# 220 CMR 125.00: INSTALLATION AND MAINTENANCE OF ELECTRIC TRANSMISSION LINES

Section



## 125.10: Scope, Nature and Application of 220 CMR 125.00

(1) Scope.

(a) Extent of Application. The following rules apply to electric transmission lines operating at alternating current voltages over 50,000 volts phase to phase in overhead and underground construction operated in connection with public utilities, privately or municipally owned. The clearances listed in the tables take into account the fact that the transmission line may be operated at 5% above the voltages indicated in the tables.

(b) Not Complete Specifications. 220 CMR 125.00 is not complete specifications, but are intended to embody the requirements which are most important from the standpoint of safety. Rules in 220 CMR 125.00 are to be regarded as mandatory are characterized by the use of the word "shall". Where a rule is of an advisory nature, it is indicated by the use of the word "should".

(c) Conformity with Good Practice. Construction should be made according to accepted good practice for the given local conditions in all particulars not specified in the rules.

(2) Application of the Rules and Exemptions.

(a) Realization of Intent. The intent of the rules will be realized by applying them to all new installations, reconstructions, and extensions made subsequent to the effective date of 220 CMR 125.00. However, the requirements of 220 CMR 125.20 shall apply to existing and new lines.

(b) Intent, Modification. 220 CMR 125.00 shall apply to all installations, except as modified or waived by the Department. They are intended to be modified or waived for reasons such as, but not limited to, the following:

1. Where construction requirements are not justified by the protection secured or where the advantage of uniformity with existing construction is greater than the advantage of construction in conformity with the rules or where the rules are shown to be impracticable; provided equivalent or safer construction can be accomplished in other ways.

2. Where lines were designed and commitments made to purchase material prior to the effective date of 220 CMR 125.00.

Requests for modification or waiver of any rule or rules in connection with particular installations shall be made in writing to the Department.

It is not intended that these rules shall supersede rules of others having jurisdiction in specific areas.

125.10: continued

(c) Temporary Installations. It will sometimes be necessary to modify or waive certain rules in cases of temporary installations or installations which are soon to be discarded or reconstructed, subject to review by the Department after a 90-day period.

(d) Interpretations. Interpretations are intended to clarify the intent of specific rules and are not intended to supply consulting information on the application of the code. Requests for interpretation may be addressed to the Department. After due consideration by the Department, the inquirer will be notified of its decision.

(e) Waiver in Emergencies. In case of emergency or pending decision of the Department, the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by the Department. The person responsible shall promptly notify the Department of any emergency action which does not conform to 220 CMR 125.00.

(3) Minimum Requirements. The rules state the minimum requirements for spacing, clearances, and strength of construction. More ample spacings and clearances or greater strength of construction may be provided if other requirements are not neglected in so doing.

(4) Design and Construction. All transmission lines shall be of suitable design and construction for the normal service and conditions under which they are to be operated.

(5) Construction and Maintenance. All transmission lines shall be constructed and maintained so as to reduce hazards to life insofar as practicable.

125.20: General Requirements Applying to Overhead Transmission Lines

(1) Inspection and Tests of Lines.

(a) Initial Compliance with 220 CMR 125.20. Transmission line construction shall comply with 220 CMR 125.20 upon being placed in service.

(b) Patrols. A visual observation of exposed components of transmission lines, their supporting structures and the condition of the right of way shall be made at least twice a calendar year at intervals not less than three months and at such other times as operating experience may dictate.

(c) Tests. Transmission lines shall be subjected to the following tests to determine their fitness for service:

1. Resistance Testing. Resistance of connections shall be tested at reasonable intervals, with consideration given to their age and the type of service, using a heat-sensing or other device. Conductors and connections, failure of which will require customers to be out of service until the failure has been repaired, shall be tested at intervals not to exceed three years for existing lines and 6 months, 18 months and 36 months after in-service date for new lines and extensions and at intervals not to exceed 36 months thereafter.

2. Wood Pole Inspection. Tests in the vicinity of the ground level shall be made to determine the soundness of the wood within 20 years after installation and within ten year periods thereafter.

3. Clearances. At intervals not to exceed five years, vertical clearances shall be measured at all crossings over water and limited access highways, permits for which were granted with designated clearances.

(d) Records. The results of all patrols and tests and corrective action taken shall be recorded, and retained in accordance with 220 CMR 75.00. Records not covered by the aforesaid order shall be retained for six years. However, in all cases, the records of the last tests shall be retained until replaced by later test records.

(e) Corrective Action. Appropriate measures shall be taken to correct any defects and deficiencies found on inspection.

(2) Isolation and Guarding. To promote safety to the general public and to employees not authorized to approach conductors and other current-carrying parts of electric transmission lines, such parts shall be arranged so as to provide adequate clearance from the ground or other space generally accessible, or shall be provided with guards so as to isolate them effectively from accidental contact by such persons.

125.20: continued

(3) Arrangement of Switches.

(a) Accessibility. All switches shall be readily accessible to authorized persons.

(b) Locking. Switches with operating mechanisms accessible to unauthorized persons shall have provision for locking in both open and closed positions and locks shall be used.

125.21: Grounding of Overhead Transmission Lines

(1) Scope. 220 CMR 125.21 shall apply to the grounding of transmission line structures and equipment where the grounding is intended to be a permanent and effective protective measure.

(2) Parts to Be Grounded. All metal conduits, cable sheaths, switch operating handles and metallic structures shall be effectively grounded.

(3) Material and Continuity. In all cases the grounding conductor shall be of a metal or combination of metals which will not corrode excessively under the existing conditions and, if practicable, shall be without joint or splice. If joints are necessary, they shall be so made as to not materially increase the resistance of the grounding conductor.

(4) Size and Capacity. The grounding conductor or conductors shall have a current-carrying capacity sufficient to insure continuity and continued effectiveness of the ground connection under and subsequent to conditions of excess current caused by either of the following:

(a) Impulse surge due to direct lightning stroke to structure or lightning protection wires.

