construction requirements for oil-filled transformer vaults.

Note: Isolation by elevation is covered in sections E 710.11 and E 710.34.

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

E 710.32 Circuit conductors. (1) They may be installed in conduit; in duct systems; as metal-armored cable; as bare wire, cable and buses, or as non-metallic sheathed cables or conductors as provided in sections E 710.03 to E 710.06 inclusive. Bare live conductors shall conform with sections E 710.33 to E 710.36 inclusive.

(2) Insulators, together with their mounting and conductor attachments, when used as supports for wires, single conductor cables and bus bars, shall be capable of safely withstanding the maximum magnetic forces which would prevail if 2 or more conductors of a circuit were subjected to short-circuit current.

(3) Open runs of insulated wires and cables, having a bare lead sheath or a braided outer covering, shall be supported in a manner designed to prevent physical damage to the braid or sheath. Supports for lead covered cables shall be designed to prevent electrolysis of the sheath.

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

E 710.33 Minimum space separation between live parts and adjacent surfaces. The minimum indoor air separation between bare live

conductors and between such conductors and adjacent surfaces shall be not less than the values given below. This rule applies to interior wiring design and construction. It does not apply to the space separation provided in electrical apparatus and wiring devices.

TABLE E 710.33
MINIMUM AIR SEPARATION IN INCHES, INDOORS*

Circuit Voltage	Between Bare Live Conductors and Adjacent Surfaces	
	Between Bare Live Conductors	Between Bare Live Conductors and Adjacent Surfaces
5,000-----	3.5	2.5
15,000-----	7	5.5
25,000-----	11	8.5

*The values given are the minimum permissible space separation under favorable service conditions. They should be increased under unfavorable service conditions or wherever space limitations permit. Proportional values may be used for intermediate voltages.

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

E 710.34 Work space and guarding. (1) WORKING SPACE. The minimum clear working space in front of electrical equipment, such as switchboards, control panels, switches, circuit breakers, motor controllers, relays and similar equipment shall not be less than set forth in the following table unless otherwise specified in this code.

TABLE 710.34 (1)
MINIMUM CLEAR WORKING SPACE IN FRONT OF ELECTRICAL EQUIPMENT

Voltage to Ground	Conditions		
	1	2	3
601-2,500-----	3 ft.	4 ft.	5 ft.
2,501-7,500-----	4 ft.	5 ft.	6 ft.
Over 7,500-----	5 ft.	6 ft.	9 ft.

(a) Where the "Conditions" are as follows:

1. Exposed live parts on one side and no live or grounded parts on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated bus bars operating at not more than 300 volts shall not be considered live parts.

2. Exposed live parts on one side and grounded parts on the other side. Concrete, brick or tile walls will be considered as grounded surfaces.

3. Exposed live parts on both sides of the work space (not guarded as provided in condition 1) with the operator between.

(b) Exception: Working space is not required in back of assemblies such as dead-front switchboards or control assemblies when there are no renewable or adjustable parts such as fuses or switches on the back and when all connections are accessible from other locations than the back.

(2) **SEPARATION FROM LOW-POTENTIAL EQUIPMENT.** When switches, cutouts or other equipment operating at 600 volts or less are installed in a room or enclosure where there are exposed live parts, or exposed wiring operating at more than 600 volts the high potential equipment shall be effectively separated from the space occupied by the low potential equipment by a suitable partition, fence, or screen.

(a) Exception: Switches or other equipment operating at 600 volts or less and serving only equipment within the high-voltage vault, room or enclosure may be installed in the high-voltage enclosure, room or vault if accessible to qualified persons only.

(3) **LOCKED ROOMS OR ENCLOSURE.** The entrances to all buildings, rooms or enclosures containing exposed live parts or exposed conductors operating in excess of 600 volts shall be kept locked, except where such entrances are at all times under the observation of a qualified attendant.

(a) Where the voltage exceeds 600 volts permanent and conspicuous warning signs shall be provided, reading substantially as follows: "Warning—High voltage—Keep Out."

(4) **ILLUMINATION.** Adequate illumination shall be provided for all working spaces about electrical equipment. The light outlets shall be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

(a) The points of control shall be so located that persons are not liable to come into contact with any live part or moving part of the equipment while turning on the lights.

(5) **HEADROOM.** The minimum headroom above working spaces about switching equipment where there are live parts exposed at any time shall not be less than 6½ feet.

(6) **ELEVATION OF UNGUARDED LIVE PARTS.** Unguarded live parts above working space shall be maintained at elevations not less than required by the following table.

TABLE 710.34 (6)
ELEVATION OF UNGUARDED LIVE PARTS ABOVE
THE WORKING SPACE

Voltage Between Phases	Minimum Vertical Clearance of Unguarded Parts	
	Feet	Inches
601- 6,600	8	0
6,601- 11,000	9	0
11,001- 22,000	9	3
22,001- 33,000	9	6
33,001- 44,000	9	10
44,001- 66,000	10	5
66,001- 88,000	11	0
88,001-110,000	11	7
110,001-132,000	12	2

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