What Challenges Face Us Today?

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NEETRAC

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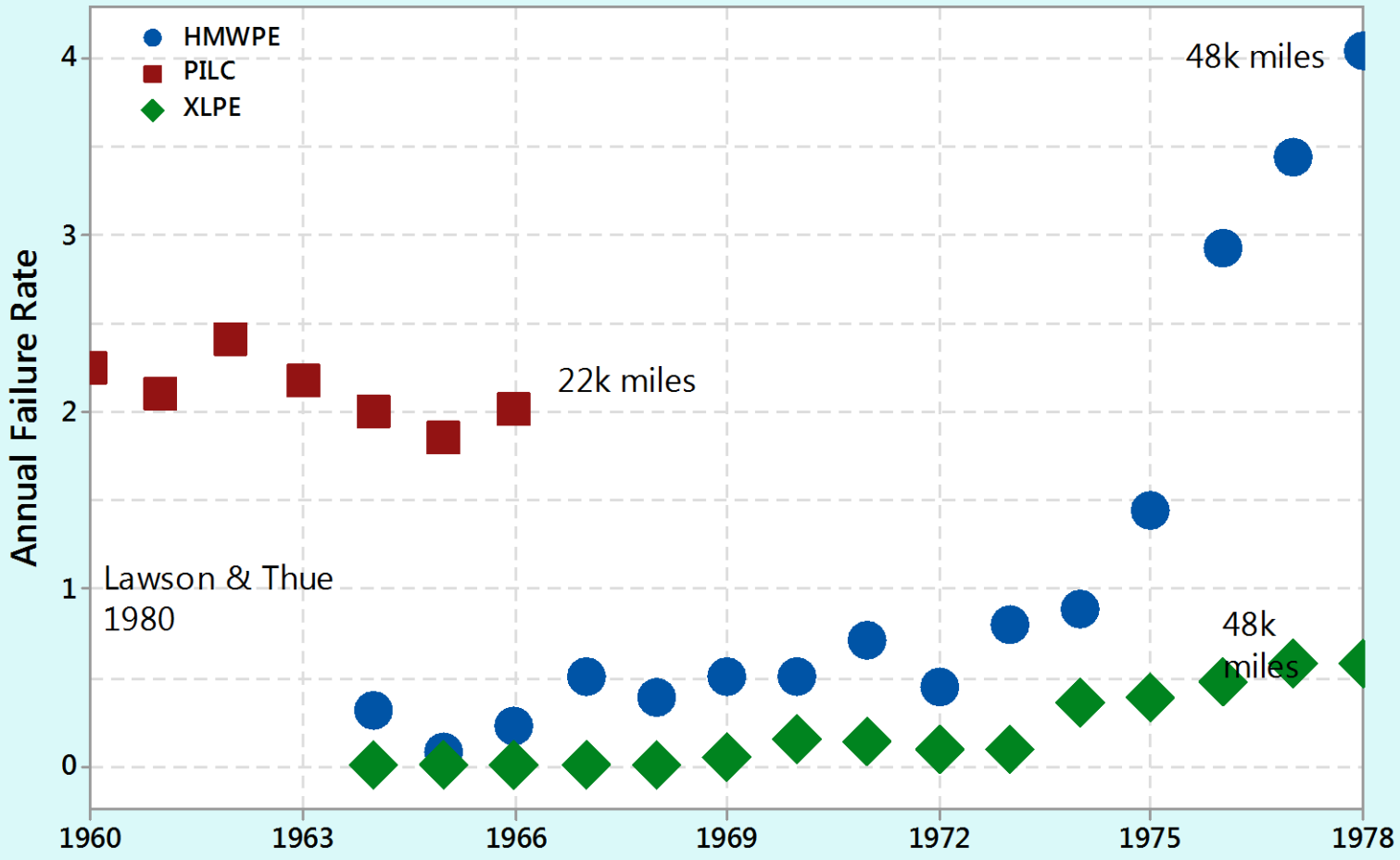
Outline