(b) Power frequency follow current due to insulation flashover for the length of time required for the protective devices to clear the circuit.

The minimum breaking strength of the grounding conductor shall be 1,000 lb.

(5) Underground Grounding Conductors. Wires used for grounding conductors, if laid underground, shall, unless otherwise mechanically protected, be laid so as to prevent their being readily broken. Joints shall be so made as to not materially increase the resistance of the grounding conductor.

(6) Ground to Railway Returns. Protective grounds shall not be made to railway negative-return circuits.

(7) Made Electrode Grounds. Where made electrodes are used, they shall, as far as practicable, be embedded below permanent moisture level. Made electrodes shall be of materials or combination of materials which shall not corrode excessively under the existing conditions. Made electrodes may be buried plates, ground rods, counterpoise, pole plates or wire attached to the pole before pole setting. Where conditions require more than one electrode, a single grounding conductor may be connected to a group of electrodes which have been bonded together for the purpose of lowering the resistance to ground of the group.

No portion of a made electrode shall be installed with less than seven feet separation from underground pipelines.

125.22: Relations Between Various Classes of Lines

(1) Standardization of Levels. The levels at which different classes of lines are to be located should be standardized where practicable, by agreement of the utilities concerned.

(2) Relative Levels. Where transmission conductors cross supply and/or communication conductors are carried on the same structure as supply and/or communication conductors, the transmission conductors should be carried at the higher level.

125.23: Clearances

(1) General.

(a) Application. 220 CMR 125.23 covers all clearances, including separations involving wires and supporting structures for effectively grounded systems.

125.23: continued

(b) Maintenance of Clearances. The clearances required by 220 CMR 125.23 shall be maintained at not less than the specified values.

(2) Horizontal Clearances of Supporting Structures from Other Objects. Supporting structures and their guys and braces shall have the following horizontal clearances from other objects. The clearance shall be measured between the nearest parts of the objects concerned.

(a) From Fire Hydrants. Not less than four feet.

(b) From Curbs. Not less than six inches measured to the street side of the curb.

(c) From Railroad Tracks. Structures supporting transmission conductors or wires which cross railroad tracks shall have a horizontal clearance, if practicable, of not less than 12 feet from the nearest track rail, except that at sidings a minimum clearance of seven feet may be allowed. At loading sidings, sufficient space shall be left for a driveway. The horizontal clearance to the structure or its attachments shall be maintained from base of rail elevation to an elevation 22 feet above top of rails.

Structures supporting transmission conductors or wires which parallel railroad tracks shall have a horizontal clearance of not less than seven feet from the nearest track rail. The horizontal clearance to the structure, its attachments, or climbing space shall be maintained from base of rail elevation to an elevation 22 feet above top of rails.

Where necessary, to provide safe operating conditions which require an uninterruped view of signals, signs, etc. along tracks, the parties concerned shall cooperate in locating structures to provide the necessary clearances.

(d) From Pipelines. Structures, structure attachments and structure foundations supporting transmission conductors or wires should have a minimum horizontal clearance of seven feet from a pipeline. Where this clearance cannot be attained, a lesser clearance may be established by mutual agreement.

(3) Vertical Clearances of Wires Above Ground, Rails or Water. The vertical clearance of all wires above ground, rails or water shall not be less than the values specified in Table 1 in 220 CMR 125.23 under either of the following conditions:

(a) Final unloaded sag, no wind, with the conductor at maximum continuous operating temperature, but not less than 120°F. In computing conductor temperature, an ambient air temperature of 100°F and a transverse wind of two feet per second should be used.

(b) Final sag, no wind, 32°F conductor temperature with not less than ½ inch radial ice on conductor.

125.23: continued

Table 1

MINIMUM VERTICAL CLEARANCE, IN FEET, ABOVE GROUND, RAILS OR WATER

| Nature of Ground, Rails or Water | Guys | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|---|
| | | 69 | 115 | 230 | 345 |
| Track rails of railroads (except electrified railroads using overhead trolley conductors) handling freight cars on top of which men are permitted. | 25 | 30 | 31 | 33 | 36 |
| Track rails of railroads (except electrified railroads using overhead trolley conductors) not included above. | 18 | 22 | 23 | 25 | 28 |
| Track rails of trolley systems and areas accessible to trackless trolleys. | 27 | 28 | 29 | 31 | 34 |
| Streets, alleys, roads or other areas accessible to vehicles (except trackless trolleys) and bodies of water not used by sailboats. | 18 | 22 | 23 | 25 | 28 |
| Driveways to residence garages. | 10 | 22 | 23 | 25 | 28 |
| Spaces or ways accessible to pedestrians only (minimum clearance in any direction). | 8 | 17 | 18 | 20 | 23 |
| Bodies of water used for sailboating. | 35 | 40 | 40 | 40 | 40 |

Note: No clearance from ground is required for guys not crossing streets, driveways, roads, or pathways, nor for guys provided with traffic guards and paralleling sidewalk curbs.

(4) Underground Risers. Open transmission conductors connecting to underground systems in unguarded areas shall not be run closer to the ground than the clearances given in Table 2 in 220 CMR 125.23.

Table 2

MINIMUM CLEARANCE ABOVE GROUND, IN FEET

| Phase to Phase Voltage (KV) for Effectively Grounded Systems | Clearance Above Ground |
|---|---|
| 69 | 22 |
| 115 | 23 |
| 230 | 25 |
| 345 | 28 |

125.23: continued

(5) Crossing Clearances of Wires Carried on the Same or Different Supports. The clearance between any two conductors or wires crossing each other and carried on the same or different supports shall be not less than the values specified in Table 3 (220 CMR 125.23) under any of the following conditions:

(a) Upper conductor or wire at final unloaded sag, no wind, maximum continuous operating temperature, but not less than 120°F and the lower conductor or wire at existing unloaded sag, no wind, 100°F. In computing conductor temperature, an ambient air temperature of 100° F and a transverse wind of two feet per second should be used.

