4.0 LOADING AND STRENGTH REQUIREMENTS

4.1 Definitions

The following definitions apply…

4.1.1 Load Factor

A value by which calculated loads are multiplied in order of provide increased structural reliability. For the purpose of structural design, Overload Capacity Factors as specified by NESC shall be considered Load Factors.

4.2.5 Longitudinal load

Forces or pressures acting parallel to the direction of the line. For angle structures, the longitudinal direction is perpendicular to the bisector of the angle of the transmission centerline.

4.1.2 Structure, Dead-End and Line Termination

Structures where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware and where the ability of the structure to resist a condition where all wires are broken on one side under full loading **is** required or desired. Typically, dead-end structures would be used where the line deflection angle is greater than 45 degrees. However, both intact and broken conductor conditions shall be evaluated in the design of these structures.

4.1.3 Structure, Strain

A structure where the phase conductors and static wires are attached to the structure by use of dead-end insulators and hardware but where the ability of the structure to resist a condition where all wires are broken on one side under full loading is **not** required or desired. Typically, strain structures would be used where the line deflection angle is 45 degrees or less.

4.1.4 Structure, Suspension

A structure where the phase conductors and static wires are attached through the use of suspension insulators and hardware or, in the case of the static wire, with a clamp not capable of resisting the full design tension of the wire.

4.1.5 Transmission Line Facilities

Transmission Line Facilities include all supporting structures, insulators, hardware, and foundations.

4.1.6 Transverse load

Forces or pressures acting perpendicular to the direction of the line. For angle structures, the transverse direction is parallel to the bisector of the angle of the transmission centerline.

4.2. Design Requirements

All transmission line facilities shall be designed to withstand the load cases defined in Sections 4.2.1 through 4.2.7. The effects of gravity, wind, ice, conductor tension, construction, and maintenance loads shall be included as applicable.

4.2.1. Legislated Loads

4.2.1.1 Transmission line facilities shall be designed to the loading conditions defined in Rules 250B, 250C, and 250D of the NESC. For Rule 250B, the provisions of Grade B construction and the Heavy loading district shall be applied. The provision permitting exclusion of structures less than 60 ft in height from Rule 250C shall not apply.

4.2.1.2 The Designated Entity shall design to all additional legislated requirements as adopted by local jurisdictions.

4.2.2. Extreme Wind

Transmission line facilities shall be designed to resist the wind loads associated with a 100 year mean return period. Wind maps are found in ASCE 7-16. All wires shall be assumed intact.

Wind pressures shall be calculated in accordance with the procedures of ASCE Manual of Practice 74, properly adjusted for structure shape, gust, and height. The load factor shall be a minimum of 1.0.

Wind loads shall be applied in the direction producing the maximum loading effect.

4.2.3. Concurrent Ice with Wind

Transmission line facilities shall be designed to resist the ice with concurrent wind loads associated with a 100 year mean return period. Ice with concurrent wind maps and associated temperature maps are found in ASCE 7-16. All wires shall be assumed intact.

The weight of ice shall be considered 57 pcf. The temperature used shall be either the values shown in the maps or 32 degrees F, whichever results in the maximum loading effect.

Wind pressures shall be calculated in accordance with the procedures of ASCE Manual of Practice 74, properly adjusted for structure shape, gust, and height. The load factor shall be a minimum of 1.0.

Wind loads shall be applied in the direction producing the maximum loading effect.

4.2.4 Heavy Ice

Transmission line facilities shall be designed to resist a minimum radial ice loading equivalent to 1.0 inch. All wires shall be assumed intact.

The weight of ice shall be considered 57pcf, the temperature 0 degrees F, and the wind speed 0 mph. The load factor shall be a minimum of 1.0.

In mountainous regions above 1200 feet, and other areas know to accumulate greater amounts of ice, the ice loading shall be based on historical weather data and 100 year return period.

4.2.5. Longitudinal Load Cases

Transmission line facilities shall be designed to resist longitudinal loads due to broken wire conditions, differential ice, and differential tension.

4.2.5.1. Broken Wire Loading

Transmission line facilities shall be designed to resist the forces due to broken wires as described below.

For single conductor phase configurations, only one conductor or the shield wire shall be considered broken in each load case considered. Each wire shall be broken individually to ensure the maximum loading effect is determined for each component.

For phase configurations with more than one sub-conductor, a minimum of one sub-conductor, or the ground wire shall be considered broken in each load case considered. The conductor bundle with the sub-conductor(s) broken shall be considered individually to ensure the maximum loading effect is determined for each component.

The minimum environmental load condition shall be .5 inches of ice, 40 mph wind, and 32 degrees F. The conductor tensions may be reduced by the effects of insulator swing where appropriate. The load factor shall be a minimum of 1.0.

This load case does not apply to braced and line post insulators.

4.2.5.2. Differential Ice Loading

Transmission line facilities shall be designed to resist the forces due to unbalanced ice as described below.

With all wires assumed intact, each conductor and static wire on one side of the structure shall be loaded with 0.5 inch of radial ice with 40 mph wind at 32 degrees F for strain structures. All conductors and static wires on the other side of the structure shall be assumed to have no ice. For strain structures, the same criteria apply, except the ice loading shall be 0.75 inch. The determination of differential tension may include the effects of insulator swing where appropriate. The load factor shall be a minimum of 1.0.

This load case does not apply to braced and line post insulators.

4.2.6. Construction and Maintenance Loads

Transmission line facilities shall be designed to meet all applicable OSHA requirements and the provisions of this section.

This load case does not apply to braced and line post insulators.
4.2.6.1 Bound Stringing Block

Transmission line facilities shall be designed to resist the forces due to a bound stringing block as defined below.

With all wires assumed intact, any one static wire or phase conductor (or all sub-conductors of any one phase) shall be assumed to bind in a stringing block during installation. The block is assumed to swing 45°in-line. Apply 2 psf wind and no ice at a temperature of 30°F. Load factor is 1.5.

4.2.6.2 Climbing and Working Loads

Structures shall be designed to support a point load of 350 pounds at all areas where personnel performing construction or maintenance activities may be present.

4.2.7. Foundation Loading

Foundation reactions shall be determined from the load cases presented in Section 4.3. Overload factors shall be a minimum of 1.0.

4.3 Strength Requirements
Structures and foundations shall be designed to the requirements of the applicable publications:

- *ASCE Standard No. 10, Design of Latticed Steel Transmission Structures*
- *ASCE Standard No. 48, Design of Steel Transmission Pole Structures*
- *ASCE Manual No. 91, Design of Guyed Electrical Transmission Structures*
- *ASCE Manual No. 104, Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures*
- *ASCE Manual No. 123, Prestressed Concrete Transmission Pole Structures*
- *ANSI 05-1, Specifications and Dimensions for Wood Poles*
- *IEEE Std. 691, Guide for Transmission Structure Foundation Design and Testing*
- *IEEE Std. 751, Trial-Use Design Guide for Wood Transmission Structures*
- *ACI 318 Building Code Requirements for Structural Concrete and Commentary*

A geotechnical study shall be the basis of the final foundation design parameters.