

# ISO Rules

## Part 500 Facilities

### Division 502 Technical Requirements

#### Section 502.2 Bulk Transmission Line Technical Requirements



#### Applicability

- 1 This [Section 502.2](#) applies to:
  - (a) the **legal owner** of any **bulk transmission line** with a voltage equal to or greater than one hundred (100) kV; and
  - (b) the **ISO**.

#### Requirements

##### New and Existing Bulk Transmission Lines

- 2(1) On and after ~~the effective date of this section 502.2~~ [January 1, 2012](#), the **legal owner** of any new **bulk transmission line** which is to be directly connected to the **interconnected electric system** must comply with the provisions of this [Section 502.2](#), prior to the new **bulk transmission line** being energized.
- 2(2) Subject to subsection 2(3), the provisions of this [Section 502.2](#) do not apply to any new **bulk transmission line** with a functional specification the **ISO** approves of prior to ~~the effective date of this section 502.2~~ [January 1, 2012](#), but that **bulk transmission line** must remain in compliance with that functional specification including all of the standards and requirements referenced in that functional specification.
- 2(3) If there is a project to design, construct and operate any extension, tap or addition to any **bulk transmission line** existing and commissioned as of ~~the effective date of this section 502.2~~ [January 1, 2012](#) and where the project circuit length will be equal to or greater than fifteen hundred (1,500) meters, then the project must be in compliance with this [Section 502.2](#).
- 2(4) If there is a project to design, construct and operate any extension, tap or addition for an existing and commissioned **bulk transmission line** where the circuit length is less than fifteen hundred (1,500) meters, then the project must be in compliance with the technical specification and design requirements for that **bulk transmission line** which were in effect as of the original date of the commencement of the design of that **bulk transmission line**, and in addition must be in compliance with the specifications set out in the most recently published edition of the *Alberta Electrical Utility Code*.
- 2(5) Notwithstanding any other provision of this subsection 2, the **ISO**, through an amendment to the original functional specification, ~~or~~ the issuance of a new functional specification [or a letter](#), may require the **legal owner** of an existing and commissioned **bulk transmission line** to comply with any specific one or all of the provisions of this [Section 502.2](#), if the **ISO** determines that such compliance is critical for the safe and reliable operation of the **interconnected electric system**.

#### Functional Specification

- 3(4) The **ISO** must, in accordance and generally consistent with this [Section 502.2](#) and any other applicable **ISO rules**, approve ~~of a~~ [written](#) functional specification containing ~~further~~ details, ~~and discrete~~ work requirements, and specifications for the design, construction, and operation of any **bulk transmission line** connection project and any associated **transmission system** connection facilities.

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~~(2) — The functional specification for the connection project referred to in subsection 3(1) must be generally consistent with the provisions of this section 502.2, but may contain material variances the ISO approves of based upon its discrete analysis of any one or more of the technical, economic, safety, operational and reliability requirements of the interconnected electric system related to the specific connection project.~~

#### Successor to Prior Requirements

4 Subject to subsection 2, this ~~Section~~ 502.2 succeeds and replaces the *Technical Requirements for Connecting to the Alberta Interconnected Electric System (IES) Transmission System Part 3 Technical Requirements for Connecting Transmission Facilities* which came in effect as of December 29, 1999, and that standard together with any other prior standards or drafts of standards on the subject matter no longer will be in force and effect as of ~~the effective date of this section 502.2~~ January 1, 2012.

#### Other Code Requirements

5(1) The design, construction and operational specifications for any new **bulk transmission line** must meet or exceed the most recently published edition and applicable provisions and requirements as set out in all federal and Alberta provincial enactments, standards, guidelines, codes, mandatory requirements and regulations governing such a **bulk transmission line**, including:

- (a) the *Alberta Electrical Utility Code*;
- (b) the *Alberta Health and Safety Code*;
- (c) the version of Canadian Standards Association (CSA) *Overhead Systems Standard (C22.3 No. 1)* referenced in the *Alberta Electrical Utility Code*;
- (d) the International Electrotechnical Commission (IEC) *Standard 61472 Live working – Minimum approach distances for a.c. systems in the voltage range 72.5 kV to 800 kV – A method of calculation*; and
- (e) all federal government requirements for obstruction marking, including those applicable to a **bulk transmission line** crossing large bodies of water and structures in the vicinity of airports, as set out in the document *Standard 621.19 – Standards Obstruction Markings*.