(b) Upper conductor or wire coated with not less than ½ inch radial ice, no wind, 32°F, final sag and the lower conductor or wire at existing unloaded sag, no wind, 32°F.

(c) Upper conductor or wire at final unloaded sag, no wind, maximum operating temperature in 0°F ambient air with a two feet per second transverse wind and the lower conductor or wire at existing unloaded sag, no wind, 0°F.

Table 3

MINIMUM CLEARANCES, IN FEET, AT CROSSINGS OF WIRES CARRIED ON THE SAME OR DIFFERENT SUPPORTS

| Nature of Wires Crossed Over | Guys | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|---|
| | | 69 | 115 | 230 | 345 |
| Communication, including cables and messengers. | 2 | 6 | 7 | 9 | 12 |
| Supply cables having effectively grounded continuous metal sheath or insulated conductors supported on and cabled together with an effectively grounded messenger, all voltages; messengers associated with such cables. | 2 | 4 | 5 | 7 | 10 |
| Trolley contact conductors.* | 6 | 6 | 7 | 9 | 12 |
| Guys; span wires; lightning protection wires; service drops 0 to 750 V. | 2 | 4 | 5 | 7 | 10 |
| Open supply wires: | | | | | |
| 0 to 750 V phase to phase | 2 | 4 | 5 | 7 | 10 |
| 750 to 50,000 V phase to phase | 4 | 4 | 5 | 7 | 10 |
| Transmission conductors: Phase to phase voltage (KV) for effectively grounded systems | | | | | |
| 69 | 4 | 6 | 7 | 9 | 11 |
| 115 | 5 | 7** | 8 | 10 | 12 |
| 230 | 7 | 9** | 10** | 12 | 14 |
| 345 | 10 | 11** | 12** | 14** | 17 |

* For minimum clearance above ground or rails, see Table 1 in 220 CMR 125.23.

** It is preferred to install the higher transmission voltage at the higher level, where practicable.

125.23: continued

(6) Separation Between Essentially Parallel Conductors or Wires.

(a) Separation Between Transmission Conductors and Conductors or Wires Carried on the Same Structure -- Fixed Conductor Supports.

1. Transmission Conductors or Wires of the Same or Different Circuits. The minimum separation at the structure between transmission conductors which are not free to swing and other transmission conductors or wires shall not be less than the larger value required by 220 CMR 125.23(6)(a)1.a. or 220 CMR 125.23(6)(a)1.b.

a. Minimum Separation: Separations at the structure shall be not less than the values given in Table 4 in 220 CMR 125.23.

Table 4

MINIMUM SEPARATION, IN FEET, BETWEEN TRANSMISSION CONDUCTORS AND OTHER TRANSMISSION CONDUCTORS OR WIRES

| Clearance of Transmission Conductors From | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|
| | 69 | 115 | 230 | 345 |
| Conductors of the same circuit. | 4 | 5 | 9 | 13 |
| Grounded or insulated lightning protection wires. | 2.5 | 3.5 | 6.0 | 8.5 |
| Conductors of different transmission circuits (phase to phase voltage for effectively grounded systems). | | | | |
| 69 | 6 | 7 | 9 | 11 |
| 115 | 7 | 8 | 10 | 12 |
| 230 | 9 | 10 | 12 | 14 |
| 345 | 11 | 12 | 14 | 17 |

b. Separations According to Sag. Separation at the structure between transmission conductors and other transmission conductors or wires shall be not less than given by the following expression:

$$\text{Separation, in feet} = .033\ (KV) + D$$

where:
(KV) is calculated as specified in Table 5 in 220 CMR 125.23.
D is given in Table 6 in 220 CMR 125.23.

Table 5
VALUE OF (KV) TO BE USED IN SEPARATION EXPRESSION

| Conductors or Wires Under Consideration | Value of (KV) |
|---|---|
| Conductors of the same transmission circuit | Phase to phase voltage of transmission circuit, in kilovolts. |
| Transmission conductor and grounded lightning protection wires | Phase to ground voltage of transmission circuit, in kilovolts. |
| Tranmission conductor and insulated lightning protection wire or trans- | Maximum effective continuous voltage between conductors or |

| | |
|---|---|
| mission conductor and conductor of different transmission circuit | wires, in kilovolts. |

125.23: continued

Table 6

VALUE OF D TO BE USED IN SEPARATION EXPRESSION
(VALUES OF SAG AT 60°F, FINAL, UNLOADED, NO WIND)

| Sag, in Feet | D | Sag, in Feet | D | Sag, in Feet | D |
|---|---|---|---|---|---|
| 2 | 0.94 | 18 | 2.83 | 55 | 4.95 |
| 4 | 1.33 | 20 | 2.98 | 60 | 5.17 |
| 6 | 1.63 | 25 | 3.34 | 65 | 5.48 |
| 8 | 1.89 | 30 | 3.66 | 70 | 5.58 |
| 10 | 2.11 | 35 | 3.95 | 75 | 5.78 |
| 12 | 2.31 | 40 | 4.22 | 80 | 5.96 |
| 14 | 2.50 | 45 | 4.48 | 85 | 6.15 |
| 16 | 2.67 | 50 | 4.72 | 90 | 6.33 |
| | | | | 95 | 6.50 |
| | | | | 100 | 6.67 |

Notes (1) Interpolate for intermediate sag values.

(2) Where conductors or wires have different sags, use greater sag to determine value of D.

2. Subconductors of the Same Phase. The requirements of 220 CMR 125.23(6)(a)1. do not apply where the two or more conductors of the same circuit are operated with no potential difference between them, such as bundled phase conductors.

3. Transmission Conductors and Supply or Communication Conductors. The minimum separation at the structure between transmission conductors and supply or communication conductors shall be not less than the values given in Table 7 in 220 CMR 125.23.

