

Overvoltages resulting from lightning strikes to overhead lines

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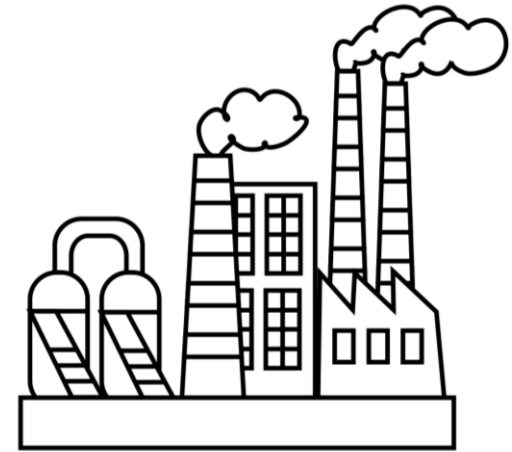
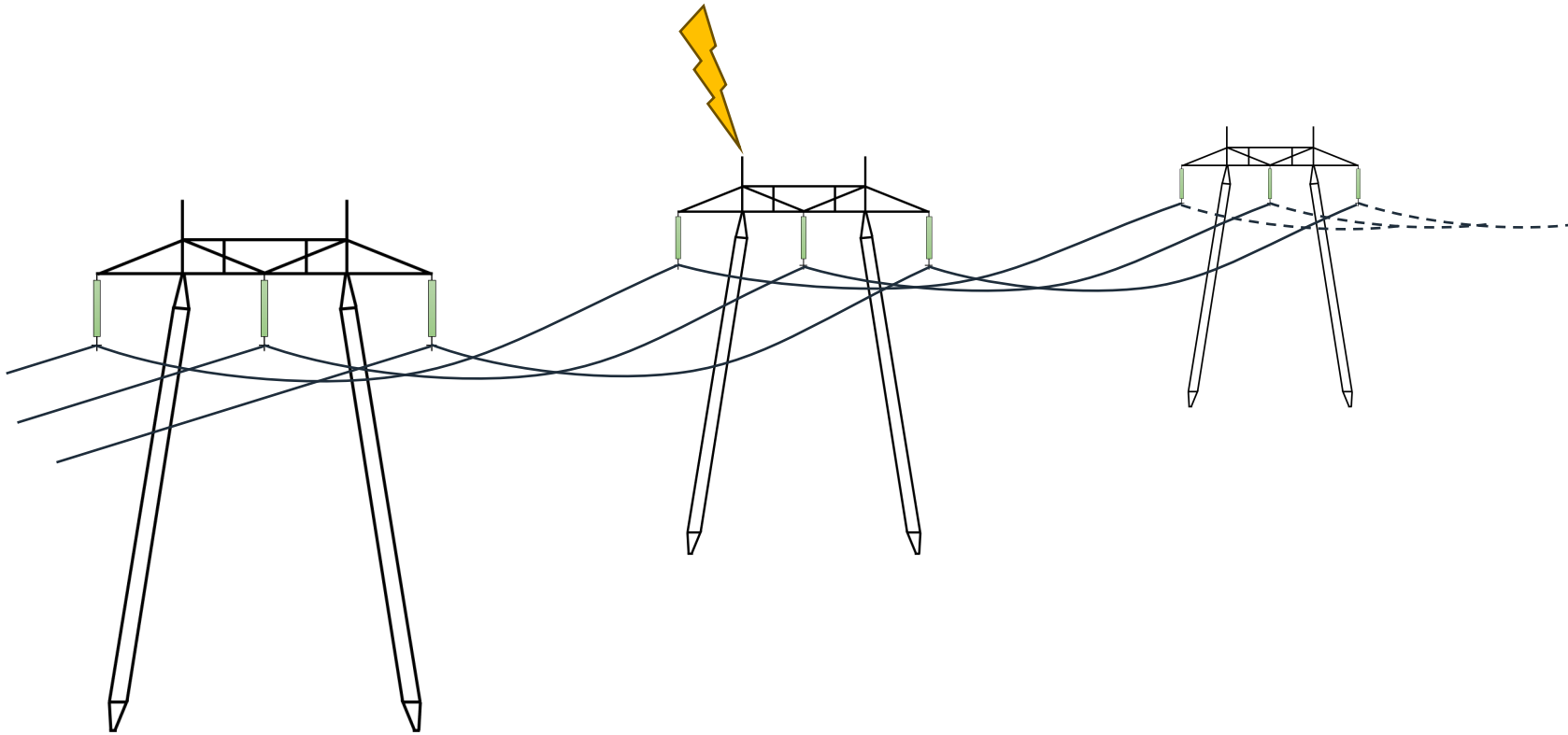
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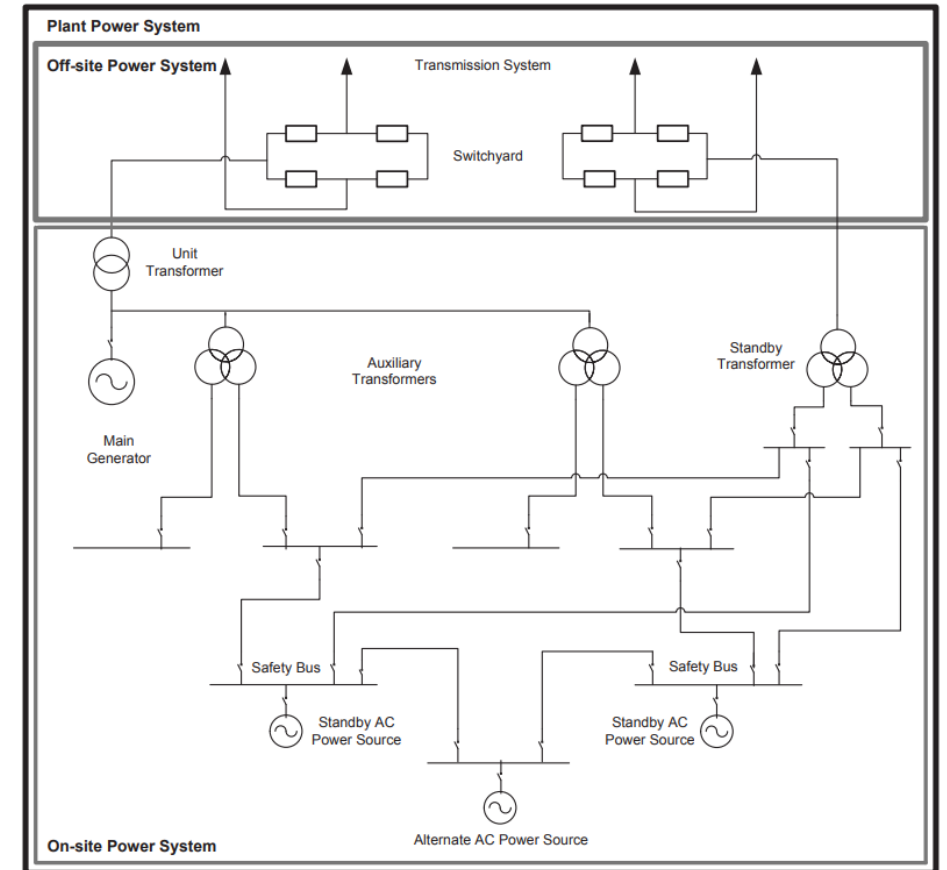
Lighting overvoltages