(2) The **legal owner** in addition must ensure that the **bulk transmission line** is designed, constructed and operated in a manner that is compliant with all provisions of any order, ruling, permit or license that the **Commission** issues, or that any other body having jurisdiction issues under any enactment.

#### Weather Loading Return Periods

6(1) Subject to subsection 6(4), the minimum return period values for weather loadings used for any **bulk transmission line** must be as follows:

- (a) for a 138kV or a 144 kV **bulk transmission line**, a fifty (50) year return period;
- (b) for a single circuit 240 kV **bulk transmission line**, a seventy five (75) year return period;
- (c) for a double circuit 240 kV **bulk transmission line**, a one hundred (100) year return period; and

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- (d) for a 500 kV alternating current or a +/- 500 kV high voltage direct current **bulk transmission line**, a one hundred (100) year return period.
- (2) For wind loading, the return periods as set out in subsection 6(1) must be based on wind gust data from the *Gust Wind Loading* map made available on the AESO website.
- (3) For wet snow and wind loadings, the return periods set out in subsection 6(1) must be based on combined wet snow and wind gust data from the *Wet Snow and Wind Loading* map made available on the AESO website.
- (4) The **ISO** must approve of, in a project functional specification for a connection project under this [Section 502.2](#), any return period which is less than the specified minimum return period set out in subsection 6(1).

#### Weather Loading for Wind

- 7(1) A **bulk transmission line** must withstand wind loadings, based on extreme value analysis of historical wind velocity or wind gust data.
- (2) Wind velocity data from the *Gust Wind Loading* map made available on the AESO website must be used as the basis for the design of any **bulk transmission line**, and the minimum return period values must be as set out in subsection 6(1) above.
- (3) Subject to subsection 7(4), wind velocity data related to a **bulk transmission line** design must be converted to pressure and adjusted for the height of wires and structures in accordance with the manual titled, *American Society of Civil Engineering Manual 74 –Guidelines for Electrical Transmission Line Structural Loading Third Edition*.
- (4) The applicable minimum wind gust response factor values, in substitution for the values calculated by the method set out in the manual referred to in subsection 7(3), must be as set out in the following Table 1:

**Table 1**  
**Wind Gust Response Factor Values**

Span Range (meters )	Gust Response Factor $G_w$
Less than 200	1.0
200 to 300	0.9
Greater than 300	0.85

#### Weather Loading for Wet Snow and Wind

- 8(1) A **bulk transmission line** must withstand combined wet snow and wind loadings, based on extreme value analysis of historical weather data.

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(2) The loading design requirements as set out in subsection 8(1) must be probability based and the minimum return period values must be as set out in subsection 6(1), except that there is no requirement to design a 138 kV or a 144 kV **bulk transmission line** for the probability based wet snow and wind loading.

(3) Combined loading data from the *Wet Snow and Wind Loading Map* made available on the AESO website must be used as the basis for the loading design.

#### Weather Loading for Vertical Loading Alone

9(1) Subject to subsection 9(2), a **bulk transmission line** must withstand vertical loading that represents in-cloud or rime ice, and the minimum return period values for such vertical loading must be as set out in subsection 6(1).

(2) For a 138 kV or a 144 kV **bulk transmission line**, a fifty (50) year return vertical loading must be used in the design, except that this loading will only be applied to the design of structure arms and not the overall structure, and must not be used to determine conductor tension for design of any type of structures.

(3) The radial accretion values from the combined wet snow and wind loading, with a density of 350 kg/m<sup>3</sup> and a temperature of minus twenty (-20) degrees Celsius assuming no wind, must be used to represent the rime ice vertical loading condition.

#### Failure Containment Loading

10(1) Subject to subsection 10(8), a **bulk transmission line** must withstand failure containment loading so as to limit the extent of a **bulk transmission line** failure, minimize greater or additional structural damages or losses beyond the location of the initial failure, and avoid longitudinal cascades.