Table 7

MINIMUM SEPARATION, IN FEET, BETWEEN TRANSMISSION CONDUCTORS AND SUPPLY OR COMMUNICATION CONDUCTORS

| | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|
| | 69 | 115 | 230 | 345 |
| Communication conductors and open supply wires 0 to 50 KV phase to phase. | 6 | 7 | 9 | 12 |

(b) Separation Between Transmission Conductors and Conductors or Wires Carried on the Same Structure -- Insulators Not Restrained from Movements. Where suspension insulators are used and are not restrained from movement, the conductor separation shall be increased so that one string of line insulators may swing transversely through an angle of 30° from a vertical position without reducing the values required by 220 CMR 125.23(6)(a). The insulator swing of 30° may be changed when such changes are supported by engineering studies that include the use of authenticated weather data and contemporary technology, provided the resultant swing angle does not reduce the clearance given in 220 CMR 125.23(6)(a).

(7) Separation Between Transmission Conductors and Conductors or Wires of Another Structure. The minimum separation between a transmission conductor and any conductor or wire carried on another structure shall not be less than the values specified in Table 8 in 220 CMR 125.23 for any of the following conditions:

125.23: continued

(a) Final unloaded sag, no wind, with the transmission conductor at maximum continuous operating temperature, but not less than 120°F.

(b) Final sag, no wind, 32°F conductor temperature, with not less than ½ inch radial ice on transmission conductor.

(c) Initial unloaded sag, no wind, 0°F transmission conductor temperature.

(d) Final sag, 6 psf. horizontal wind with the transmission conductor at not less than 60°F.

Note: In determining minimum separation for all conditions listed above, it shall be assumed that the conductor or wire on the other structure is in a vertical position and is at the temperature (between 0° and 60°F) which produces the minimum separation between the conductor or wire on the other structure and the transmission conductor in its equilibrium position for the loading condition under consideration.

Table 8

MINIMUM SEPARATION, IN FEET, BETWEEN TRANSMISSION CONDUCTORS AND CONDUCTORS OR WIRES CARRIED ON ANOTHER STRUCTURE

| Nature of Wires Carried on Another Structure | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|
| | 69 | 115 | 230 | 345 |
| Communication, including cables and messengers; trolley contact conductors. | 6 | 7 | 9 | 12 |
| Supply cables having effectively grounded continuous metal sheaths or insulated conductors supported on and cabled together with an effectively grounded messenger, all voltages; messengers associated with such cables; guys; span wires; lightning protection wires; service drops and open supply wires 0 to 50,000 volts phase to phase. | 4 | 5 | 7 | 10 |
| Transmission conductors: Phase to phase voltage (KV) for effectively grounded systems | | | | |
| 69 | 6 | 7 | 9 | 12 |
| 115 | 7 | 8 | 10 | 12 |
| 230 | 9 | 10 | 12 | 14 |
| 345 | 11 | 12 | 14 | 17 |

(8) Clearances of Transmission Conductors from Structures and Guys.

(a) Clearances from Structures to Which They are Attached. The clearance in any direction from transmission conductors to structures and to span wires and guys attached to the same structure shall be not less than the values given in Table 9 in 220 CMR 125.23 with the conductors at final, unloaded sag, at 60°F.

125.23: continued

Table 9

CLEARANCES, IN FEET, OF TRANSMISSION CONDUCTORS FROM STRUCTURES AND EFFECTIVELY GROUNDED PARTS

| Clearances of Conductors From | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|
| | 69 | 115 | 230 | 345 |
| Surfaces of structures; conduits; effectively grounded switch parts and effectively grounded parts of span wires and guys. | 1.5 | 2.5 | 4.5 | 6.5 |

Where suspension insulators are used and are not restrained from movement, the conductor clearances shall be such that the values of clearance required above will be maintained with an insulator swing of 30° from the vertical position.

The insulator swing of 30° may be changed when such changes are supported by engineering studies that include the use of authenticated weather data and contemporary technology, provided the resultant swing angle does not reduce the clearances given above.

(b) Clearances from Supporting Structures of Another Line, from Bridges and from Buildings -- General. Clearances shall be not less than the values given in Table 10 for any of the following conditions:

1. Final unloaded sag, no wind, with the conductor at maximum continuous operating temperature, but not less than 120°F.
2. Final sag, no wind, 32°F conductor temperature with not less than ½ inch radial ice on conductor.
3. Final sag, six pounds per square foot horizontal wind, with the conductor at not less than 60°F.
4. Initial unloaded sag, no wind, 0°F conductor temperature.

Table 10

CLEARANCES, IN FEET, OF TRANSMISSION CONDUCTORS FROM STRUCTURES OF ANOTHER LINE, BUILDINGS AND BRIDGES

| Clearances of Transmission Conductor | Phase to Phase Voltage (KV) for Effectively Grounded Systems | | | |
|---|---|---|---|---|
| | 69 | 115 | 230 | 345 |
| From structure of another line (grounded parts) | 4 | 5 | 7 | 9 |
| * From building surface where conductors are attached and are guarded or made inaccessible | 1.5 | 2.5 | 4.5 | 6.5 |
| From building surface where conductors pass by the building which is accessible | 10 | 11 | 13 | 16 |
| * Passing over buildings and over or near bridges | 17 | 18 | 20 | 23 |

* Above roof level of buildings, pass-by clearances shall be maintained horizontally if the angle of the

diagonal with the horizontal is 50° or less. If this angle is greater than 50°, the diagonal clearance shall be not less than the pass-over clearances given.

125.23: continued

(c) Clearances from Supporting Structures of Another Line, from Bridges and from Buildings -- Special Requirements.

1. Clearances from Buildings. Transmission conductors shall be arranged and maintained so as to hamper and endanger firemen as little as possible in the performance of their duties.

Transmission conductors carried along the surface of a building shall be guarded or made inaccessible. Clearances given in Table 10 in 220 CMR 125.23 shall be maintained from the building or its attachments (balconies, platforms, *etc*.).