- 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



Todays Industry Outlook

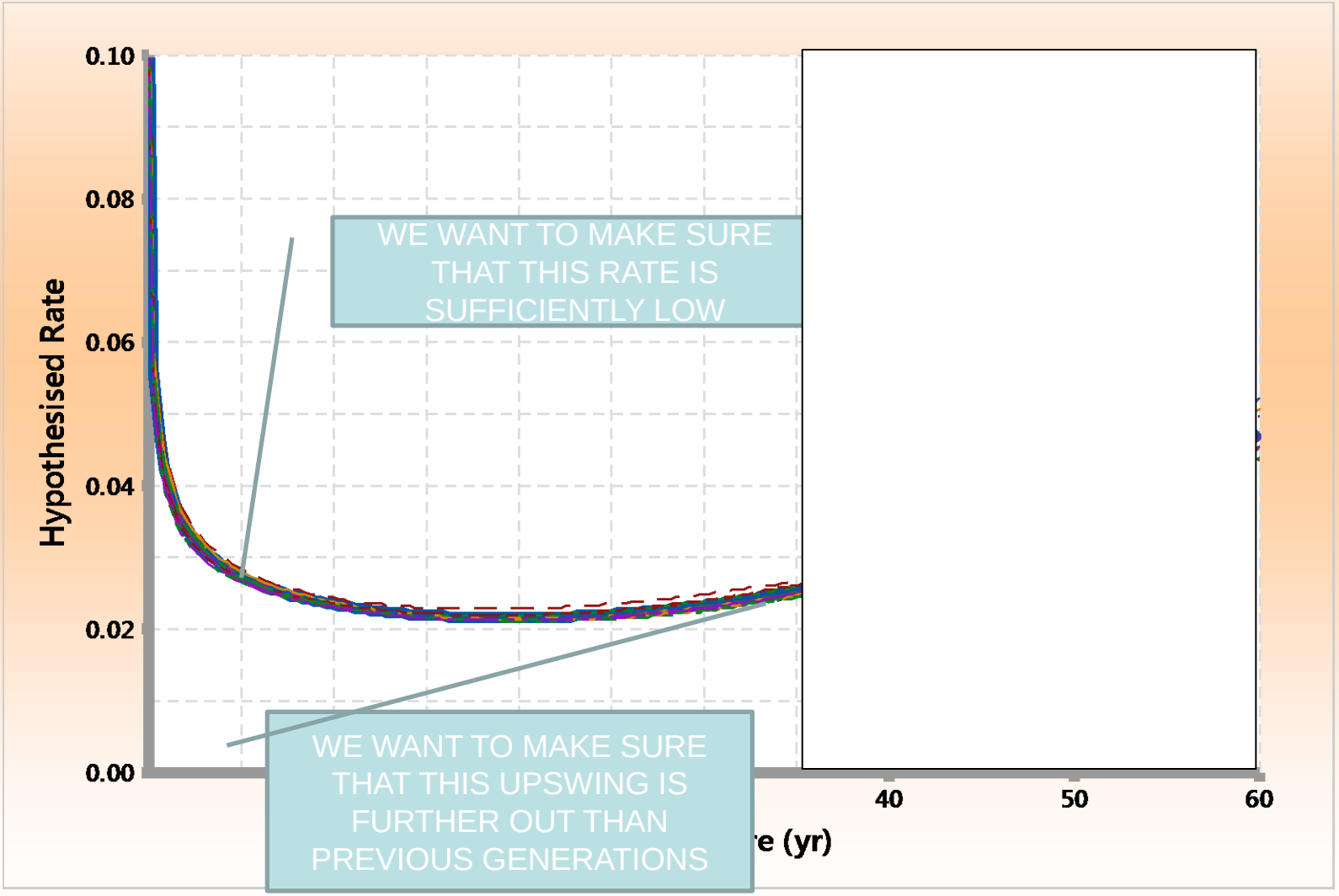
- Investment: $5-6 Billion predicted between 2010 & 2030
- Ageing Infrastructure: EEI indicates that utilities believe
  - 4 % of Distribution Infrastructure is at End Of Life
  - 41% is Distribution Infrastructure is Near End Of Life
- Increasing demand for Reliability: ASCE estimates the average cost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

We will be:

