Example of TLA optimization

• This example compares two methods to place transmission line surge arresters
  – Taking into consideration only tower footing resistance and three arresters per structure
  – Taking into consideration tower footing resistance, historical lightning incidence data along the circuit, and placement of 1, 2, or 3 arresters per structure

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Considerations

- Moderately long 115 kV circuit with a combination of lattice and wood structures.
- Stroke data from the Canadian LDN from 1994 to 2002
- Unit cost estimates are a placeholder and do not reflect actual costs
- Placement of 1, 2, or 3 arresters per structure is based on the methodology described in CEAT report T023700-3102 “HV line arresters: Selection based on grounding impedance of towers and position”, October 2004.
Considerations (cont.)

- Historical lightning varies by a factor of two in parts of the circuit.
- Eight years of data is a modest sample space.
- This is a high resistivity region.
Fig. 1 Tower (pole) data before installing TLAs

(Predicted interruption rate 1.96/year, length = 87km)
Reported interruption rate = 3.22
Confirmed interruption rate = 1.56
Fig. 2 Flashover rate reduction vs. investment (considering factors of foot resistance, tower/pole structure and lightning density, $2500/аррéster and $300/km for Rg measurement, up to 958 arresters needed for solid line, 1521 for dashed line)
Fig. 3 Number of arresters needed for each tower (correspond to Fig. 2, 958 arresters altogether)
Fig. 4 Backflashover reduction in % vs. cost when only footing resistance is considered. 3 arresters if Rg>50ohm. Fr=2.0295 without arresters, Fr=1.5873 with 588 arresters.
Consider all factors, $0.5M, 190 arresters, Fr 34.2% reduction
Consider all factors, $1.0M, 390 arresters, Fr 61% reduction
Consider all factors, $1.5M, 590 arresters, Fr 82.8% reduction
Consider all factors, $2M, 790 arresters, Fr 91.7% reduction
Consider all factors, $2.42M, 958 arresters, Fr 93.9% reduction
If consider Rg only, investment $1.5M, 588 arresters, Fr reduction 78.2%
If consider Rg only, $1M, 390 arresters, Fr reduction 51.7%
If consider Rg only, $0.5M, 192 arresters, Fr reduction 25.5%
Observations

• Using fewer than 3 arresters per structure is a factor when trying to achieve performance improvements above 80%.
• The simplified TLA placement criterion of 3 arresters/structure if $R_g > 50 \, \Omega$ is surprisingly close to the more elaborate method using different numbers of arresters and local lightning density for performance improvements under 80%.
• In all instances it is critical to have a footing resistance survey.