2. Clearances from Bridges. Clearances given in Table 10 in 220 CMR 125.23 shall be maintained from the bridge, its attachments or wing walls. Where the conductors pass over traveled ways, the clearances of 220 CMR 125.23(3) shall apply if they are greater than those required by Table 10 in 220 CMR 125.23.

(9) Clearance of Transmission Conductors from Gas Pipeline Blow-Offs. The minimum horizontal clearance between transmission conductors and gas pipeline blow-offs should be 100 feet.

125.24: Loadings

(1) Loading on Conductors. The loading on conductors at 0° F shall be assumed to be:

$$W_e = W_v^2 + W_h^2 + K$$

where:

$W_e$ = Resultant loading in pounds per foot of conductor length.

$W_v$ = Vertical load in pounds per foot of conductor length, covered with ½ inch radial thickness of ice.

$W_h$ = Transverse loading in pounds per foot of conductor length due to a transverse, horizontal wind pressure of four pounds per square foot upon the projected area of the conductor, covered with ½ inch radial thickness of ice.

K = 0.29 for bare conductor of copper, steel, copper alloy, copper-covered steel, aluminum-covered steel, and combinations thereof.

K = 0.31 for bare conductors of aluminum (with or without steel reinforcement).

In applying loadings to bare stranded conductors, the coating of ice shall be considered as a hollow cylinder touching the outer strands.

Ice is assumed to weigh 57 pounds per cubic foot. The weight of ice in pounds per lineal foot can be calculated by the formula:

$$\text{Weight of Ice} = 1.243\ t\ (D+t)$$

where:

D = Diameter of conductor in inches
t = Radial thickness of ice in inches

(2) Loadings on Line Supports.

(a) General. The loads upon line supports shall be the loads delivered by the conductors, including conductor tensions, when loaded as specified in 220 CMR 125.24(1), assuming all conductors intact, plus the weight of the supports plus the wind load on supports. In combining loads, due account shall be taken of different directions of loads.

125.24: continued

(b) Weight of and Wind on Conductors. The vertical load delivered to the support by the conductor shall be calculated using the weight span $S_v$, which is the horizontal distance between the low points of sag in the two spans adjacent to the support concerned, *i.e.*, $W_v \times S_v$.

The wind load delivered to the support by the conductor shall be calculated using the wind span $S_h$, which is the average of the two spans adjacent to the support concerned, *i.e.*, $W_h \times S_h$.

(c) Weight of Ice on Supports. The weight of ice upon supports may be ignored for the sake of simplicity.

(d) Wind Loading on Supports. The minimum wind loading shall be assumed as four pounds per square foot on projected area of cylindrical surfaces, and 6.4 pounds per square foot on flat surfaces.

For latticed bodies of structures, the actual exposed area of one face shall be increased by 50% to allow for the pressure on the opposite face. This total, however, need not exceed the pressure which would occur on a solid structure of the same outside dimensions. The results obtained by more exact calculations may be substituted for the values obtained in 220 CMR 125.24.

(e) Wind Direction. Wind direction shall be assumed which will give the maximum stresses in all parts of the structure, proper reduction being made to account for the reduced wind pressure on the wires resulting from the angularity of the application of the wind to the wires.

(f) Simultaneous Application of Loads. All applicable loads shall be taken as acting simultaneously.

125.25: Strength Requirements

(1) General. Structures shall be capable of supporting, without failure or permanent set in any part, the loads specified in 220 CMR 125.24 multiplied by the following overload factors:

Table 1

| Type of Supporting Structure | Vertical Loads | Wind Loads | Conductor Tension |
|---|---|---|---|
| Metal, Reinforced Concrete, Sawn Timber, Laminated Wood, Guys | 1.27** | 2.54 | 1.65 |
| Wood Pole - When Installed | 4.00* | 4.00* | 2.00* |
| Wood Pole - At Replacement | 2.67 | 2.67 | 1.33 |

* When lines are built for a fixed period of temporary service not exceeding five years, the prescribed overload factors at installation may be decreased, provided that at no time during the life of the line will the overload factors be less than those required at replacement.

** When vertical loading contributes all or a major portion of the stress in a member, the overload factor shall be increased from 1.27 to 2.00.

For metal, reinforced concrete, sawn timber or laminated wood members of structures and for guys, stresses resulting from loads specified in 220 CMR 125.64 multiplied by the appropriate overload factors specified above shall not exceed the yield or ultimate stresses, as applicable, of the particular materials.

For wood poles, including spar crossarms, bending stresses resulting from loads specified in 220 CMR 125.24 multiplied by the appropriate overload factors specified above shall not exceed the ultimate fiber stresses approved as standard by the American National Standards Institute under conditions specified in Section 4 of ANSI 05.1-1963, or latest revision thereof.

125.25: continued

All parts of structures upon which personnel can stand or climb shall be capable of supporting such weight.

(2) Corrosion Resistance. All metal parts of supporting structures, guys, anchor rods, conductors, insulators, and hardware shall be corrosion-resistant materials or shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion. Such protective covering shall be adequately maintained.

(3) Metal Supporting Structures.

(a) Thickness of Metal. The thickness of metal in members of metal supporting structures shall be not less than the following:

Table 2

| | Thickness of Main Members of Cross-Arms and Legs, In. | Thickness of Other Members, Inches |
|---|---|---|
| For localities where experience has shown rapid corrosion | ¼ | 3/16 |
| For other localities | 3/16 | ⅛ |

(b) Slenderness Ratio of Compression Members. The slenderness ratio, L/R, of a compression member shall not exceed the following (these figures do not apply to the completed structure):

Table 3

| Kind of Compression Member | L/R |
|---|---|
| Leg members | 150 |
| Other members having figured stresses | 200 |
| Secondary members without figured stresses | 250 |

(c) General Construction Features. Metal supporting structures, including parts of footings above ground, shall be constructed so that all exposed parts are accessible for inspection, cleaning, and painting, and so that pockets are not formed in which water can collect.

