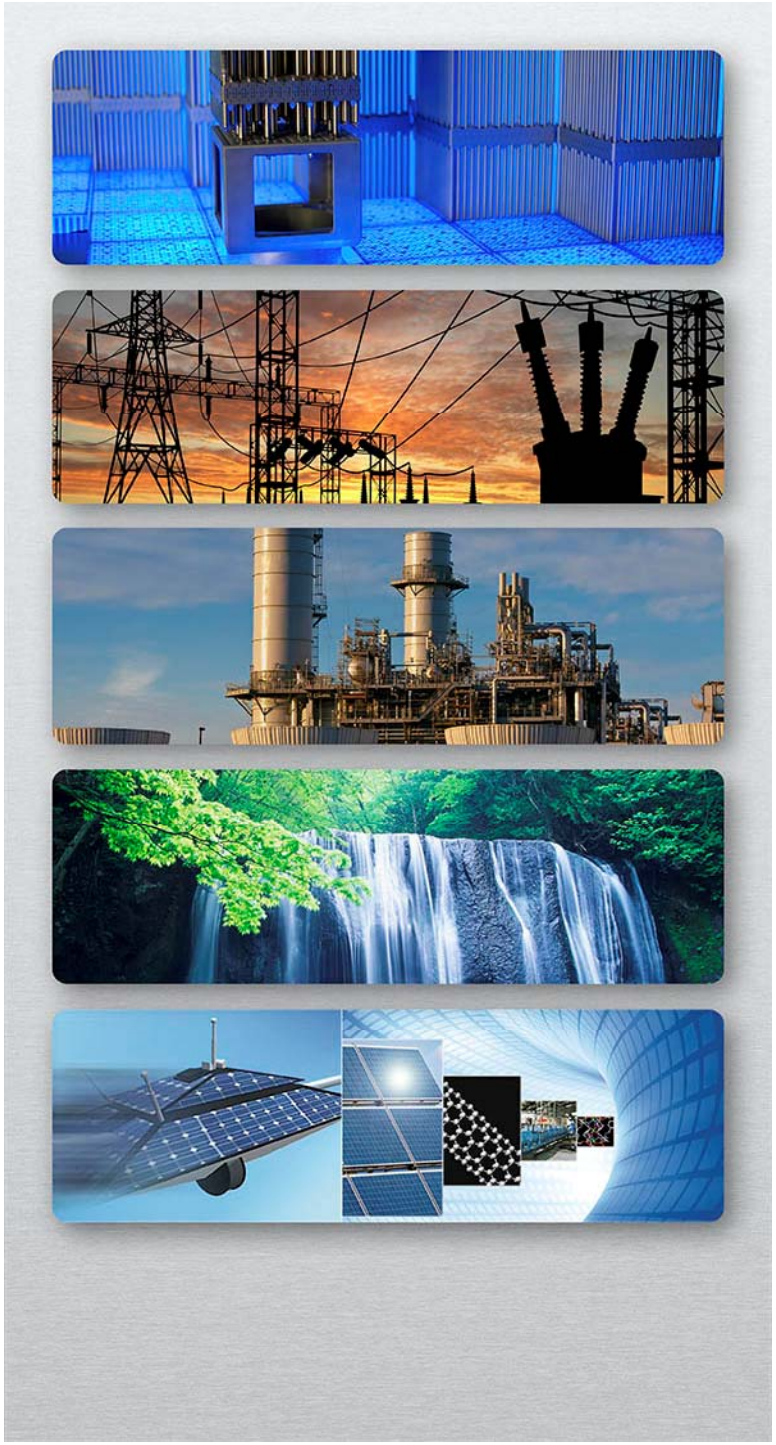


EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Cable System Aging Management Implementation and Its Affect on Cable System Longevity