Voltages in plant?

Lighting overvoltages

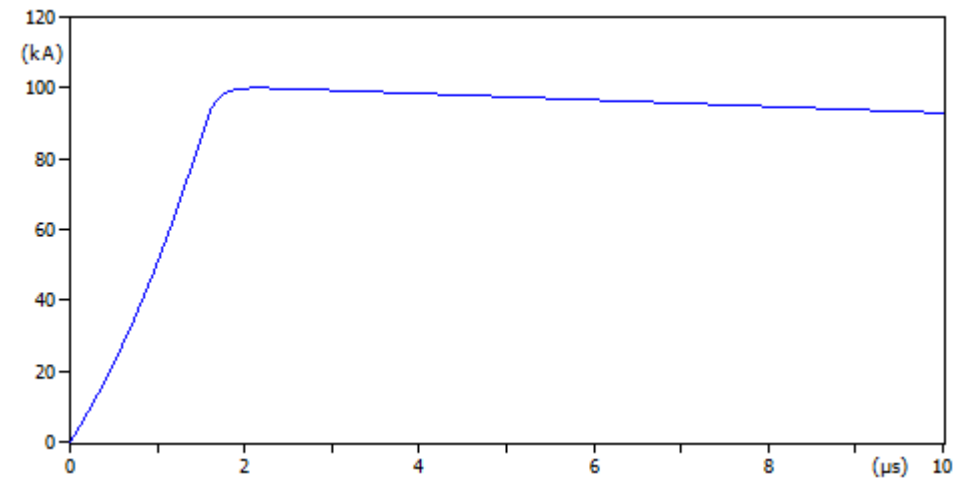
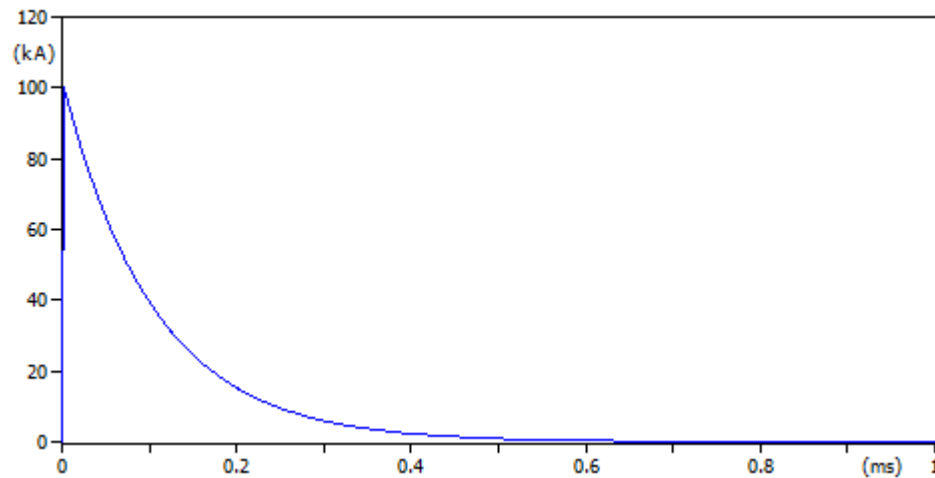
- Time domain simulations
 - ATP/EMTP model
 - Lightning current