(4) Wood Supporting Structures. Wood poles, sawn timber, and glued laminated timber shall be free from defects which might render them unsuitable for the intended use.

Timber shall be of decay-resistant species or shall be treated with a preservative.

(5) Guys. When guys are used with wood or other poles or towers capable of considerable deflection before failure, the guys can be considered as supporting the structures without deflection at points of guy attachments. When guys are used with rigid metal poles or towers incapable of considerable deflection before failure, the stresses in all parts of such structures, including guys, shall be determined giving due consideration to deformation of both structures and guys.

(6) Foundations. Foundations, including guy anchors, and embedment of poles in earth shall be designed to withstand, without failure or excessive movement, loads at least 10 percent greater than those specified in 220 CMR 125.24 multiplied by appropriate overload factors given in 220 CMR 125.25(1). Due consideration shall be given to varying soil conditions, such as fluctuations in ground water levels.

125.25: continued

All portions of structures, foundations, or guy anchors subject to injurious corrosion or decay shall be suitably protected.

(7) Conductors.

(a) Lightning Protection. Lightning protection wires shall be regarded in respect to loadings and strength requirements as conductors with which they are associated.

(b) Sags and Tensions. Conductor sags shall be such that, under the loading, $W_e$ of 220 CMR 125.24(1), the tension of the conductor shall be not more than 60% of its ultimate strength. Also the tension at 60°F without external load, shall not exceed the following percentages of the conductor ultimate strength:

Initial unloaded tension -- 35%

Final unloaded tension -- 25%

In the case of conductors having a cross-section of a generally triangular shape, such as cables composed of three wires, the final unloaded tension at 60° F. shall not exceed 30% of the ultimate strength of the conductor.

The above limitations are based on the use of recognized methods for avoiding fatigue failures by minimizing chafing and stress concentration. If such practices are not followed, lower tensions should be employed.

(c) Splices. Splices within a span shall be of such a type and so made as to have a strength and conductivity substantially equal to that of the conductor in which they are placed.

(8) Suspension Insulators. Suspension insulators shall have sufficient strength to support, without failure, at least twice the loads specified in 220 CMR 125.24.

(9) Conductor and Insulator Hardware. Hardware for attaching conductors and wires to insulators or to structures and for attaching insulators to structures shall support, without failure, all loads specified in 220 CMR 125.24 multiplied by an overload factor of 1.65.

125.26: Line Insulators

(1) Material and Marking. Insulators used to support transmission conductors shall be of porcelain, made by the wet process, or other material which can be expected to give equally good results in respect to mechanical and electrical performance and durability. Identification of maker, year of manufacture, and strength rating should be marked on each unit. Marking shall be so applied as not to reduce the electrical or mechanical strength of the insulator.

(2) Electrical Strength of Insulators in Strain Position. Where insulators are used in a strain position, they shall have not less electrical strength than the insulators generally used on the line, when under the mechanical stresses imposed by the loadings specified in 220 CMR 125.24.

(3) Ratio of Flashover to Puncture Voltage. The dry flashover voltage of insulators shall be not more than 75% of their puncture voltage at a frequency of 60 Hertz.

(4) Selection of Insulators. In selecting the amount of insulation to be used for any nominal voltage between conductors, consideration should be given to the following factors:

(a) Power frequency overvoltages
(b) Lightning impulses
(c) Switching surges
(d) Weather variables
(e) Contamination
(f) Effect of structure on electrical strength
(g) Maintenance requirements
(h) Operating experience

125.27: Miscellaneous Requirements

(1) Supporting Structures.

(a) Warning Signs and Marking.

1. Structures. If poles and structures are of any material except wood, they shall be plainly and conspicuously marked "Dangerous. Keep Away" in compliance with M.G.L. c. 166, § 34.

All structures supporting wires over streets or buildings or structures on private property shall be plainly marked with the name or initials of the owner of the structure in compliance with M.G.L. c. 166, §§ 31 and 36.

All structures should be marked or numbered so as to facilitate identification by employees authorized to work thereon.

Date of installation of such structures should be recorded by the owner.

2. Bridges. Structures attached to bridges for the purpose of supporting conductors shall be plainly marked with the name or initials of the utility responsible for the attachment and in addition by a warning sign entitled "Dangerous. Keep Away," or its equivalent.

3. Equipment. All transmission line switching equipment should be marked or numbered so as to facilitate identification by employees authorized to work thereon.

(b) Steps. Steps closer than 8 feet from the ground or other readily accessible places shall not be permanently placed on structures.

(c) Structure Guards. Where structures are subject to damage because of their location in public parking lots, warehousing, or other areas, the structures should be adequately protected with guards.

(2) Guying.

(a) Point of Attachment. The guys should be attached to the structure as near as practicable to the center of the conductor load to be sustained but the insulation afforded by wood crossarms and poles shall not be reduced any more than is necessary.

(b) Guy Fastenings. At attachments, stranded guys should be protected by thimbles or other suitable means.

(c) Guy Guards. The ground end of all guys attached to ground anchors exposed to traffic shall be provided with a substantial and conspicuous guard not less than eight feet long.

(d) Anchor Rods. Anchor rods should be installed so as to be in line with the pull of the attached guy when under load. The anchor rods shall have an ultimate strength in the eye and shank equal to or greater than that required of the guy.

(3) Insulators in Guys Attached to Structures.

(a) Material. Guy insulators where used shall be made of fiberglass, wood or other material of suitable mechanical and electrical properties.

(b) Electrical Properties. Guy insulators shall have a dry flash-over voltage at least double the normal phase to phase voltage and a wet flash-over voltage at least as high as the normal phase to phase voltage.

(c) Mechanical Strength. Guy insulators shall have a mechanical strength at least equal to that required of the guys in which they are installed.