(2) The failure containment loading design must satisfy the requirements of either one of the following subsections (a) or (b):

- (a) subject to subsection 10(3), all suspension type structures must have longitudinal strength;
- (b) anti-cascade structures must be constructed at the intervals as set out in subsection 10(5).

(3) The suspension type structures design requirement of subsection 10(2) (a) in addition must provide for both of the two (2) loading conditions as set out in the following subsections (a) and (b):

- (a) broken wire loading, with loading values calculated assuming bare wires, no wind, final tension and zero (0) degrees Celsius:
  - (i) for a single circuit **bulk transmission line**, the loading from a complete broken phase or broken overhead shield wire must be applied to any single conductor phase support or at any one (1) ground wire support;
  - (ii) for a double circuit **bulk transmission line**, the loading from a complete broken phase or broken overhead shield wire must be applied to any two (2) conductor phase supports, two (2) ground wire supports, or one (1) conductor phase and one (1) ground wire support; and
  - (iii) allowance must be made for insulator swing and structure deflection; and

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- (b) unbalanced wet snow on one (1) or more phases, or overhead shield wires in the span on one side of the structure and no wet snow on the wires in the span on the other side of the structure where:
  - (i) the wet snow loading must be equal to the return period values as set out in subsection 6(1);
  - (ii) loading values calculated assuming wet snow density of 350 kg/m, no wind, final tensions and zero (0) degrees Celsius; and
  - (ii) allowance must be made for insulator swing and structure deflection.
- (4) If longitudinal strength is not provided for each suspension type structure of a **bulk transmission line**, then anti-cascade structures must be used to limit the extent of longitudinal cascade failures.
- (5) The interval between anti-cascade structures must not exceed:
  - (a) ten (10) km for a 138 kV or a 144 kV **bulk transmission line**; or
  - (b) five (5) km for a 240 kV, a 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line**.
- (6) Anti-cascade structures for a **bulk transmission line** must be designed to be capable of withstanding all loading due to all wires on one side of the structure being broken, with final unloaded tensions at zero (0) degrees Celsius.
- (7) Heavy angle and deadend structures may be utilized as anti-cascade structures, but only if they are of the requisite strength as set out in subsection 10(6).
- (8) For a wood pole **bulk transmission line** including one constructed with wood laminate poles, if a longitudinal loading analysis for that **bulk transmission line** is carried out using a computer program that accurately models the characteristics of the structures on that **bulk transmission line**, using the broken wire and unbalanced ice loadings as set out in subsection 10(3), and the results indicate that either:
  - (a) no structure failures will occur, or
  - (b) the number of structure failures does not exceed ten (10);

then the anti-cascade structure requirements of subsections 10(4) through 10(7) are not required for that **bulk transmission line**.

#### Overload and Strength Factors for Reliability Based Loadings

- 11(1) The overload factor for **reliability** based loading for a **bulk transmission line** must be one point zero (1.0) for all structural materials, including steel, wood and any composite material.
- (2) Subject to subsection 11(3), the **reliability** based strength factors for **bulk transmission line** components must be as set out in the following Table 2:

**Table 2**  
**Reliability Based Strength Factors**

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Component	Strength Factor
Metal structures	1.0
Wood structures	0.75
Support hardware	1.0
Guy wire	0.9

(3) In addition to being in compliance with the requirements of Table 2, a **bulk transmission line** must meet the following minimum strength factors for metal structures and hardware for the purpose of establishing a desired sequence of failure:

- (a) the strength factor for angle and deadend metal structures must be zero point nine (0.9); and
- (b) the strength factor for deadend hardware must be zero point nine (0.9).

#### Conductor Selection

12(1) The selection of conductor size and type for a **bulk transmission line** must be in accordance with the following requirements:

- (a) the conductor must be standard aluminum conductor steel reinforced (ACSR) or aluminum conductor steel reinforced / trapezoidal wire (ACSR/TW);
- (b) for any extension of an existing radial **bulk transmission line**, the conductor used for the new line segments must have no less than the same thermal capacity as the conductors of that existing **bulk transmission line**;
- (c) for a new **bulk transmission line** having a total length equal to or greater than ten (10) km, the conductor selection must include consideration of both capital costs and net present value of electricity losses, and be based on the results of either:
  - (i) a **bulk transmission line** optimization study provided to the **ISO** which includes the cost of structures; or
  - (ii) a conductor optimization study which includes only the cost of the conductor and assumes that the cost of structures does not change significantly with changes in conductor size; and
- (d) for a new **bulk transmission line** of 240 kV or above and a total length equal to or greater than fifty (50) km, a **bulk transmission line** optimization study must be conducted and provided to the **ISO**, and be used as the basis for conductor selection.

