What Challenges Face Us Today?

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Outline

• Introduction
• What questions a utility might ask in the future
• Life expectancy of an installed system
• Better understanding from existing Information
• Refurbishment technologies - what should we be asking ourselves about approvals / monitoring / validation
• Conclusions
Early Experience - shows the concerns

- 48k miles
- 22k miles

Lawson & Thu 1980

Annual Failure Rate


Graph showing the failure rate over time.
Todays Industry Outlook

• Investment: $5-6 Billion predicted between 2010 & 2030
• Ageing Infrastructure: EEI indicates that utilities believe
  - 4% of Distribution Infrastructure is at End Of Life
  - 41% is Distribution Infrastructure is Near End Of Life
• Increasing demand for Reliability: ASCE estimates the average cost of power interruptions at:
  - 3$/hr Residential,
  - 1000$/hr Commercial
  - 4000$/hr Industrial
• Move to Renewable Energy
• Very Distributed Generation
• More and different power

We will be:
• Asking for more
• Expecting more
WHAT QUESTIONS A UTILITY MIGHT ASK IN THE FUTURE
Todays Goal

- We want to make sure that this rate is sufficiently low.
- We want to make sure that this upswing is further out than previous generations.
Tomorrow's Goal

WE STILL WANT TO MAKE SURE THAT THIS RATE IS SUFFICIENTLY LOW

WE WANT TO MAKE SURE THAT THIS UPWING IS ACCEPTABLY FAR OUT AND ESTIMATE WHERE IT IS

WE WANT TO MAKE SURE THAT THIS UPWING IS ACCEPTABLY LOW
• HOW MUCH LIFE LEFT IN MY OLD CABLE SYSTEM?
• HOW FAST WILL THINGS CHANGE FROM HERE?
• HOW DIFFERENT ARE THE NEW OFFERINGS (DESIGNS, MATERIALS, WALL THICKNESS, ETC) AMONG THEMSELVES AND FROM WHAT I HAVE IN THE GROUND?
• WHAT ARE THE FAILURE MODES?
• ARE THE MODES DIFFERENT FROM PREVIOUS ONES?
Is the cable upswing real?
What has caused it?
LIFE EXPECTANCY OF AN INSTALLED SYSTEM
Language of Life Expectancy

- A Life Statement or Requirement has three parts
- It is driven by performance data

1. Environmental Description – describes the conditions
2. Survival Level – defines the acceptable level
3. Time – defines the time

For an XLPE cable system under normal operating conditions and moderate loading installed in ducts 95% of cables and splices will survive to age 50

A 40 year life for an XLPE cable system under normal operating conditions and moderate loading installed in ducts means 93% of terminations, 98% of splices & 99.5% of cables will survive
This approach is useful

- If failure data is available

- If failure data can be estimated from recent failures – see Hampton & Perkel ICC Fall 2014 Sub A

- Ageing modes have been consistent
Age Segregated Failures

see Hampton & Perkel ICC Fall 2014 Sub A
Assuming:

- All failures are repaired
- No replacement
- Good performance in early years
- Purchase records are reliable
- Few Hybrid/mixed circuits

Estimated Combined Survival Curve

For a direct buried XLPE cable system under normal operating conditions and moderate loading with no replacement — repair on failure between 82 and 77% of cables will survive to age 50.

see Hampton & Perkel ICC Fall 2014 Sub A
Failure In Service Prognosis

see Hampton & Perkel ICC Fall 2014 Sub A
If data is not available can testing help us?

“Early” “Young” cables failed “on test” within a reasonable amount of time.

Do “Early” “Old” Cables fail in the same way?

If they don’t fail in the same way, should we test them in the same way?
Future Testing Needs

We need accelerated aging tests to:

- Qualify cable core designs
- Provide cable aging information (reliability)
- Predict remaining life
  - Standard designs
  - Reduced wall designs
  - Rejuvenated cables

*The tests we have are focused at Normal Operation in “Young Cables”*

*Take the opportunity to:*
- *Uprate the tests we have*
- *Add the ability to study the ageing and wearout of “Mid Life Cables”*
WHAT SHOULD WE BE ASKING ABOUT OUR REFURBISHMENT TECHNOLOGIES
Installed Base and Failures In Service

Cable Age (ys)

Age at Fail (yrs)

# of Sections (%)
Refurbishment Approaches

- Replace with new
  - Cable section
  - Joint
  - Termination
- Rejuvenate

- All of these require that we make Conductor and Dielectric connections onto Old Cable

- Do we do a good job at developing / testing approving these technologies?
Challenges

• We test connectors and joint bodies on new cable
• If we are installing a connector / joint system on an old cable – should they not be tested together on old cable?

If a joint on an XLPE cable system under normal operating conditions and moderate loading installed in ducts has a life of 50 years at the 95% level

Does a repair joint need the same life?

The cable it is repairing is unlikely to last that long?

What should that Life Statement be?
Conclusions

• We have solved many many issues
• We have made the cables we install last much longer
• We are likely to start to see new and currently unknown issues, because
  – We will change the way our system operates
  – We will ask more of it
  – Our understanding of Mid Life and beyond is poor
• We will need to uprate our understanding
  – Be precise about what we mean by “Life”
  – Strengthen our test procedures to predict performance in Mid Life
  – Be open to the questions that are to come