IAEA SSG-34

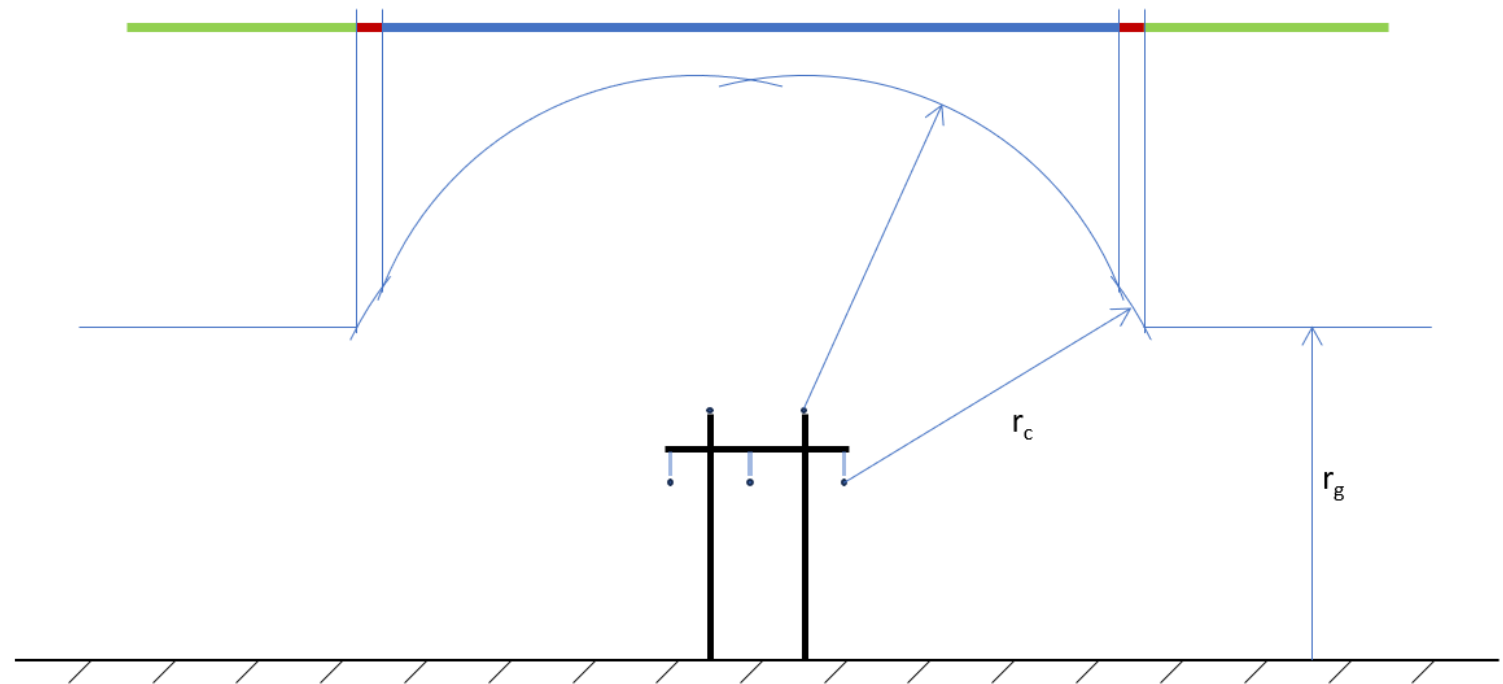
Lightning current

- Deterministic approach
 - Amplitude / Wave shape