(2) The **ISO** must approve of, in the project functional specification for a connection project under this Section 502.2, any conductor type other than the standard conductor types as set out in subsection 12(1)(a).

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(3) Conductor mechanical strength must be such that the tension as set out in the *Alberta Electrical Utility Code* loading requirements does not exceed sixty percent (60%) of the rated tensile strength of the conductor.

(4) Tension under the maximum loading conditions, including those involving high wind, combined wet snow and wind, or in-cloud icing, must not exceed ninety percent (90%) of the rated tensile strength of the conductor.

#### Sequence of Failure

**13(1)** A 240 kV, a 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line** which is to be constructed of steel structures, excluding direct embedded tubular structures, must have a target sequence of failure in order to minimize or contain the damage due to failure of a single component or structure.

(2) All **bulk transmission line** components must be designed to fail in the following sequential order:

- (a) tangent towers, followed by their foundations and hardware; then
- (b) angle towers, followed by their foundations and hardware; then
- (c) dead-end towers, followed by their foundations and hardware; and finally
- (d) conductors, followed by insulators and conductor attachment hardware.

(3) The design of the **bulk transmission line** components must ensure that the strength of all components are coordinated, or adjusted by means of strength factors, so as to achieve the design failure sequence as set out in subsection 13(2).

(4) For greater certainty, a sequence of failure analysis is not required for a **bulk transmission line** with wood structures, given the relatively high strength variation of wood structures.

(5) The **ISO** must approve of, in the functional specification for a connection project under this [Section 502.2](#), any sequence of failure other than the standard one as set out in subsection 13(2).

#### Overhead Shieldwires

**14(1)** For the purposes of this [Section 502.2](#), a reference to shieldwires includes galvanized steel strand, aluminum clad steel strand and optical ground wires.

(2) Shieldwires must be installed on a 138 kV, a 144 kV, a 240 kV, a 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line**.

(3) The number and positioning of the shieldwires must be so as to produce lightning flashover rates that are consistent with all **reliability** requirements of the **bulk transmission line**.

(4) The size of any shieldwire must be adequate to withstand the fault current expected at any given location on the **bulk transmission line**, taking into account the applicable magnitude and duration parameters of the fault.

(5) Shieldwires must be sized appropriately to satisfy ground fault currents the **ISO** specifies in the functional specification for the **bulk transmission line**, and without loss of strength or degradation of the protective coating that may reduce life expectancy.

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(6) The size of any shieldwire must be adequate to withstand the weather loading expected at any given location on the **bulk transmission line**.

(7) For a **bulk transmission line** having average span lengths in excess of one hundred and fifty (150) meters, the minimum size of the shieldwire must be 3/8" Gr. 220 galvanized steel strand.

#### Aeolian Vibration Control

**15(1)** Vibration dampers must be installed on all conductors and overhead shieldwires for a **bulk transmission line** where the average span exceeds one hundred (100) meters, with the exception of slack spans.

(2) The design and location of the dampers must take into account the characteristics of the **bulk transmission line** wire, including spans, tension values and terrain.

(3) The application of conductor dampers that reduce the thermal capacity of the wire is prohibited.

(4) Spacer dampers must be installed on a **bulk transmission line** with bundled conductors and a rated design voltage equal to or greater than 500 kV.

(5) The application of spacer dampers having two (2) part metal clamps that result in metal to metal contact between the conductor and the clamp is prohibited.

(6) For standard ACSR conductor and steel strand overhead shieldwires:

- (a) the initial tension must not exceed twenty five percent (25%) rated tensile strength under a winter design temperature of minus thirty (-30) degrees Celsius; and
- (b) final tension must not exceed twenty percent (20%) rated tensile strength under an average annual temperature of four (4) degrees Celsius.