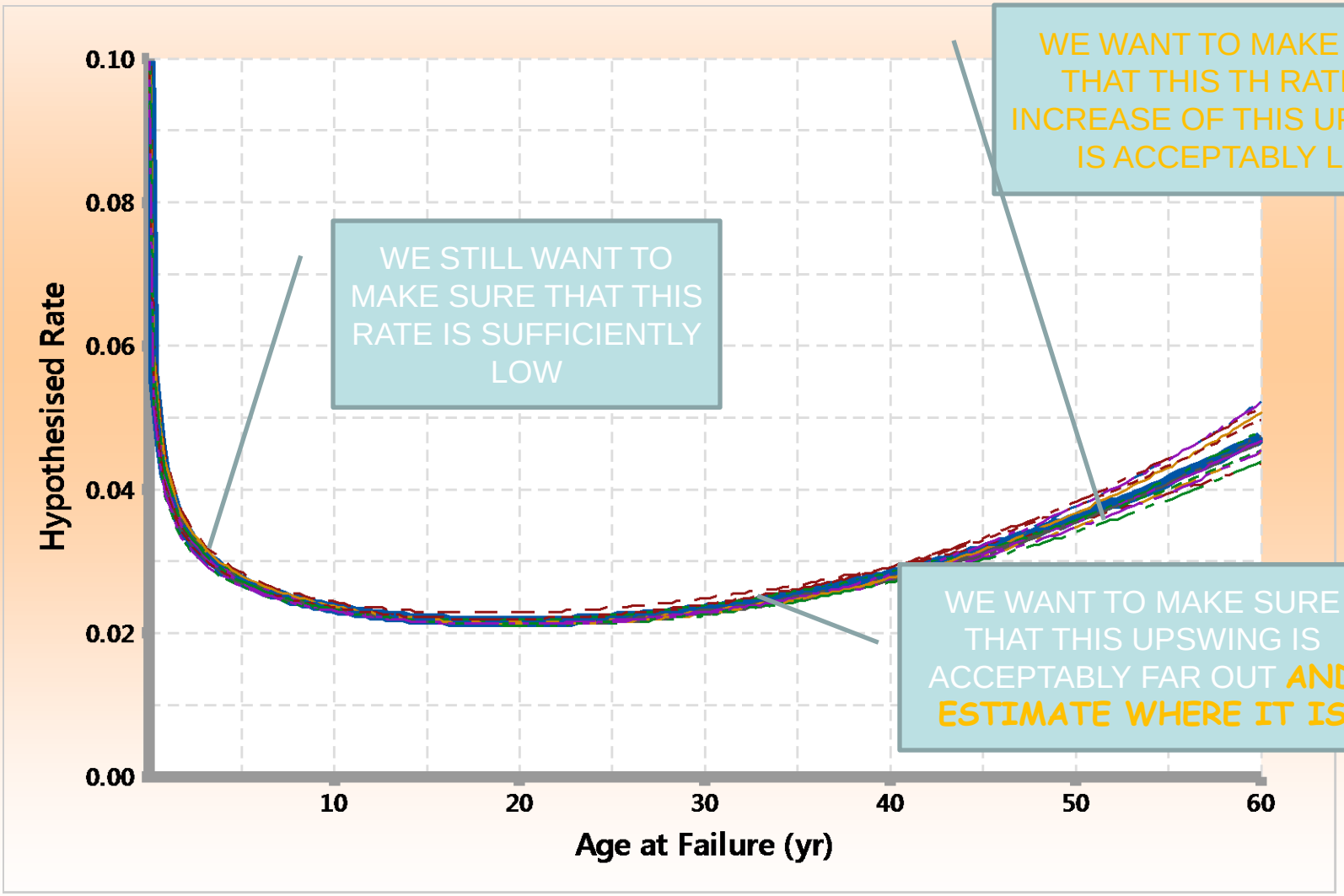
- Asking for more
- Expecting more

WHAT QUESTIONS A UTILITY MIGHT ASK IN THE FUTURE

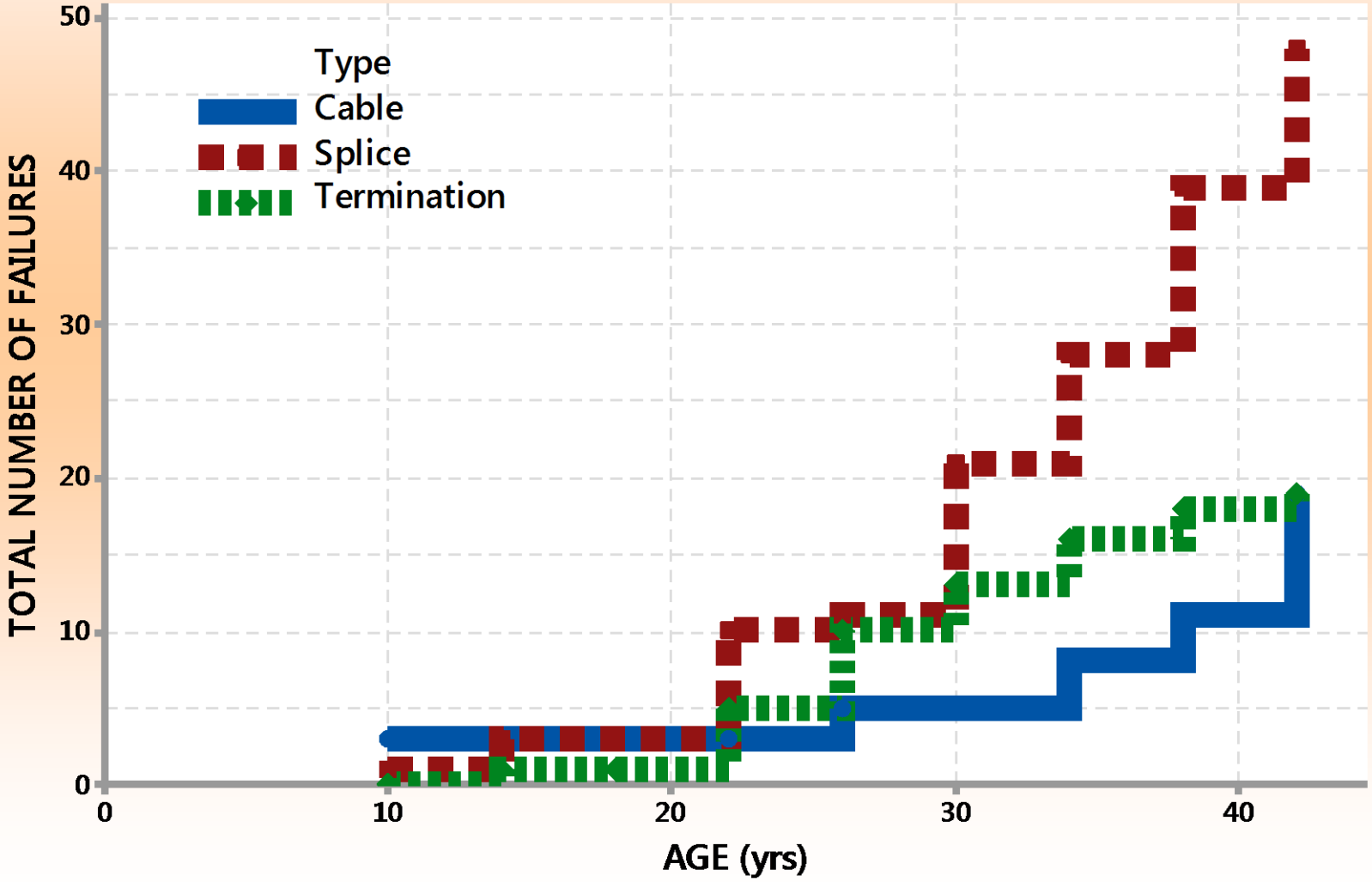
Todays Goal


0.10
0.08
0.06
0.04
0.02
0.00
Hypothesised Rate
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
40
50
60
e (yr)