(4) Mechanical Protection of Cable Risers. Where within eight feet of the ground, cable risers in unguarded areas shall be protected by a covering which gives suitable mechanical protection. This covering may be omitted from wires used to connect the structure or lightning protection wires to ground.

125.30: Underground Transmission Lines Location

(1) General Location. Underground systems of electric conductors should be located so as to be subject to the least practicable disturbance. Railway tracks and underground structures, including catch basins, gas pipes, etc., should be avoided where practicable.

(2) Ducts. The ducts between adjacent manholes or other outlets should be laid as straight and direct as practicable. A minimum of 24 inches cover should be maintained where practicable.

125.30: continued

(3) Manholes. Manhole openings, where practicable, shall be located so as to provide safe and convenient access. At crossings under railroads, the manholes, pull boxes, and terminals should, where practicable, be located away from the roadbed.

125.31: Construction of Duct and Cable Systems

(1) Material, Size, and Finish of Ducts. Ducts shall be of such material, size, mechanical strength, and finish as to facilitate the installation and maintenance of conductors or cables. Ducts shall be freed from burrs before laying and shall have clear bores.

(2) Grading of Ducts. Where it is necessary to drain ducts, the grade of the ducts shall be such as to permit proper and adequate drainage.

(3) Settling. Ducts should be suitably reinforced or be laid on suitable foundations of sufficient mechanical strength where necessary to protect them from settling.

(4) Clearances.

(a) General. The clearance between duct or cable systems and other underground structures paralleling them, shall be as great as practicable. The distances between the top covering of the system and the pavement surface, or other surface under which the system is constructed, shall be sufficient to protect the system from injury by traffic.

(b) Below Base of Rail. The top of all duct and cable system structures, except as hereinafter specified, shall generally be located at a depth of not less than 30 inches in the case of street railways, and not less than 42 inches in the case of diesel and electric railroads, below the base of rail. Where unusual conditions exist or where proposed construction would interfere with existing construction, a greater depth than specified above may be required.

Exception: Where this is impracticable, or for other reasons, this clearance may be reduced by agreement between the parties concerned. In no case, however, shall the top of the conduit protection extend higher than the bottom of the ballast section which is subject to working or cleaning.

(c) Metallic Conduit. Where metallic pipe is used as a conduit for underground cables or conductors, it shall not be laid in contact with water, gas or steam metallic pipe systems. Where the clearance is less than 12 inches for gas mains or gas pipelines and less than two inches for other metallic structures, the metal conduit shall be adequately separated from other metallic pipe systems by a barrier of suitable materials, or they shall be electrically bonded together at the point of least separation. Where metallic electrical conduit is known to be located within four feet of other buried metallic structures, the owner of said structures should be notified relative to mutual protection.

(5) Duct Entrances into Manholes. Iron pipe conduit terminating in manholes, handholes or other permanent openings of underground systems, shall be provided with an effective shield, bushing, fairleader, or other smooth outlet.

(6) Duct Arrangement for Dissipation of Heat. Duct systems intended to carry transmission cables of large current capacity should be arranged, where practicable, so that ducts carrying such cables will not dissipate their heat solely through other ducts.

125.32: Construction of Manholes

(1) Minimum Strength. The design and construction of manholes and handholes shall provide sufficient strength to sustain, with a suitable margin of safety, the loads which may reasonably be imposed on them.

(2) Dimensions. Manholes should meet the following requirements where practicable:

(a) Width. The least horizontal inside dimension should be not less than three feet six inches.

125.32: continued

(b) Working Space. A clear working space should be provided. The horizontal dimension should be not less than three feet. The vertical dimension should be not less than six feet except in manholes where the opening is within one foot on each side of the full size of the manhole.

(3) Drainage. Where drainage is into sewers, suitable traps shall be provided to prevent entrance of sewer gas into manholes.

(4) Manhole Openings. Round openings to any manhole should be not less than 24 inches in diameter. Rectangular openings should have dimensions not less than 24 by 20 inches.

(5) Manhole Covers. Manholes and handholes, while not being worked in, shall be securely closed by covers of sufficient strength to sustain such loads as may reasonably be imposed upon them.

(6) Supports for Cables. Cables should be adequately supported at each manhole.

(7) Manhole Location. Manhole openings shall, where practicable, be located so that barriers or other suitable guards can be placed to protect the opening effectively when uncovered.

125.33: Location of Cables

(1) Accessibility. Cables in manholes shall be reasonably accessible to workmen and clear working space shall be maintained at all times.

(2) Separation Between Conductors.

(a) Cables of Different Voltages. Cables shall be arranged and supported in ducts and manholes so that those operating at higher voltages will be separated as far as practicable from those operating at lower voltages.

(b) Cables of Different Systems. Cables belonging to different systems, particularly supply-distribution and communication systems, shall not be installed in the same duct.

125.34: Protection of Conductors in Duct Systems and Manholes

(1) Protection Against Arcing. A suitable fire-resistant covering should be placed on closely grouped lead-sheathed transmission cables to prevent injury from arcing.

(2) Bonding. Exposed metallic sheaths shall be bonded at suitable intervals with a conductor of suitable size, electrolysis conditions permitting.

125.35: Guarding of Live Parts in Manholes

(1) Conductor Joints or Terminals. Joints of conductors or cables systems shall be arranged so that there are no bare ungrounded current-carrying metal parts exposed to accidental contact within manholes or handholes.

(2) Apparatus. Live parts of protective, control or other apparatus installed and maintained in manholes should be enclosed in suitable grounded cases or in cases having no exposed metallic parts.

125.36: Construction of Risers from Underground

(1) Separation Between Risers of Communication and Supply Systems. The placing of risers for communication systems and risers for transmission systems on the same pole should be avoided where practicable. Where located on streets or highways, risers should, where practicable, be placed on poles so as to be in the safest available location from the point of view of traffic damage.

125.36: continued

(2) Mechanical Protection of Conductors. In unguarded areas all transmission cables from underground systems which connect to overhead systems shall be protected by a covering which gives suitable mechanical protection up to a point 8 feet above the ground.