#### Voltage Values for Electrical Clearances

**16** The values of voltage used to determine electrical clearances for a **bulk transmission line** must be based on nominal voltage, taking into account the operating practices for that portion of the **interconnected electric system** where that **bulk transmission line** is to be constructed.

#### Basic Design Clearances

**17(1)** A **bulk transmission line** must satisfy basic electrical clearances, including ground clearances for various locations, as specified in the *Alberta Electrical Utility Code* and its referenced version of *CSA C22.3 No. 1*.

(2) Ground clearance requirements for a **bulk transmission line** must be maintained under conditions of maximum sag in accordance with the following:

- (a) for a 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line**, the maximum sag conditions must be the most stringent of either of:
  - (i) sag under *Alberta Electrical Utility Code* loading conditions of combined ice and wind; or
  - (ii) the conductor temperature corresponding to the maximum load transfer specified in the functional specification for the connection project under this [Section 502.2](#);



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- (b) for a **bulk transmission line** less than 500 kV, the maximum sag conditions must be the most stringent of either of:
  - (i) the conductor at one hundred (100) degrees Celsius; or
  - (ii) sag under *Alberta Electrical Utility Code* loading conditions of combined ice and wind.
- (3) A 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line** must have a minimum of twelve point two (12.2) meters of ground clearance above any agricultural land.
- (4) Suspension type structures must be designed to provide clearances from the conductors, in a swung position, to the nearest point of the structure, in accordance with the following requirements:
  - (a) with conductors subjected to a wind pressure of 230 Pa, at four (4) degrees Celsius and final tension, clearances from the energized conductors to the structure as per the flashover-to-ground distance requirements of *CSA C22.3 No. 1-10 Table A.1*;
  - (b) with a five (5) year return wind gust, with conductors at four (4) degrees Celsius and final tension, with no ice and minimum clearance equal to the sixty (60) Hz flashover distances; and
  - (c) with moderate wind gust, with conductors at minus thirty degrees (-30) degrees Celsius, final tension and no ice, with wind pressure values as set out in the following Table 3 and corresponding electrical clearances as set out in subsection 17(5);

**Table 3**  
**Wind Pressure Values**

Loading Area (As Defined on ISO's Snow and Ice Loading Zones Map)	Wood Pole Lines Wind Pressure (Pa)	1-Cct Lattice & Monopole Structure Lines Wind Pressure (Pa)	2-Cct Lattice & Monopole Structure Lines Wind Pressure (Pa)
A	450	550	600
B	350	400	500
C	300	350	400
D	250	300	350

- (5) Electrical clearances for use with the wind pressure values of Table 3 must be determined from the application of the methodology outlined in *IEEE Standard 1313.2 The Application of Insulation Coordination*, for transmission line phase to ground switching over voltages.
- (6) The clearance values as set out in subsection 17(5) must be determined assuming wet conditions, and switching surge values must be determined in accordance with *CSA C22.3 No. 1-10 Table A.1*.

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- (7) For angle structures where the insulators are free to swing, the clearance requirements set out in subsection 17(4) must be maintained with both forward and reverse wind and for both initial and final tensions.
- (8) The clearance requirements as set out in subsection 17(4) may be reduced if line surge arrestors are installed and the following conditions are satisfied:
- (a) a qualified professional engineer must complete an insulation study which must include a **bulk transmission line** design with the clearances specified in subsection 17(4) and with the proposed surge arrestors and reduced clearances; and
  - (b) the insulation study must demonstrate that the **bulk transmission line** with the surge arrestors is as reliable as if the clearances as set out in subsection 17(4) were not reduced.
- (9) The electrical clearance values as set out in subsection 17(4) (c) may be replaced by values from an insulation design study, if the study:
- (a) is completed by a qualified professional engineer; and
  - (b) demonstrates that the **bulk transmission line** is as reliable as it would be if the clearances as set out in subsection 17(4) (c) were not replaced.
- (10) Suspension type structures of a 500 kV alternating current, or a +/- 500 kV high voltage direct current **bulk transmission line** must provide clearances from the conductors, in a swung position, to the nearest point of the structure, in accordance with the results of a comprehensive insulation design study conducted by a qualified professional engineer.