Tomorrows Goal

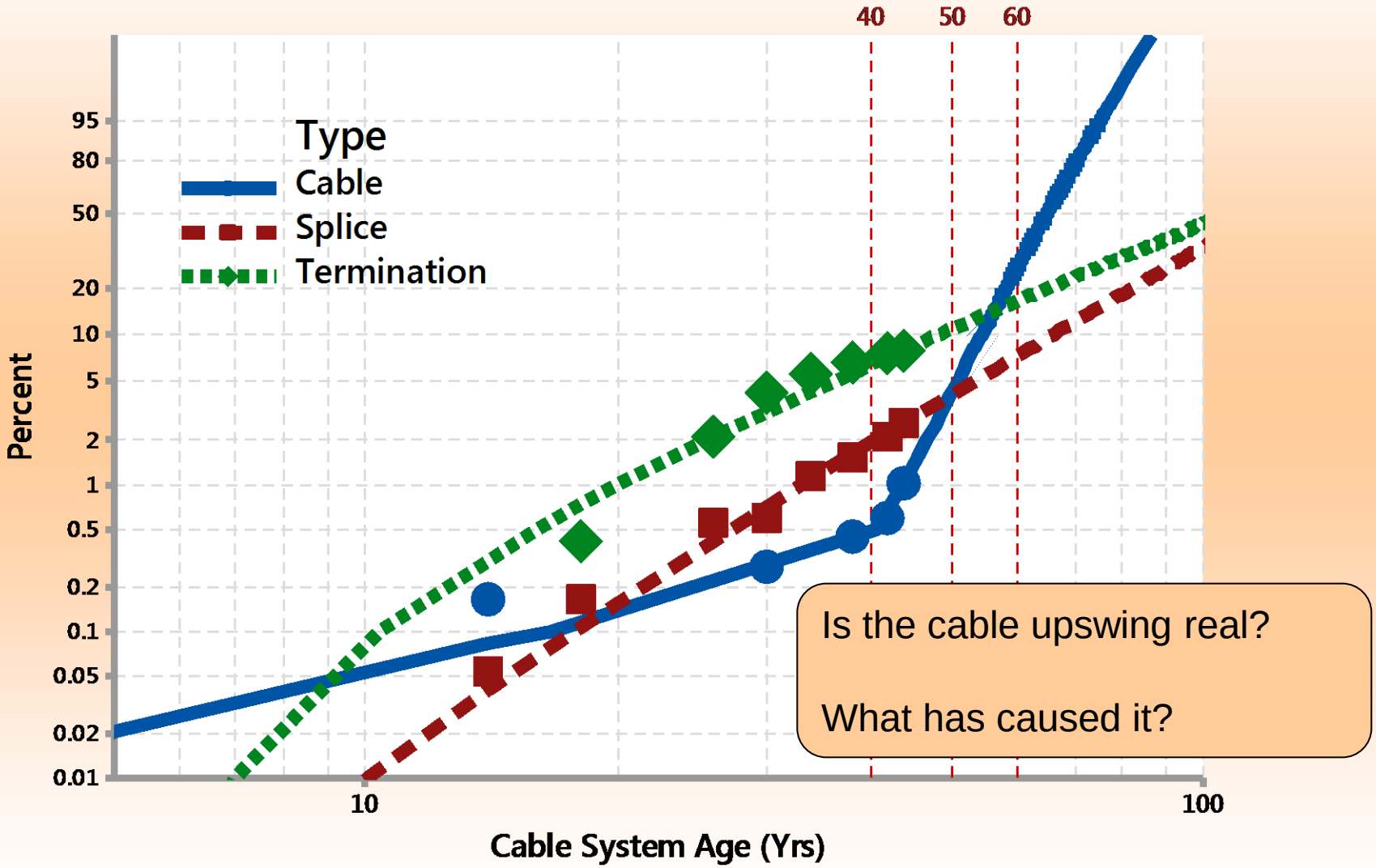


Aged Cable System



- 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?