 - Frequency of occurrence



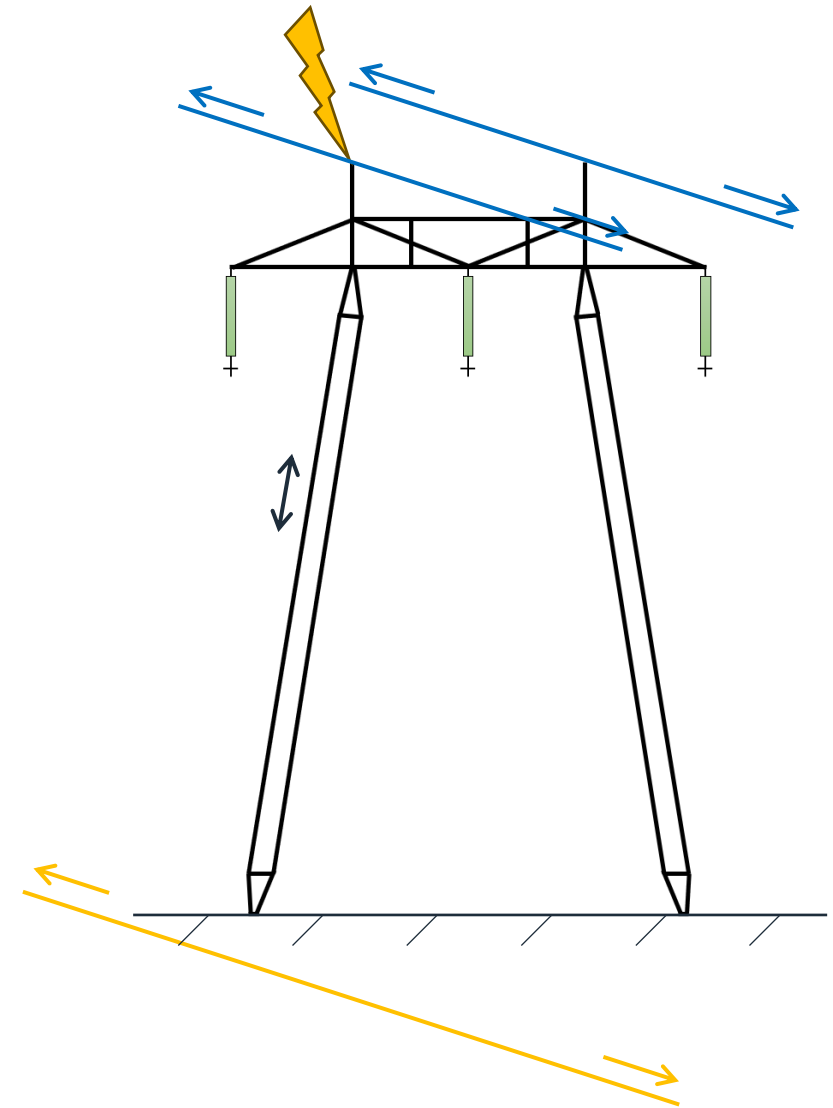
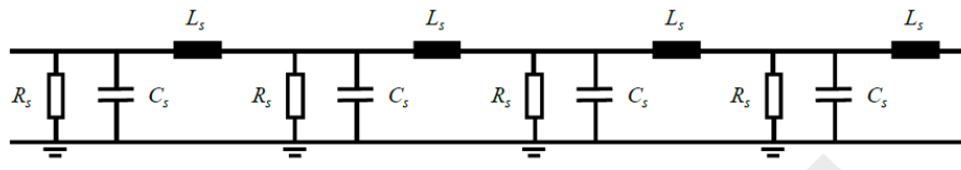
Lightning strikes to overhead lines

