End of Life in Extruded Cables!

Can we estimate where it is?
How would we recognize it when we get there?

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NEETRAC
End of Life in Extruded Cables!

Outline

• How do we define End of Life?
• When we ask the question about “End of Life” matters to the answers we might consider!
• Can / should we estimate a life at all?
• If we can, what would a “Life Statement” for utility devices look like?

• Including Examples considering: Cables, Cable Systems, Wood Poles
How do we define End of Life?
What do we say?

The existing electric power delivery relies on an aging infrastructure and largely reflects technology developed in the 1950’s that struggles to meet today’s demand. In a recent survey, 147 investor owned utilities reported that between 35% & 48% of their T&D assets either currently need or will soon need replacement.

Source: EEI / Harris Williams Co, Summer 2014
What do we say?

The US Department of Energy (DoE) estimates 70% of transformers are 25 years old or older and 60% of circuit breakers are more than 30 years old compared to useful lives of 25 years and 20 years respectively.

Source: DoE / Harris Williams Co, Summer 2014

Impacted if the “useful life” is 25 years
What does this mean?

- What do the numbers “Useful Lives of 25 years and 20 years” mean?

- What are the implications of a 25 year “Useful Life”? 
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What do the numbers “useful lives of 25 years and 20 years” mean?

If we are not precise, we cannot be certain of the interpretation.

Good for 25 years but 50% are gone by age 38?

Pretty much good for 5 - 10 years but 50% are gone by age 25?
Where does this leave us?

- We have “Useful Lives” that are open to multiple interpretations
- We cannot readily explain where they come from
- The consequences that arise do not match with reality
It matters how we frame our Life Expectancies

Given the impact of Life Expectancies, it would be valuable to be as clear as possible

Life Statement
“Lifetime” Statement

Lifetime statements are needed to:
• describe what a utility needs
  AND
• what the manufacturer has designed.

They have three elements:
• Time
• Survival Rate
• Conditions
Let's consider Wood Poles

- Pole are removed from the system for a variety of different reasons.
  - Vehicles – impacts SAIDI / SAIFI
  - Storms – impacts SAIDI / SAIFI
  - Relocations
  - Inspection

- As an example – Pole Inspection
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Pole Inspection

<table>
<thead>
<tr>
<th>Installed</th>
<th>Inspect 2016</th>
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<tbody>
<tr>
<td>1950</td>
<td>OK</td>
</tr>
<tr>
<td>1999</td>
<td>OK</td>
</tr>
<tr>
<td>1960</td>
<td>NOK</td>
</tr>
<tr>
<td>2010</td>
<td>OK</td>
</tr>
<tr>
<td>1970</td>
<td>NOK</td>
</tr>
<tr>
<td>1980</td>
<td>OK</td>
</tr>
<tr>
<td>etc</td>
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</tbody>
</table>
Hazard Rate of Poles

Failure Rate Increase becomes noticed

Rate

Pole Age (Years)
Survival of Poles

B5 life of US utility poles by inspection is 50 years.

50% of US utility poles will be rejected, with current inspection methods, before age 90 years.
When we ask the question about “End of Life” matters. The answers are different!
Human Life Expectancies

0 Iceland 65

Male: 81.2
Female: 83.8

how long, on average, a newborn can expect to live, if current death rates do not change

Male: 84.5
Female: 86.3

average number of years that a person at that age can be expected to live, assuming that age-specific mortality levels remain constant

Source: OECD 2017
Test Data / Modeling
Uncertainty in
• Environment
• Load / Temperature
• Maintenance

If I do or don’t do this
How long will it last?

ASSET LIFE
Cable Design Simulation

- 15kV
- 1000 kcmil
- 175 mil
- 300 ft
- 45 C
- Jacket
- 70% LF
- Current
  - Loading
  - Defects

The simulated B25 life of these cables is 51 years.
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Performance Data / Model
Uncertainty in
• Fidelity
• Completeness
• Complexity

ASSET LIFE

Given the experience / exposure so far

How much longer will it last?
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Cable System vs Cable Lives

<table>
<thead>
<tr>
<th>Age</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-25</td>
<td>T</td>
</tr>
<tr>
<td>10-15</td>
<td>S</td>
</tr>
<tr>
<td>30-40</td>
<td>C</td>
</tr>
<tr>
<td>47</td>
<td>C</td>
</tr>
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<td>20–28</td>
<td>S</td>
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<tr>
<td>30</td>
<td>S</td>
</tr>
<tr>
<td>5</td>
<td>T</td>
</tr>
<tr>
<td>etc</td>
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</tbody>
</table>

B5 life of these cables is 57 years

B5 life of the cable system is 45 years

Utility Data
Can / should we estimate a life at all?

If we do, what would a “Life Statement” for utility devices look like?
Why estimate Life Expectancy – back to poles

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Now
9% reject between age 60 and age 70

Source: NEETRAC Application
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Asset Management Need – Wood Poles

Test Data / Modeling Uncertainty

ASSET LIFE

Performance Data Uncertainty

No. of Poles Replaced (thousands)

Mean Pole Age (Years)

Source: NEETRAC Application
Conclusions

- The term “Cable Life” is used but is ambiguously defined

- “Life Statements” are useful / needed to define the life

- Concept is being applied in a number of areas: Batteries, Cable, Controllers, Outdoor Insulation, Poles, Switches, Systems, Transformers, Wires etc

- Curves can be obtained from “Assessment Audits” & “Scaled Laboratory Tests”

- Whatever we mean by “Life” will a) Not be simple & b) Continue to be important for the cable system infrastructure as it drives many activities