Prognosis from Failures

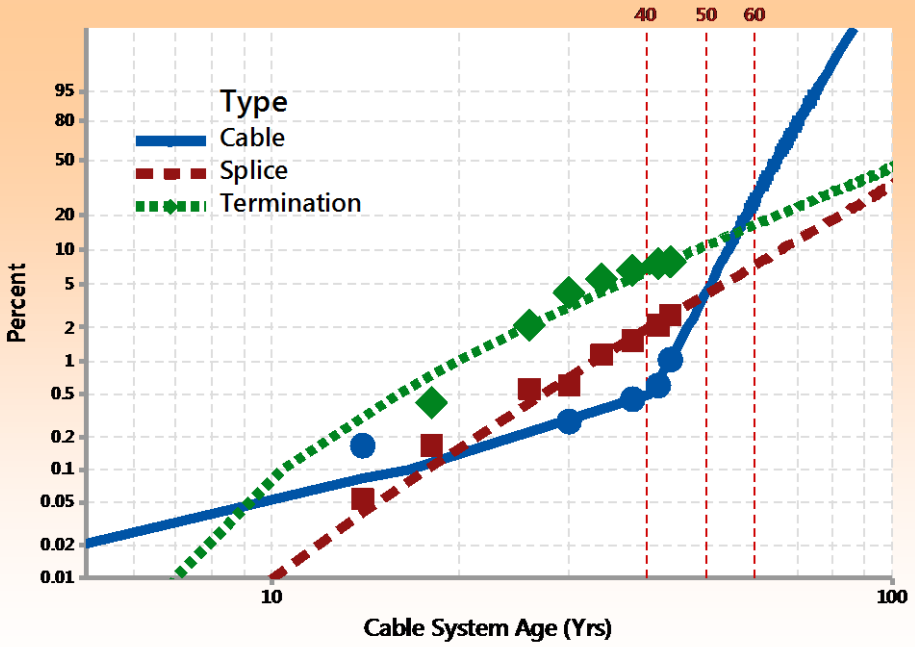


LIFE EXPECTANCY OF AN INSTALLED SYSTEM

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



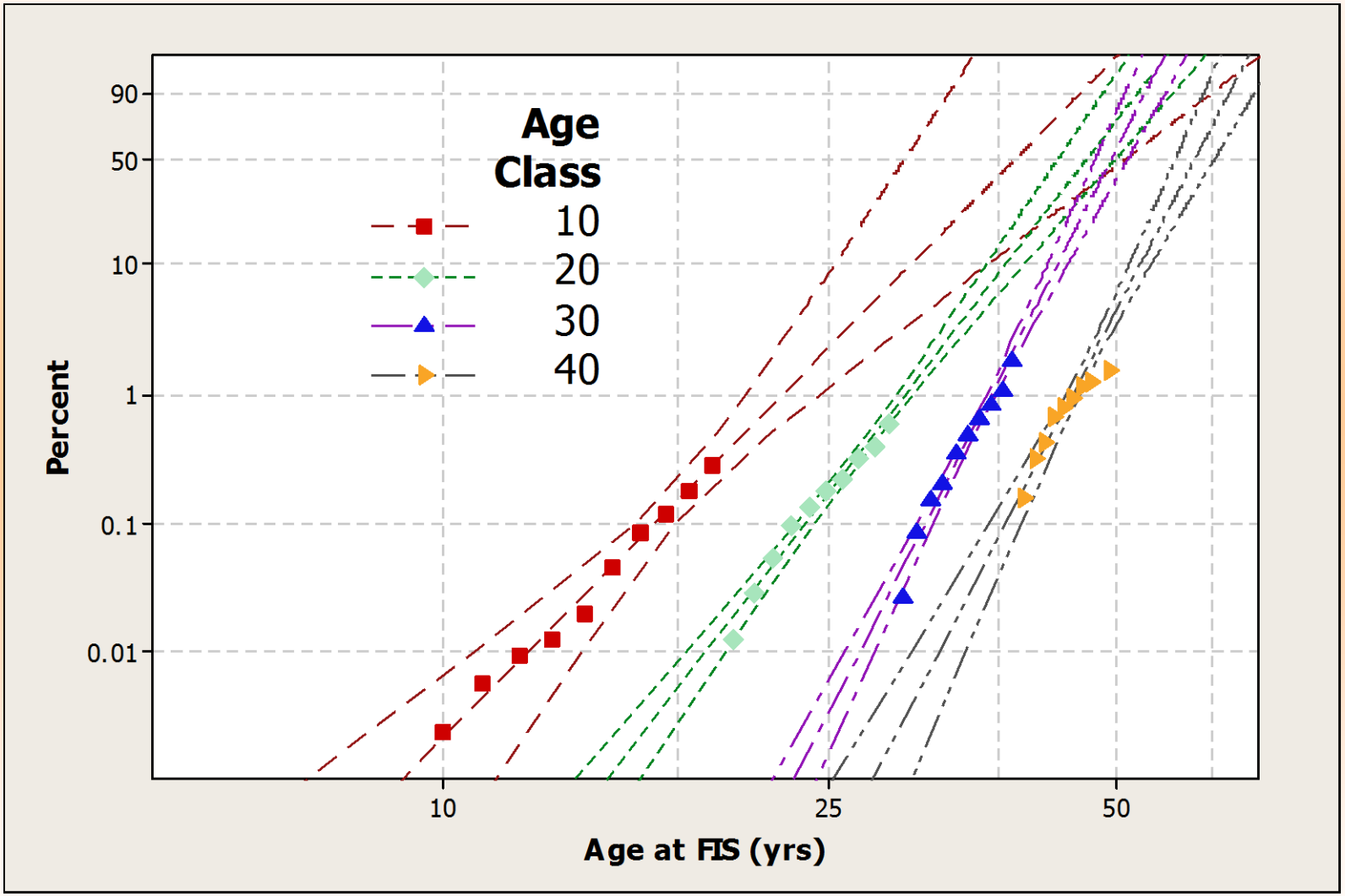
For an XLPE cable system under normal operating conditions and moderate loading installed in ducts 95% of cables and splices will survive to age 50

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

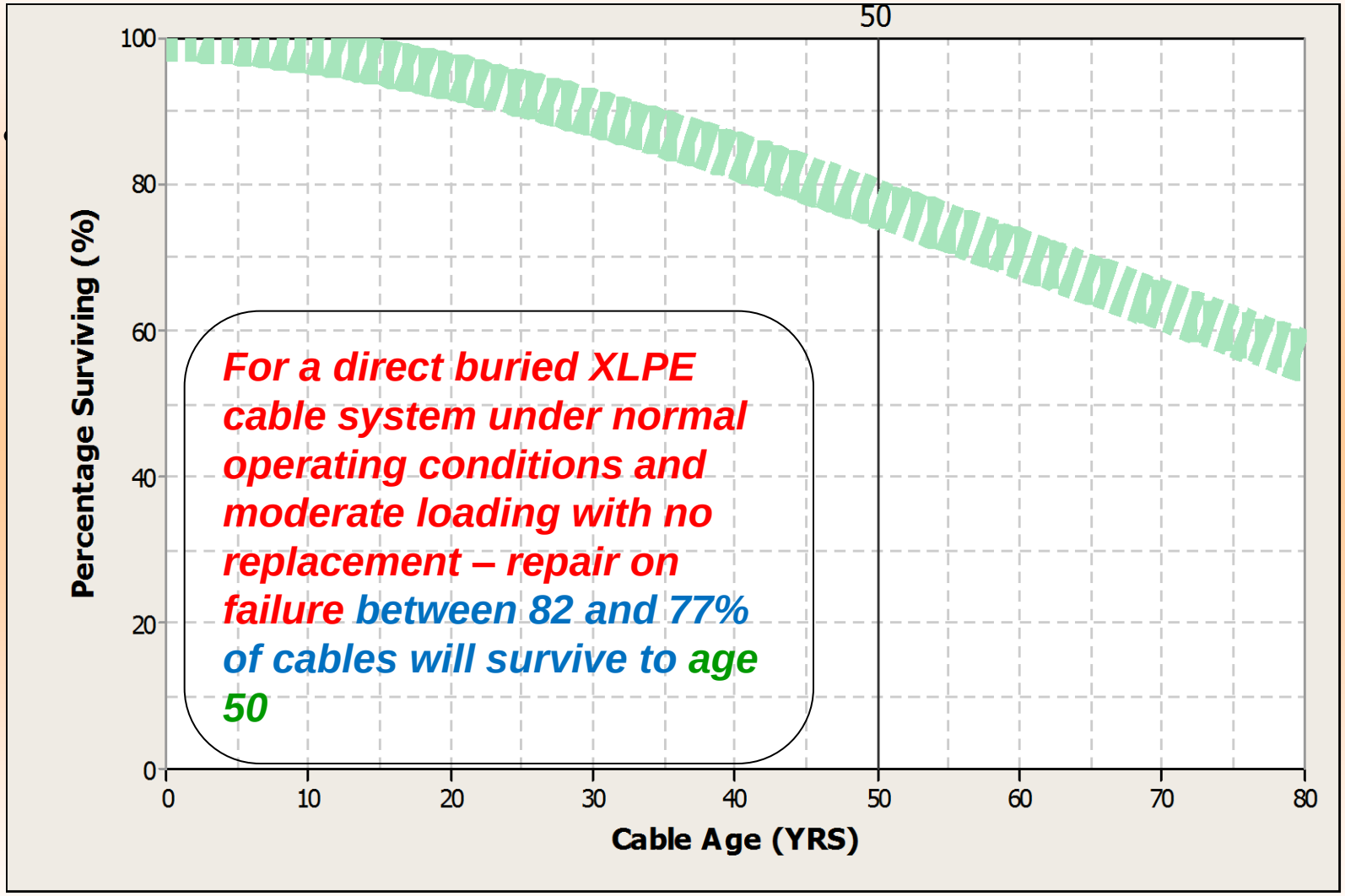
- If failure data is available
- If failure data can be estimated from recent failures – see Hampton & Perkel ICC Fall 2014 Sub A
- Ageing modes have been consistent