Gary Toman
704-595-2573
gtoman@epri.com

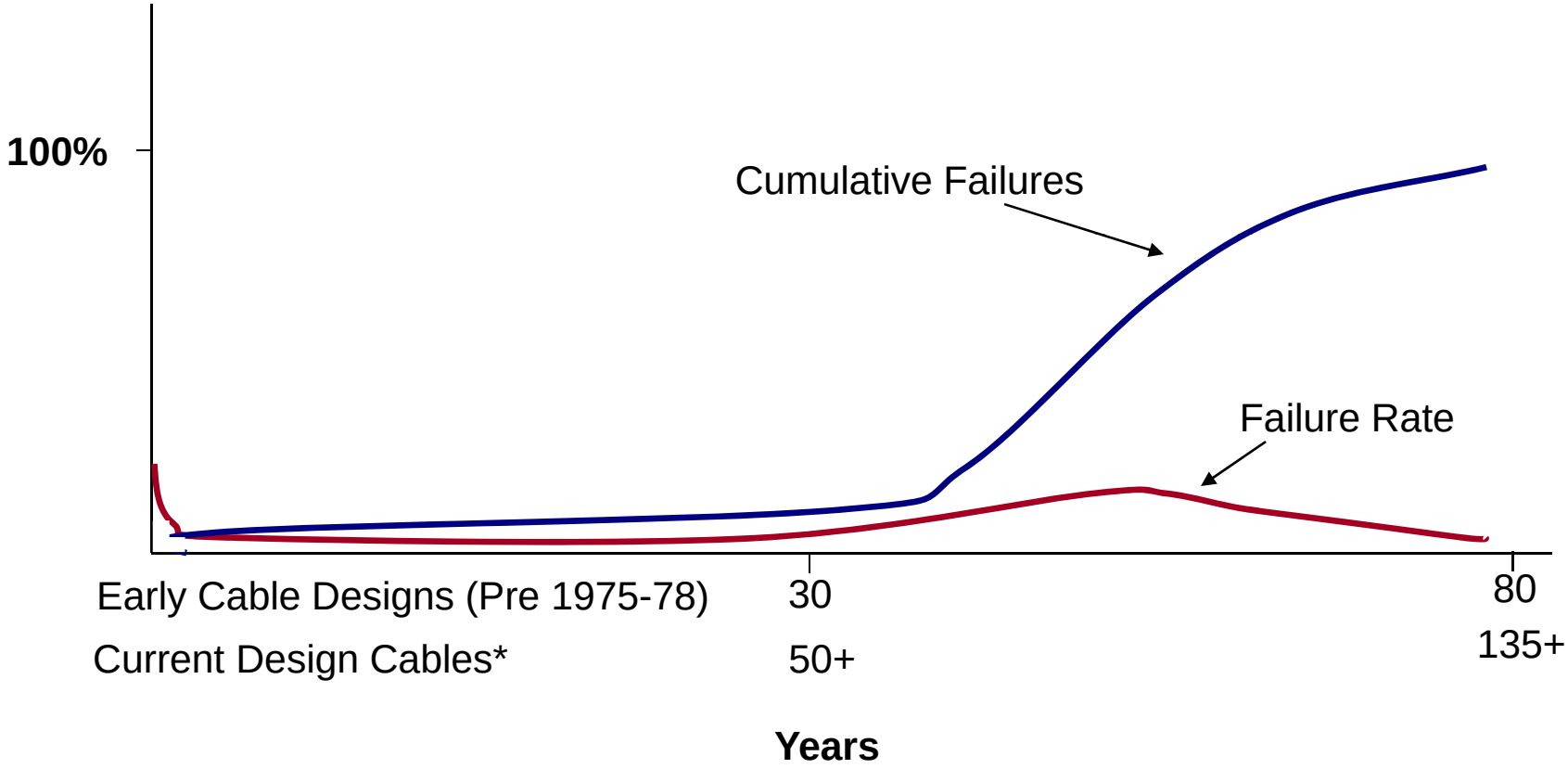
Topics

- Aging and Wearout of Medium Voltage EPR cables
- Cable Aging Management Implementation
- Replacement Issues and Predictions