- Backflash
- Shielding failure



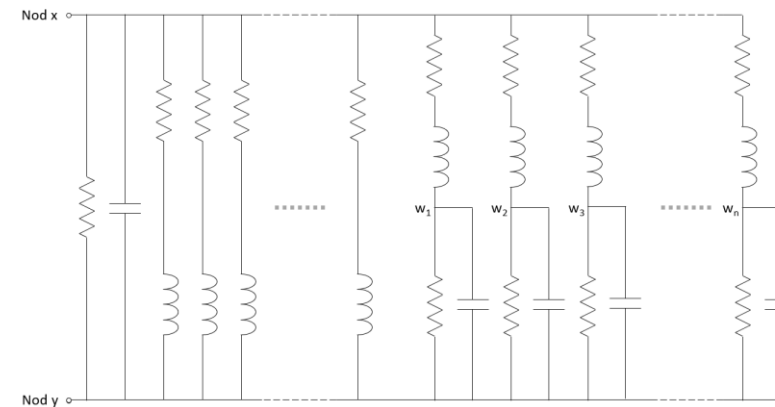
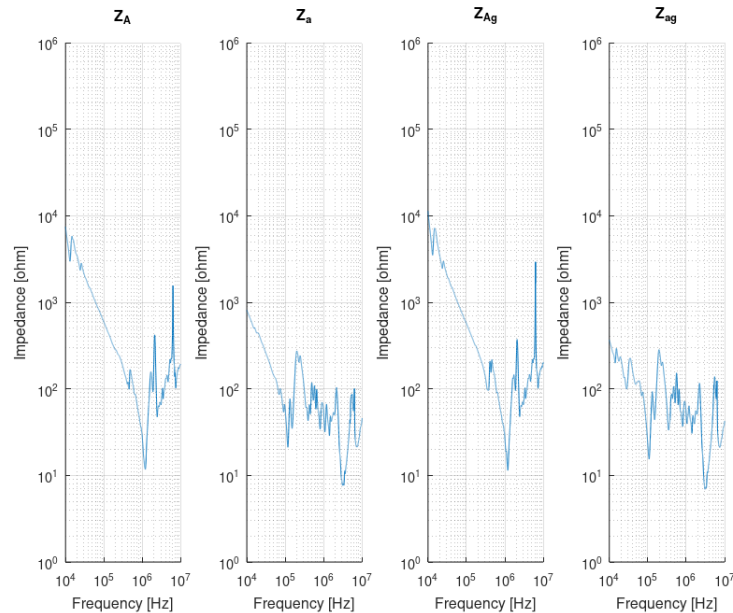
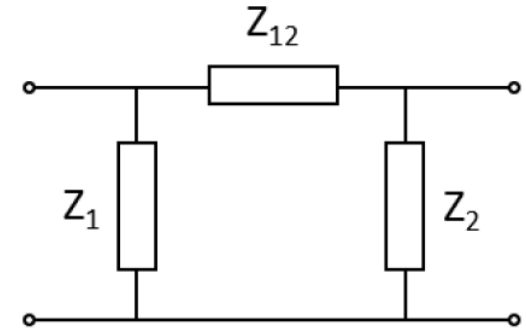
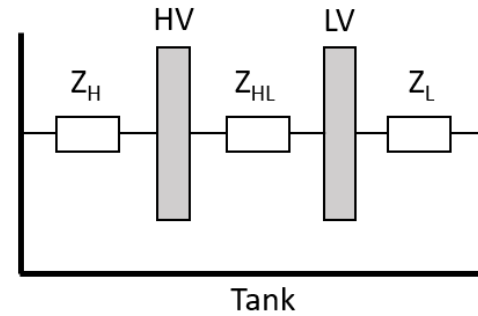
Overhead lines

- Conductors
- Insulator flashover models
- Towers
- Tower grounding



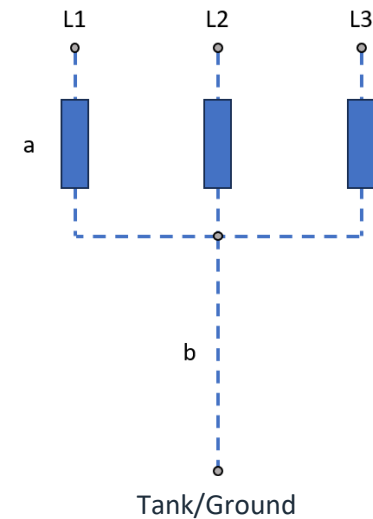
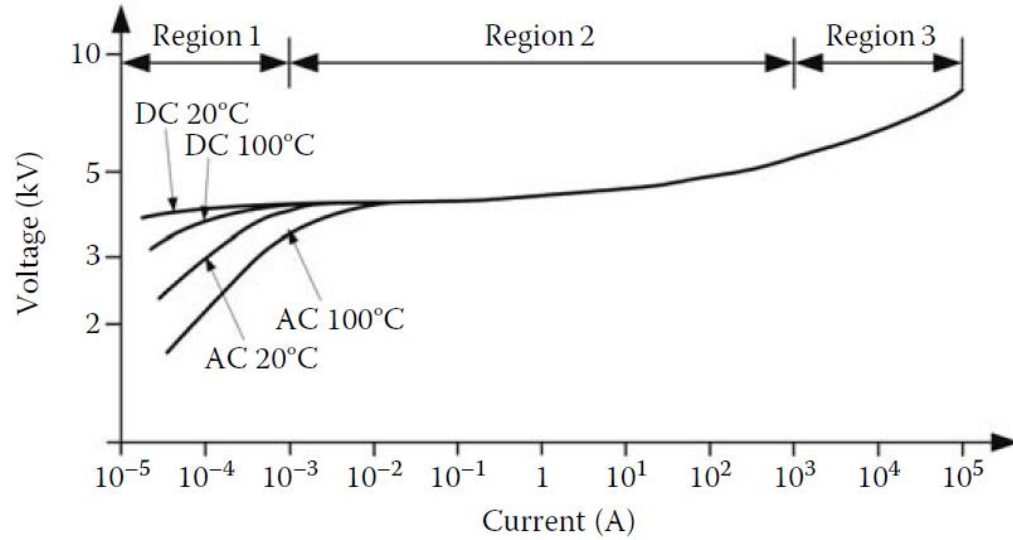
Transformers