Age Segregated Failures



see Hampton & Perkel ICC Fall 2014 Sub A

Estimated Combined Survival Curve



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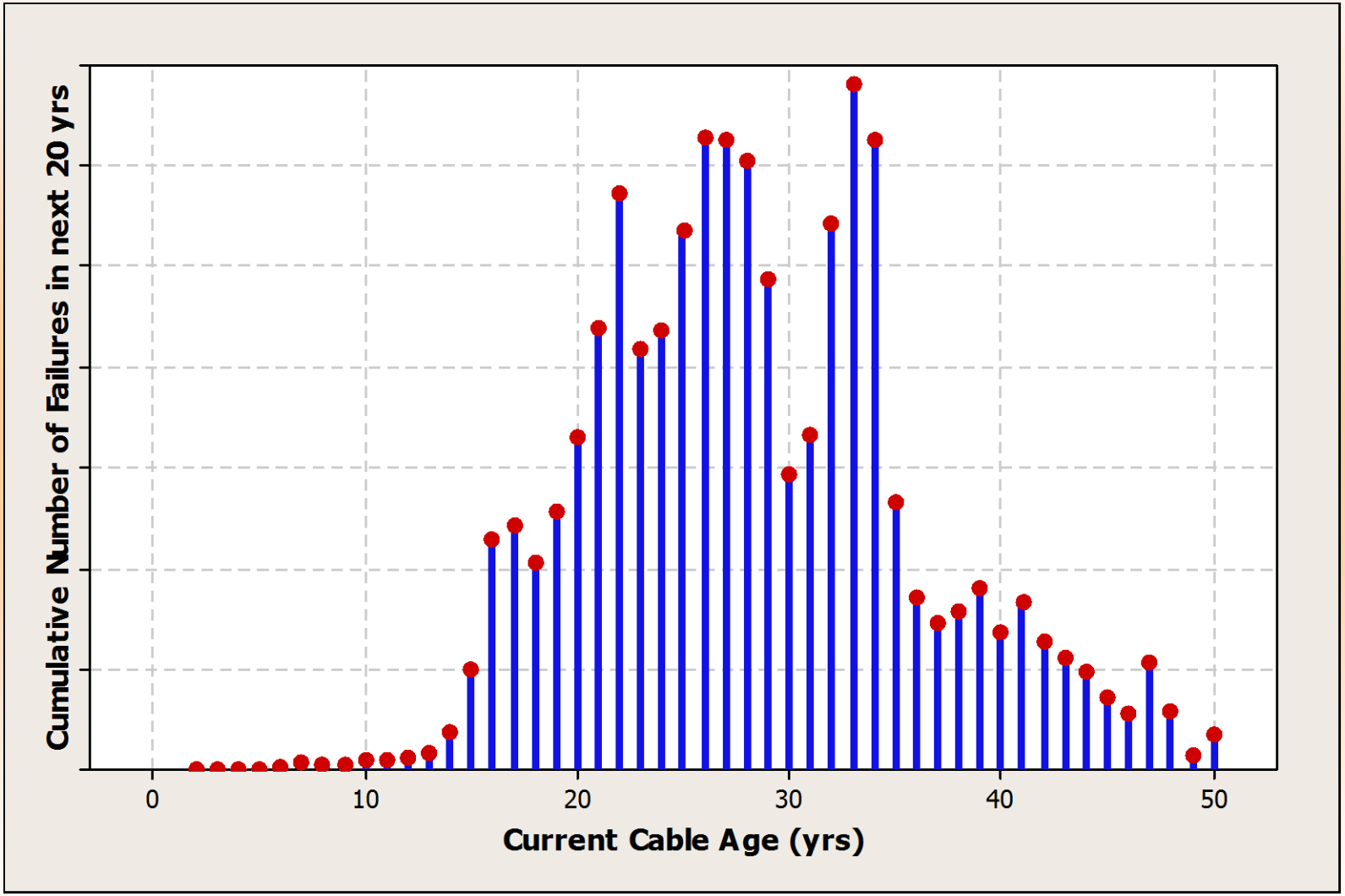
Failure In Service Prognosis