#### Clearances Under Differential Loading

- 18 For the design of a **bulk transmission line**, clearances in any direction for the switching surge air gap values specified in subsection 17(5) must be maintained under the following loading conditions:
- (a) overhead shield wire or upper phase loaded with twelve point five (12.5) mm radial glaze ice at a density of 900 kg/m<sup>3</sup> and no wind at minus twenty (-20) degrees Celsius, and the phase below unloaded at minus twenty (-20) degrees Celsius, with all wires under final sag conditions; and
  - (b) for a **bulk transmission line** of 240 kV and above, overhead shield wire or upper phase loaded with forty (40) mm radial rime ice at a density of 350 kg/m<sup>3</sup> and no wind at zero (0) degrees Celsius, and the phase below unloaded at zero (0) degrees Celsius, with all wires under final sag conditions.

#### Clearances to Edge of Right of Way

- 19(1) With respect to the requirement for conductor swing clearance at or near the edge of a right of way for any **bulk transmission line**, the horizontal clearance requirements of CSA C22.3 No. 1 are deemed to be satisfied if the actual swing clearance is equal to the clearance requirements for the location of a building as set forth in CSA C22.3 No. 1.
- (2) A 138 kV or a 144 kV **bulk transmission line** located on a road allowance is exempt from the requirements of subsection 19(1).

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#### Fall Free Spacing

**20(1)** Subject to subsection 20(2), if one (1) or more 500 kV **bulk transmission lines** are located in a corridor, then those **bulk transmission lines** must meet the following minimum requirements for fall free spacing:

- (a) if there are two (2) or more 500 kV **bulk transmission lines** in the corridor and the structures of any one of those 500 kV **bulk transmission lines** fail and fall toward an adjacent 500 kV **bulk transmission line**, then neither the structures nor the wires of the failed **bulk transmission line** must come into contact with the structures or wires of that adjacent 500 kV **bulk transmission line**;
- (b) if there is one (1) or more lower voltage **bulk transmission line** in a corridor with one (1) or more 500 kV **bulk transmission line** and the structures of a lower voltage **bulk transmission line** fail and fall toward an adjacent 500 kV **bulk transmission line**, then neither the structures nor the wires of the failed lower voltage **bulk transmission line** must come into contact with the structures or the wires of that adjacent 500 kV **bulk transmission line**.

**(2)** For a **bulk transmission line**, all structures must be assumed to fail at the groundline, unless either one of the following assumption requirements are complied with:

- (a) a detailed analysis of the structure, conducted by a qualified professional engineer or resulting from a full scale structure test at a qualified testing site, must confirm that there is a different failure location under loading for both high wind and combined wet snow and wind; or
- (b) if there are results from both a full scale structure test and a detailed analysis of the structure, then the failure location results of the test will govern and take precedence over results of the analysis.

**(3)** If a **bulk transmission line** enters and exits a substation or converter station, then the free fall spacing requirements set out in subsection 20 (1) do not apply to the first five (5) spans of the **bulk transmission line**.

#### Insulators

**21(1)** For a **bulk transmission line**, insulator shed material for ceramic insulators must be made of porcelain or glass.

**(2)** Shed material for synthetic insulators used in contaminated areas must be made of silicone rubber.

**(3)** Porcelain or glass insulators must satisfy all requirements of *CSA-C411.1*, except that dovetail head designs are prohibited.

**(4)** Synthetic insulators must satisfy all requirements of *CSA-C411.4 Composite Suspension Insulators for Transmission Applications*.

**(5)** The length of insulator strings must be adequate to allow live **bulk transmission line** maintenance activities.

**(6)** The following specified insulator types must meet the following specified mechanical strength requirements:

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- (a) tension in a glass and porcelain insulator must not exceed fifty percent (50%) of the combined mechanical and electrical rating, and the "*Specified Mechanical Load*" for synthetic insulators, under *Alberta Electrical Utility Code* loading conditions;
  - (b) tension in a glass or porcelain insulator must not exceed eighty percent (80%) of the mechanical and electrical rating under maximum loading conditions;
  - (c) tension in a synthetic insulator must not exceed fifty percent (50%) of the "*Specified Mechanical Load*" rating under maximum loading conditions; and
  - (d) insulators used for deadend applications must have a strength rating at least equal to the rated tensile strength of the conductor attached to the insulators.
- (7) The minimum insulation levels for a **bulk transmission line** and any 25 kV distribution line located on **bulk transmission line** structures must be as set out in the following Table 4:

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**Table 4**  
**Required Insulation Levels**

Nominal Voltage (kV)	Critical Impulse Flashover (CIFO) (kV)
25	165
138/144	715
240	1155

**Conductor Thermal Ratings Methodology**

**22(1)** The calculation of thermal ratings of conductors for a **bulk transmission line** must be determined in accordance with the provisions of *IEEE Standard 738 – IEEE Standard for Calculating the Current-Temperature Relationship of Bare Overhead Conductors*.

- (2)** The following requirements must be used in the calculation of conductor ampacity:
- (a) a wind speed of 0.6 m/s at right angles to the conductor is assumed;
  - (b) the time of day is assumed to be 1200 hours;
  - (c) the elevation above sea level, latitude and **bulk transmission line** direction must be based on the **bulk transmission line** location and orientation;
  - (d) the atmosphere is assumed to be clear;
  - (e) the solar absorption coefficient is assumed to be zero point eight (0.8); and
  - (f) the emissivity is assumed to be zero point six (0.6).

**(3)** The maximum temperature for a standard ACSR conductor must not exceed one hundred (100) degrees Celsius.

**(4)** A new **bulk transmission line**, other than a 500 kV alternating current **bulk transmission line** or a +/-500 KV high voltage direct current **bulk transmission line**, must be designed to operate up to a steady state ampacity level that corresponds to a conductor temperature of one hundred (100) degrees Celsius.

**(5)** For a 500 kV alternating current **bulk transmission line** or a +/-500 kV high voltage direct current **bulk transmission line**, the steady state ampacity level must be approved **by the ISO of in the functional specification for the connection project under this section 502.4.**

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**Conductor Emergency Thermal Ratings Methodology**

**23(1)** A **bulk transmission line** conductor emergency thermal rating must be based on a thirty (30) minute time period.

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(2) Conductor emergency thermal ratings are deemed to be equal to the static ratings as set out in subsection 22.

#### Galloping

**24(1)** A **bulk transmission line** which is required to be designed to withstand one hundred year (100) year return loadings must also be designed for conductor galloping.

(2) For design purposes, the galloping envelope condition must be assumed to be twelve point five (12.5) mm of radial glaze ice and 96 Pa wind at zero (0) degrees Celsius and with final condition wire sags.

(3) The electrical clearance between galloping envelopes must be the sixty (60) Hz flashover value, either phase to phase or phase to ground, depending upon which two (2) galloping envelopes are being compared.

(4) The galloping envelopes requirements, for determination of acceptable galloping performance, must be designed and constructed in accordance with the requirements and illustrations of Appendix 1.

(5) If the functional specification for a connection project under this Section 502.2 specifies a compact line design or the use of any existing towers and the galloping envelope design and clearances as set out in subsections 24(2), (3) and (4) cannot be met, then the project functional specification must contain a further provision that the compact line design or existing towers must include interphase spacers.

#### Hardware Requirements

**25(1)** Ferrous components of hardware installed on a **bulk transmission line** must have low temperature impact properties, in accordance with *CSA C83 Communication and Power Line Hardware*.

(2) Without limiting subsection 25(1), the minimum requirement for energy absorption must be Level 1 as referenced in *CSA C83 Communication and Power Line Hardware*, which is twenty (20) joules at minus twenty (–20) degrees Celsius.

#### Provisions for Maintenance

**26** A **bulk transmission line** must accommodate all reasonably anticipated maintenance methods and requirements for the **bulk transmission line**, including:

- (a) live line maintenance access from and to all structures, with minimum approach distances as calculated using the methodology in *IEC 61472 Live working – Minimum approach distances for a.c. systems in the voltage range 72.5 kV to 800 kV – A method of calculation*;
- (b) access to all structure locations, whether along the right of way or otherwise;
- (c) access to conductors and insulators by ensuring of the ability to attach to rated fall protection anchor points, having strength as specified in section 152 of *the Alberta Occupational Health and Safety Code*; and
- (d) any other requirements necessary to allow routine and emergency maintenance to be conducted in a timely manner at all structural, tower and any other **bulk transmission line** locations.

