# Tutorial on Safe Line Design Tensions - CIGRE WG11

## *Presented by Claude Hardy, Consultant*

## *Monday, June 19, 1PM to 2PM, Room 522b*

The commonly used Everyday Stress criterion (EDS), expressed as the percentage of the rated tensile strength (%RTS), may not be the best way to avoid strand fatigue in overhead lines due to Aeolian vibration. Simply specifying a %RTS value at a given conductor temperature does not consider the following important fatigue endurance issues:

- The effect of persistency of wind speed and direction relative to the line section;
- Terrain covers of trees, shrubs and buildings and the terrain itself, which have a marked effect on the degree of turbulence;
- The dangerous conditions existing for short-span construction with high tensions at very low-temperature operation, when much of the damage may occur during a month or two of winter;
- The effect of conductor stranding and the amount of steel in ACSR, which has different effects on mass and strength.

In light of these issues, it has been suggested that a tension-over-weight per unit length criterion (H/w) be used instead of (%RTS). The H/w parameter is related to aluminium stress, and therefore to the self-damping properties of the conductor.

Recently, CIGRE B2.11 (formerly SC22 WG11) published three papers [**Error! Reference source not found.**, **Error! Reference source not found.**, 15] where the H/w parameter has been used as a criteria for vibration control considering the effect of the terrain among other important factors.

For unprotected (no armor rods or AGS clamps), round strand single conductors (not bundles nor protected single conductors), the recommended H/w parameter constraint, where vibration dampers are not used, depends on terrain. Recommended maximum values of H/w range from 1000 to 1425 m. As can be seen in the following Table 1, for Drake ACSR in a 300 m span, this would correspond to an unloaded initial tension of between 10% and 15% RTS. If dampers are used, then a higher H/w level would be acceptable.

Table 1 - H/w values for Drake ACSR in a 300 m span.

| Initial, unloaded conductor tension at 15°C [%RTS] | Initial unloaded H/w at avg temp for coldest month) [m] | Tension at -20°C with max ice and wind load [%RTS] | Tension at max ice and wind load [kN] | Final sag at 100°C [m] |
|---|---|---|---|---|
| 10 | 900 | 22.6 | 31.6 | 14.6 |
| 15 | 1500 | 31.7 | 44.4 | 11.0 |

| | | | | |
|---|---|---|---|---|
| 20 | 2100 | 38.4 | 53.8 | 9.4 |
| 25 | 2700 | 43.5 | 61.0 | 8.4 |

If vibration dampers are applied at the ends of each span, higher tension levels can be used in the line. The line parameters in the adjacent Figure 1are:

L – span length; D – conductor diameter; m – conductor mass per unit length;

H – initial horizontal tension at average temperature of the coldest month of the year

w – conductor weight per unit length

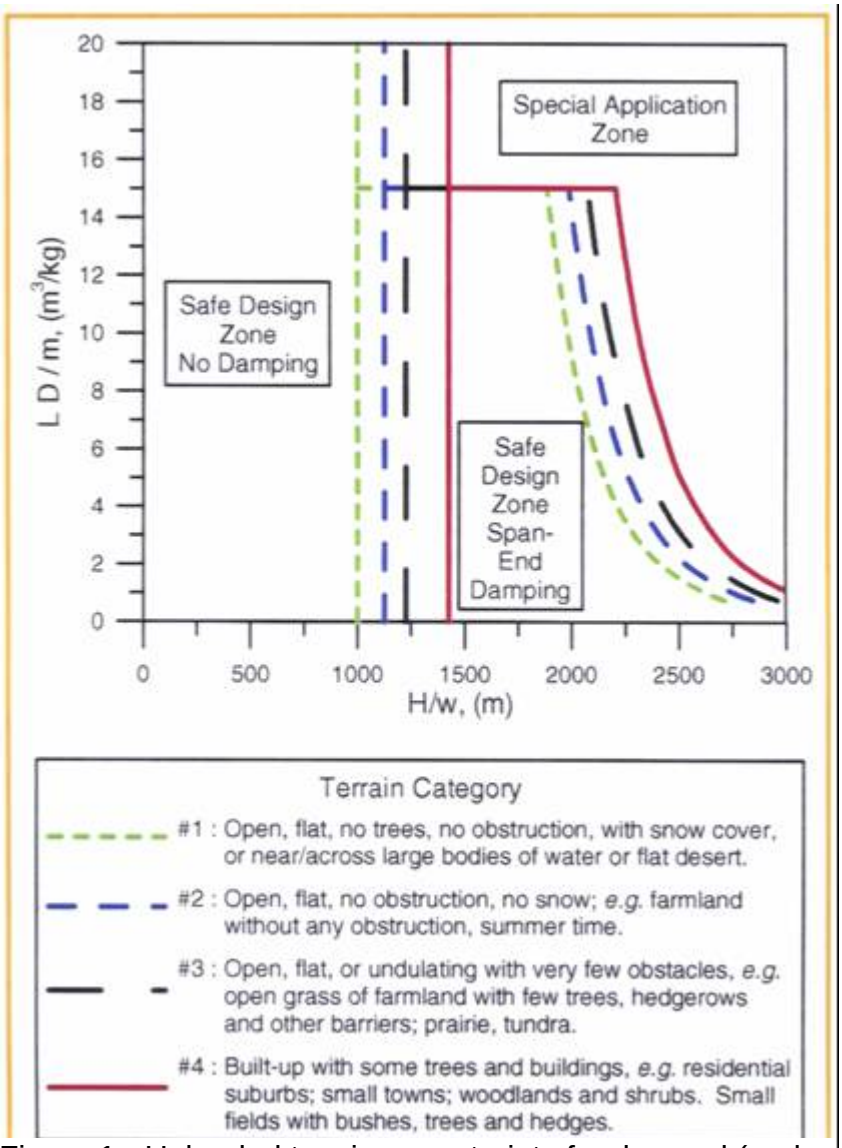


Figure 1 - Unloaded tension constraints for damped (and un-damped) spans of single (not bundled) conductors [**Error! Reference source not found.**]

As noted before, the H/w value for the Drake ACSR at -20°C in 300 m spans, is between 1000 and 1425 m. This corresponds to a stringing tension between 11% and 15% of RTS at 15°C.

For the example case, LD/m is 5.2 $m^3$/kg and the corresponding H/w value for Category 4 terrain is about 2500 m. Normal dampers should be adequate up to that tension in this terrain. Maximum safe H/w is smaller for the other terrain categories, as indicated in the figure.