- HF representation
 - Simplified/complex
 - **Non-standard** measurements



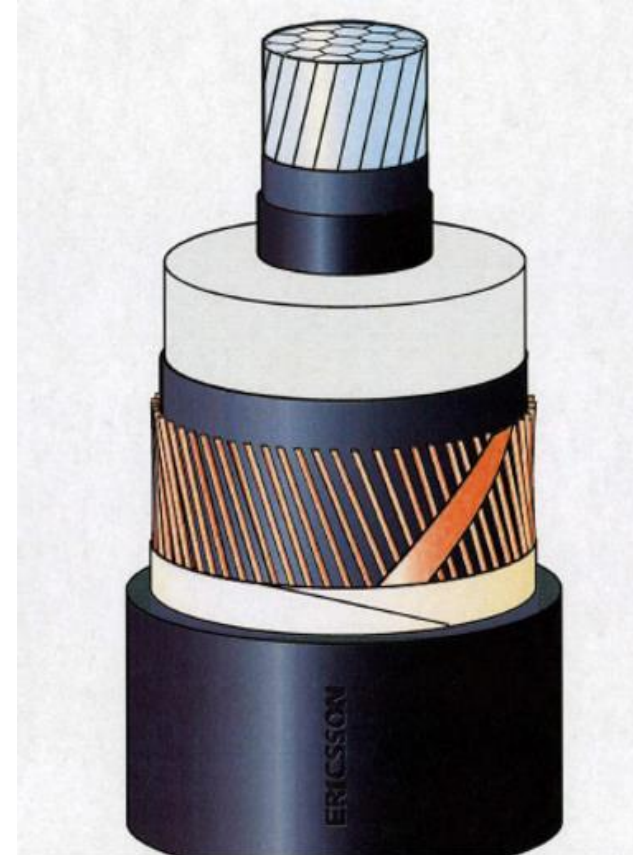
Arresters

- Non-linear resistance
- Connection leads



Cables

- Electrical data
 - Resistance of conductor and screen
 - Permittivity of insulation and sheath
- Geometric data
 - Conductor diameter
 - Thickness of conductor screen
 - Thickness of insulation
 - Thickness of insulation screen
 - ...
- Length



Evaluation

- Lightning current is injected at one tower at the time.
- Resulting voltages are calculated at a number of nodes in the system.
- Maximum voltage are compared with insulation levels of equipment including safety margin.

- Results can be used for assessment of effectiveness of existing and different prospective protection schemes.

General observations

- Large amounts of detailed/specific data
 - Lack of data
 - Measurements
 - Sensitivity analysis
- Study cases
 - Representative configurations
 - Conservative
- Arrester locations (practically feasible)
- Overhead line design
 - Tower grounding

Questions?