Exception: Armored cables or cables installed in a grounded metal conduit.

(3) Grounding of Riser Pipes. Electrolysis conditions permitting, exposed metal riser pipes on poles containing transmission conductors shall be grounded unless such conductors are covered with a grounded metal sheath or are themselves grounded.

(4) Conductor Terminal Construction. The terminals of underground transmission cables connecting to overhead open wire systems shall meet the following requirements:

(a) Protection Against Moisture. Protection shall be provided so that moisture will not enter the cable.

(b) Insulation of Conductors. Conductors shall be properly insulated from the grounded metal sheath. In addition, the conductors of multiple-conductor cable shall be properly separated and insulated from each other.

Note: These requirements may be fulfilled by the use of potheads or other equivalent devices, such as oil switches, if they accomplish the same purpose.

125.37: Identification of Cables

Cables shall be permanently identified by tags or otherwise at each manhole or other permanent opening of the underground system. Where the duct formation on opposite sides of the manhole is the same, the cables, where practicable, should be installed in corresponding ducts.

125.40: Definitions

The following definitions are for use with the Massachusetts Code for the Installation and Maintenance of Electric Transmission Lines. For other use and for definitions not contained herein, see Definitions of Electrical Terms, ANSI C42.35.

Circuit. A conducting part or a system of conducting parts through which an electric current is intended to flow.

Conductor. A wire or combination of wires not insulated from one another, suitable for carrying electric current.

Grounding Conductor. A conductor which is used to connect the equipment or structure with a grounding system.

Department. The Massachusetts Department of Public Utilities.

Ground. A conducting connection, whether intentional or accidental, by which an electric circuit is connected to the earth, or to some conducting body, of relatively large extent, which serves in place of earth. It is used for establishing and maintaining the potential of the earth (or of the conducting body) or approximately that potential, on conductors connected to it, and for conducting ground current to and from the earth (or the conducting body).

(a) Grounded. Grounded means that the system, circuit, or apparatus referred to is provided with a ground.

(b) Effectively Grounded. Grounded through a grounding connection of sufficiently low impedance (inherent or intentionally added or both) that fault grounds which may occur cannot build up voltages in excess of limits established for apparatus, circuits, or systems so grounded.

125.40: continued

(c) Effectively Grounded System. A system in which, for all points on the system or specified portion thereof in the ratio of zero-sequence reactance to positive-sequence reactance is positive and not greater than three and the ratio of zero-sequence resistance to positive-sequence reactance is positive and not greater than one for any condition of operation and for any amount of connected generator capacity.

Guarded. Covered, shielded, fenced, enclosed or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger. Wires which are insulated but not otherwise protected are not considered as guarded.

Guy. A tension member having one end secured to a fixed object and the other end attached to a pole, crossarm or other structural part which it supports.

Anchor Guy. A tension member having one end secured in the ground and the other end attached to a pole, crossarm or other structural part which it supports.

Insulated. Separated from other conducting surfaces by a dielectric permanently offering a high resistance to the passage of current and to disruptive discharge. When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of 220 CMR 125.00, uninsulated.

Isolated. Means that an object is not readily accessible to persons unless special means for access are used.

Lines.

(a) Communication Lines. The conductors and their supporting or containing structures which are located outside of buildings and are used for public or private signal or communication service, and which operate at not exceeding 400 V to ground or 750 V between any two points of the circuit, and the transmitted power of which does not exceed 150 W. When operating at less than 150 V no limit is placed on the capacity of the system. Telephone, telegraph, railroad-signal, messenger-call, fire, police-alarm, community television antenna and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

(b) Electric-Supply Lines. Those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting electric energy at a phase to phase voltage less than 50,000 V. Does not include open wiring on buildings, in yards or similar locations where spans are less than 20 feet, and all the precautions required for stations or utilization equipment, as the case may be, are observed.

Railway signal lines of more than 400 V to ground are always supply lines within the meaning of 220 CMR 125.00, and those of less than 400 V may be considered as supply lines, if so run and operated throughout.

(c) Transmission Lines. Those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting electric energy at a phase to phase voltage exceeding 50,000 V.

(10) Reconstruction. Replacement of any portion of an existing installation by new equipment or construction. Reconstruction does not include ordinary maintenance replacements.

(11) Sag.

(a) Final Unloaded Sag. The sag of a conductor after it has been installed for a long period of time or after it has been subjected to external load for an appreciable period of time and the loading removed.

125.40: continued

(b) Initial Unloaded Sag. The sag of a conductor immediately after installation.
(c) Unloaded Sag of a Conductor at Any Point in a Span. The distance measured vertically from the particular point in the conductor to a straight line between its two points of support, without any external load.

(12) Span Wire. A wire or cable used as an auxiliary support for wires, cables or equipment. While not normally used to carry current, it may do so under certain abnormal conditions.

(13) Tension.
(a) Final Unloaded Conductor Tension. The longitudinal tension in a conductor after it has been installed for a long period of time after it has been subjected to external load for an appreciable period of time and the loading removed.
(b) Initial Conductor Tension. The longitudinal tension in a conductor immediately after installation.

(14) Voltage.
(a) Voltage of an Effectively Grounded Circuit. The highest effective voltage between any conductor and ground unless otherwise indicated.
(b) Voltage of a Circuit Not Effectively Grounded. The highest effective voltage between any two conductors unless otherwise indicated.

If one circuit is directly connected to another circuit of higher voltage (as in the case of an auto-transformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

(c) Voltage to Ground of an Effectively Grounded Circuit. The highest effective voltage between any conductor of the circuit and that point of the circuit which is grounded.
(d) Voltage to Ground of a Conductor of an Effectively Grounded Circuit. The highest effective voltage between such conductor and that point or conductor of the circuit which is grounded.

REGULATORY AUTHORITY

220 CMR 125.00: M.G.L. c. 164, § 76C.