Ageing of medium voltage overhead lines

EDF R&D – France
Introduction

• Report in France:
  – Underground MV lines are nowadays the rule for network development
  – Overhead MV lines represent an important part of the assets (even in the future)

• Goal of the study:
  – Improve the efficiency in managing maintenance and investments of MV distribution lines

• Means:
  – Determine each component mechanical behaviour along time
  – Failure risk of a line in case of climatic event
Climatic environment

- Mean parameters
  - Govern the degradation speed of components
  - Distribution

- Exceptional conditions
  - Event return period for different levels

- Optimise the accuracy of sampling
Ageing rules - conductors

- Phenomena:
  - Creep
  - Non-elastic non-linear behaviour of conductor
  - Broken strands (lightning impacts + vibratory phenomena)
Ageing rules – wood poles

• Phenomena:
  – Increase of humidity
  – Animal attacks
  – Mushrooms

• Model:
  – No ageing model existing
  – Possibility to use non destructive tools to anticipate failures
Ageing rules – concrete poles

- Phenomena:
  - Corrosion of steel reinforcement

- Model:
  - Carbonation and chlorine penetration laws

- Other causes (frost / thaw …): study in progress
Ageing rules – fittings (1/2)

• Phenomena:
  – Wearing due to the insulator sets swinging

• Model:
  – Analysis of climatic conditions and assembly geometry
Ageing rules – fittings (2/2)

- Link between component appearance and residual load:
  - Mechanical tests
  - Useful for managing maintenance
Methodology (step 1)

- Step 1: Initial conditions
  - Building date: specific design rules, beginning of ageing
  - Specification of the components
  - Climatic environment (mean and exceptional)
Methodology (step 2)

- Step 2: Ageing calculation on a period:
  - Mean climatic environment (ageing rules of each component)
  - Possible degradation due to an exceptional event (random sampling)
  - Taking into account of maintenance operations (some components recover their initial conditions)
Methodology (step 3)

- Step 3: Calculation of residual mechanical state
  - Identify the line weak points
Methodology (step 4)

- Step 4: Behaviour of the line regarding climatic events
  - Calculation of a failure risk indicator
  - Random failure (some components recover their initial conditions)
  - Definition of a final state for the considered period
Methodology (step 5)

- Step 5: Resuming of the calculations to cover the line lifetime
Methodology (step 6)

- Step 6: Determine several possible occurrences of the line lifetime
Methodology (step 7)

- Step 7: Analyse the relevancy of the obtained line lifetimes looking at:
  - The experience of local operators
  - Failure statistics
  - Maintenance records

Initial conditions → Ageing calculation → Residual mechanical state → Final state → Possible line lifetimes

Environment

Bias analysis

Experience
Step 8: Fit the model and start again the previous steps until the model is close to experience.
Methodology (step 9)

- **Step 9**: When the model is checked:
  - Continue the calculations to anticipate possible future failures
  - The same process of exceptional events random sampling is used in the future
Conclusion

The final tool could be used in different ways:

- Better knowledge of ageing laws for different components
- Improve the anticipation of investments and maintenance
- Decision-making support for network operators
- Integrated to a global platform taking also into account system aspects and economic constraints
- ...

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