Aging and Wearout of Medium Voltage Cable

- There is a belief in the industry that the period of cable wearout for a plants cables will be narrow
- Statistical evidence indicates that this is not true
- While the first failure in a wet medium voltage cable population may occur at approximately 30 years, the last failure, if all of the cables were allowed to run to failure, would occur at approximately 80 years
- Given that the failure distribution is quite broad and that the failure rate does not increase inordinately, a strategy of test and replace on condition is applicable

Wet Medium Voltage Failure Rate (EPR Cables)



* Except UniShield Design

Inferences for Wet Medium Voltage Cables

- Plants having early style EPR medium voltage cables will begin to see cable wearout at about 35 years
- A small percentage of cables have to be replaced each outage
- Once replaced the new style cable should have lives that last will out live a plant if it runs to 100 years
- Plants will experience a very wide distribution in end of life from wearout and a replacement based on condition strategy seems logical and replacement costs will be distributed and should be predictable

Cable System Aging Management

- Plants are implementing cable system aging management based on commitments to the NRC and INPO
- This aging management applies to medium voltage, low voltage power, and instrument and control cable
- The scope of the programs is the same as covered by the Maintenance Rule
- The programs focus on cables in adverse environments (wet, elevated thermal and/or radiation, chemical, etc. environments)

Aging Management Implementation Guidance

- In 2010, EPRI issued three cable system aging management implementation guides:
  - 1020805 for Medium Voltage Cables (4160V+)
  - 1020804 for Low Voltage Power Cables
  - 1021629 for Instrument and Control Cables
- Separate guides were developed due to the differences in concerns and test methods applicable to the different classes of cables

Aging Management Implementation Issues

- Technology for aging management exists. However, in-plant implementation has been limited and we are at the start of the learning curve
- To allow electrical testing of medium voltage cables, separable connectors need to be installed (Note: Such connectors will improve the ability to test motors as well)
- Adverse environment assessments will be based on plant walkdowns and evaluation of identified thermal, radiation, and chemical conditions that are identified
- Once adverse environments are identified and managed, wholesale replacement of cables will not be necessary and replacements that are necessary will be distributed over long periods

Replacement of Connected Components

- Switchgear, load centers, and motor control centers are likely to be replaced at least once
  - Cabling may not match layout of new equipment and need to be replaced
- Instrumentation and signaling is likely to transition to fiber optic eliminating need for many instrumentation cables
- Electrical containment penetrations are likely to have to be replaced due to age especially for older plants with early designs

Replacement Issues and Predictions

- Low and medium voltage power cable will continue to be needed but some is likely to have to be replaced due to age if it is in adverse environments or interface issues with new equipment occurs
- Replacements due to aging will be distributed over a long period
- Instrument and control cable is likely to be eliminated to a great extend as fiber optic based signaling is implemented
- In-containment instrument and control cable is likely to remain in service but have to be replaced unless high radiation fiber optic systems are developed
- Most or all cabling in containment and connecting to containment will have to be re-terminated due to electrical penetration replacements (earlier plant concern)

Replacement Issues and Predictions

- Abandonment of cables in-place may not be allowed if replacement cables need to use the same tray systems due to seismic loading of trays
- Abandonment of a significant portion of the cabling system may add too much fire load as well
- Removal of cables from trays when other cables will remain may be a significant problem due to th entangled condition of cables in the trays
- Switchyard control and instrument cables may have to be replaced due to hard service (water, rodent damage, etc.)

Positive Side

- A small number of fiber optic cables will replace a much larger population of instrument and control cables
- Careful selection of replacement cables will allow longer life and only one replacement especially for medium voltage cable
- Options will exist for redesign of cable layout allowing cable to be located out of harm's way
- Selection of termination devices for replacements that allow easy disconnection for testing of loads and cables separately.

Questions??

Together…Shaping the Future of Electricity