ISO Rules  
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Requirements



**Appendices**

Appendix 1 – Galloping Envelope Requirements

**Revision History**

<b>Effective</b>	<b>Description</b>
<a href="#"><u>2019-xx-xx</u></a>	<a href="#"><u>Removed duplication with new Section 103.14, <i>Waivers and Variances</i>; standardized functional specifications language; capitalized references to "Section".</u></a>
2012-01-01	Initial Release

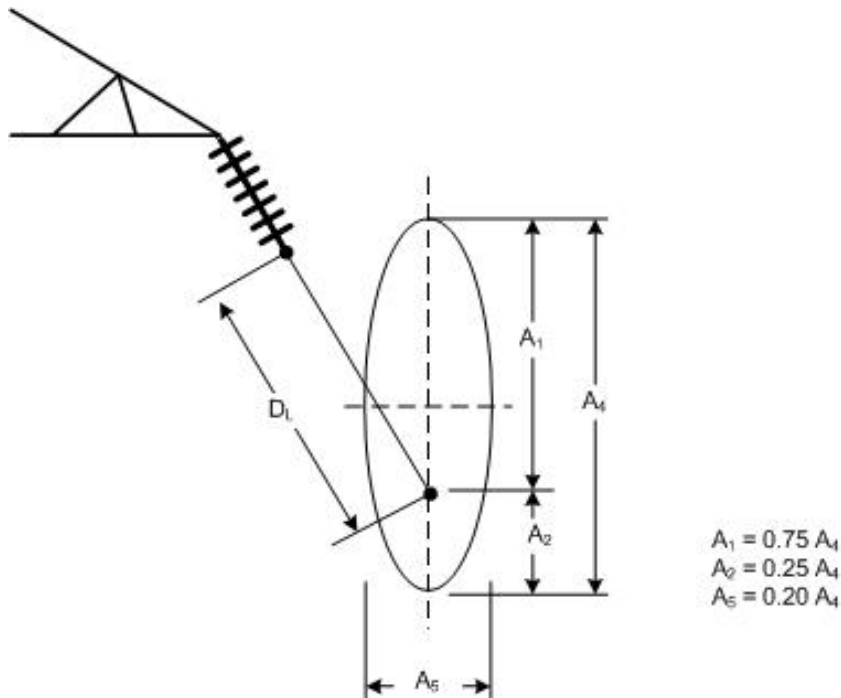
Appendix 1

Galloping Envelope Requirements

1 The **bulk transmission line** galloping envelope requirements for the determination of acceptable galloping performance must be in accordance with the following provisions and illustrations of this Appendix 1.

Illustration 1

Galloping Ellipse Parameters





# ISO Rules

## Part 500 Facilities

### Division 502 Technical Requirements

#### Section 502.2 Bulk Transmission Line Technical Requirements



2 The galloping envelope ellipse parameters for tower head design must be calculated in accordance with the following requirements, with reference to Illustration 1:

- (a) the major axis or amplitude,  $A_4$ , must be computed as follows:
  - (i) for a single conductor:  $A_4/Dia$  equals  $80 LN(8xSi / (50xDia))$ ; and
  - (ii) for a bundled conductor:  $A_4/Dia$  equals  $170 LN(8xSi / (500xDia))$

where:

$A_4$  equals the major axis of galloping ellipse (m), as set out in Illustration 1;

$Dia$  equals the diameter of conductor (m); and

$Si$  equals the conductor final sag with 12.5mm radial glaze ice and 96 Pa wind, at 0° Celsius (m), with glaze ice assumed to have a density of 900 kg/m<sup>3</sup>.

- (b) The major axis must not exceed twelve (12) meters, regardless of the results of the above calculation,
- (c) The minor axis must be computed as follows:  
 $A_5$  equals  $0.2 \times A_4$

where:

$A_5$  and  $A_4$  are as set out in *Illustration 1*; and

- (d) The final conductor galloping envelope must be determined by rotating the galloping ellipse by five (5) degrees either side of the vertical axis in accordance with Illustration 2

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**Illustration 2**  
**Galloping Envelope**