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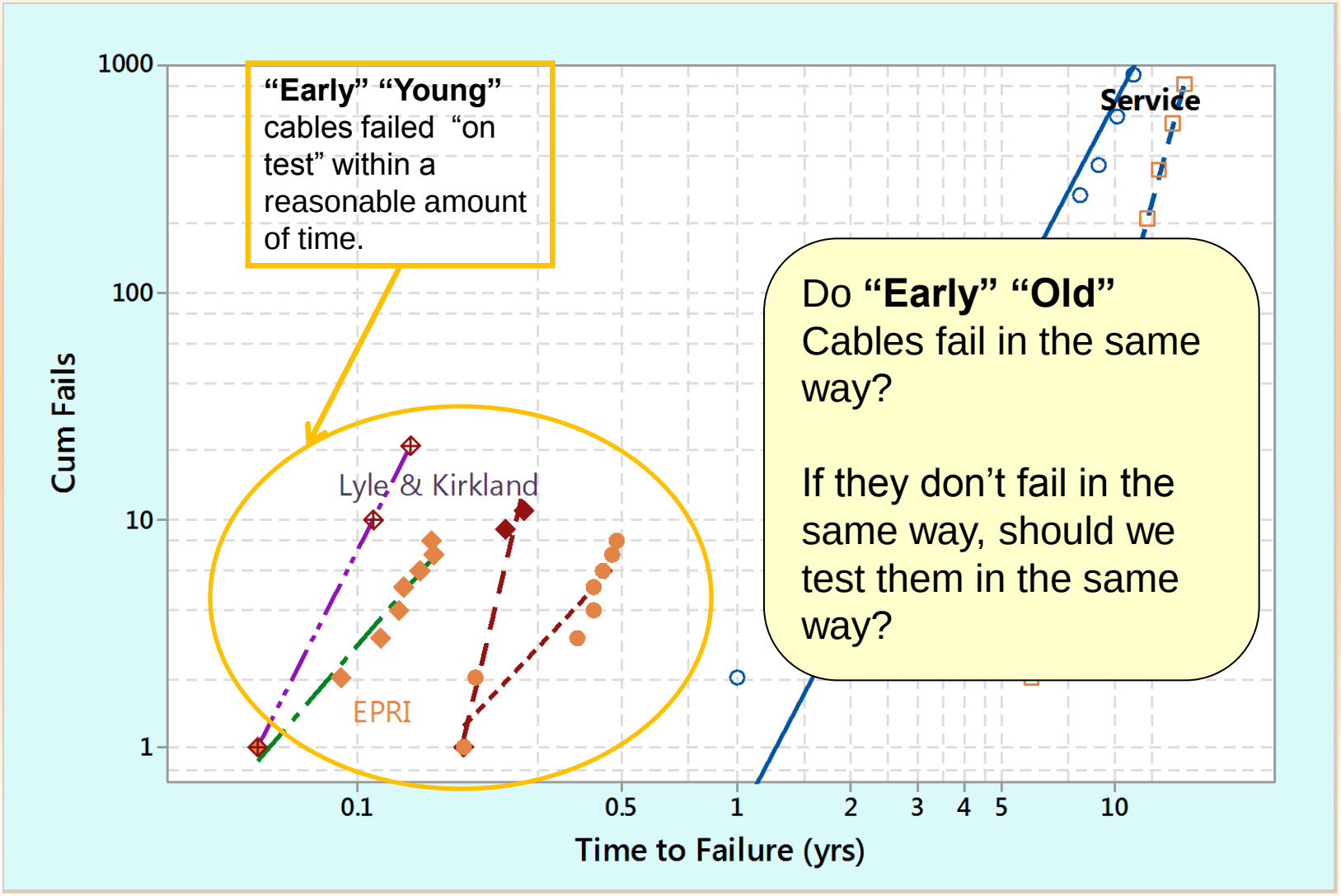
If data is not available can testing help us?



Future Testing Needs

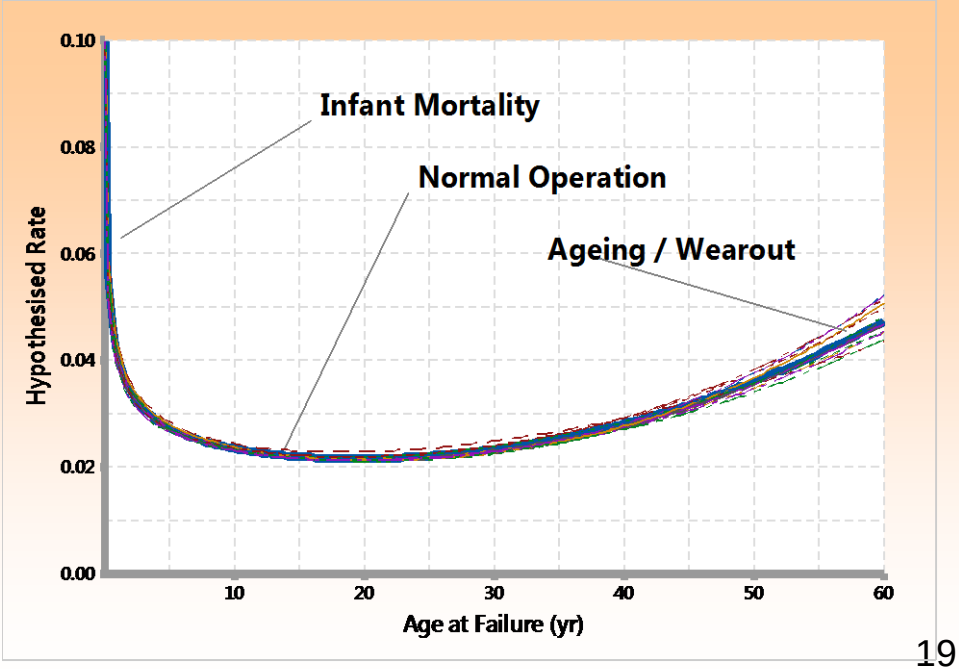
We need accelerated aging tests to:

- 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"

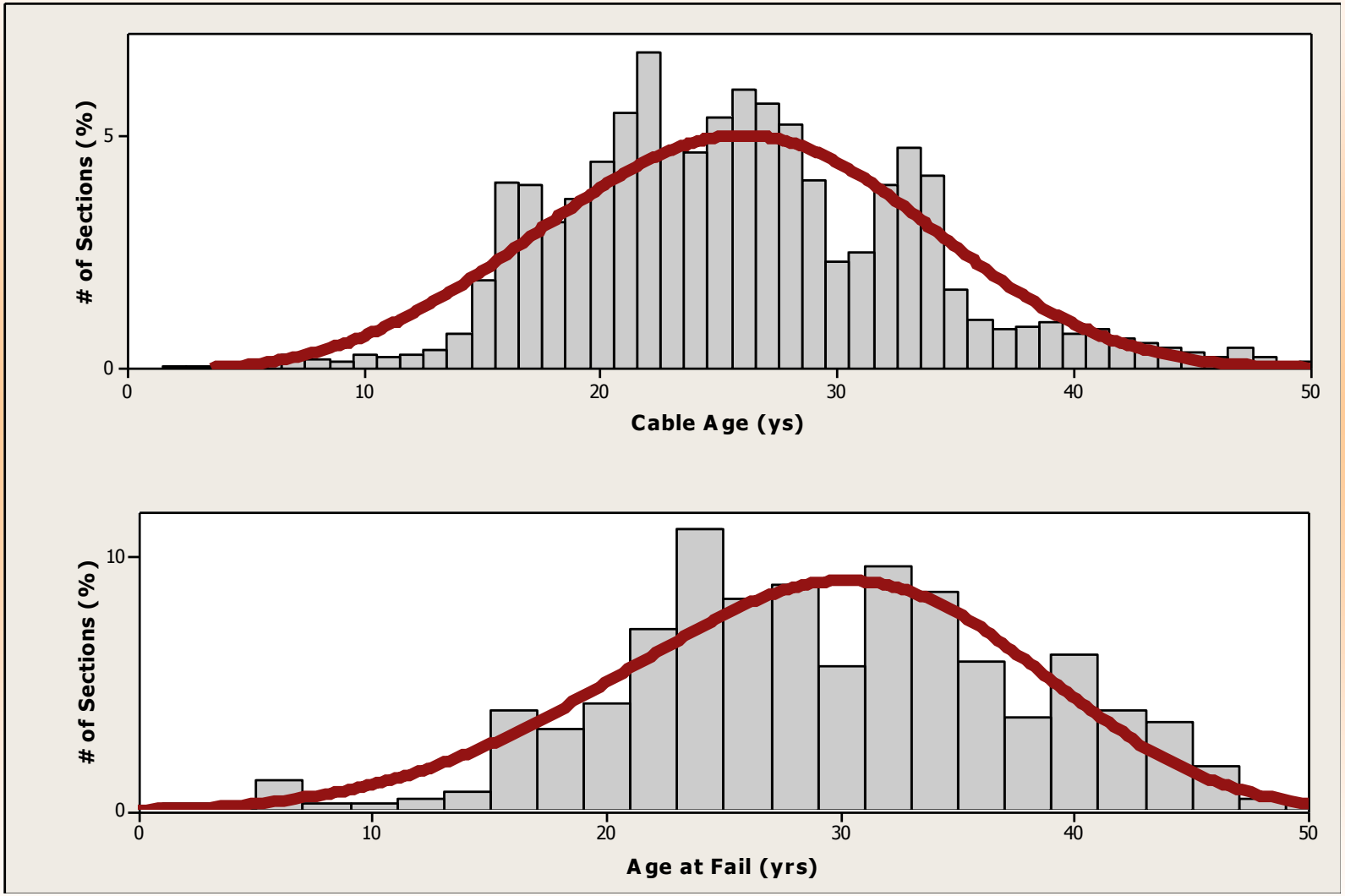
Take the opportunity to:

- ***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



Refurbishment Approaches

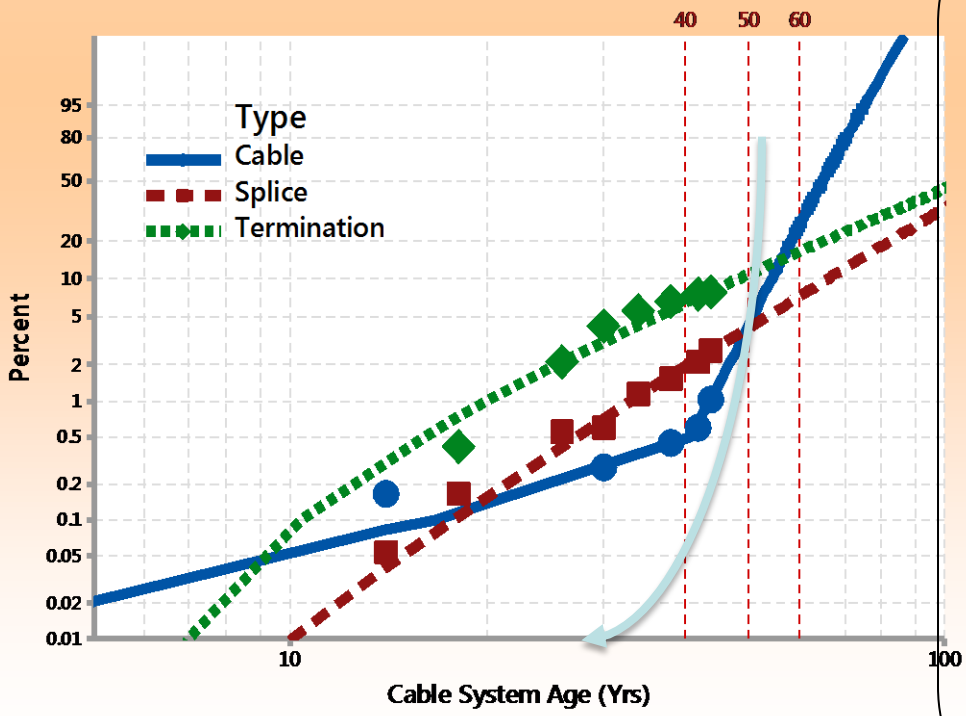
- Replace with new
  - Cable section
  - Joint
  - Termination
- Rejuvenate

- 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 un known 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