MV Cable Life Extension Technology

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Failures are Imminent

- While the failure rate for cables installed after 1985 is about 1 failure per 160 kilometers per year, the failure rate for pre-1985 vintage cable is typically 20 failures per 160 kilometers per year.
- 75,000 distribution cable failures per year on PE and EPR cable installed before 1985 - affects 8.6 million Americans each year.
Water Intrusion Sources

- Manufacturing process
- Storage
- Installation
- *Diffusion*
- Dig-in or failure
- Flooding
- Termination leaks
Water Trees

Vented Water Tree

(Shown here with Electrical Tree)

Vented water trees are generally initiated at protrusions on the interfaces between the dielectrics and conducting materials.

The visible tubules in the water trees are tracks which have been oxidized to form water-filled channels.

Bow Tie Water Tree

Bow Tie water trees usually initiate inside the bulk of the dielectrics at voids or contaminations.
Electrical Trees

Untreated, water trees become electrical trees, which cause failure in days or weeks.
Degradation Profile

Typical Performance of pre-1980 vintage XLPE Cables

“The [AC breakdown] values obtained were at best 1/3 of the level generally regarded as normal for … new cable (31.5 kV/mm).”

Source: Characterization of Failed Solid-Dielectric Cables: Phase 2, EPRI EL-5387, project 1782-1, Final report September 1987.

Cables with less than 15.75 kV/mm are “poor”

After the first decade, the degradation slope makes it difficult to distinguish “poor” from “bad”
How CableCURE® Works

- CableCURE® dielectric enhancement fluid is injected into the conductor strands.
- The fluid rapidly diffuses from the conductor strands into the solid dielectric material.
- Once inside the insulation, the fluid repairs the damage caused by existing water trees and other dielectric defects.
- CableCURE® also retards the growth of future water trees and extends the life of even badly-aged cable by more than 20 years.
The CableCURE® Process

- De-energize, test and ground cable.
- Inspect manholes, enclosures devices and cable.
- Apply TDR (Time Domain Reflectometer).
  - Confirm actual cable length.
  - Confirm condition of neutrals.
  - Verify number of splices and locations.
Cable Tracking System (CTS)

- Each TDR is carefully analyzed by our technicians in the field.
- Detailed Cable Field Reports (CFR) are completed and saved to our network, along with TDR waveforms.
  - Each is assigned a segment number in our Cable Tracking System (CTS) and saved as permanent serialized record.

Customers access their CTS data via our website.
Install Injection Terminations

- Injection elbows or live-front injection adaptors typically retrofit. They are installed and remain permanently on the cable.
- Cable may then be re-energized, minimizing the duration of any service interruptions.
**Flow & Pressure Tests are Performed**

- Nitrogen is injected into one end of cable.  
  (Typically at 69 – 135 MPa)
- Outflow is measured at other end and pneumatic resistance is calculated.
- Cable is pressurized from both ends and flow is monitored to ensure there are no leaks.
Treat – Low Pressure Injection

- A feed tank injects fluid into the cable. (Typically at 69 – 135 MPa)
- A vacuum tank is placed on the collection end to hasten the fluid through and ensure a thorough fill.
- CableCURE® fluid travels completely through the cable. (Typically overnight)
- Once the cable is flushed and filled, the vacuum tank is removed and a permanent cap is installed.
Diffusion

- The CableCURE® fluid rapidly diffuses from the strands into the insulation.
- Inside the insulation, CableCURE® fluid reacts with the water in the tiny micro-voids and fills them with a dielectric oligomer, repairing the damage.
- Since the molecules of the resulting oligomer are 47 times larger than water molecules, they lock into place and retard the growth of future water trees.
Silicone Treatment

“The obtained [AC breakdown] values are comparable to voltage breakdown values of new cables manufactured in the late Seventies.”
For a 175 mil (4.44 mm) thick insulation this is 50.5 kV versus 163.3 kV!

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Why CableCURE®?

- CableCURE® treatment remedies the damage caused by existing water trees.
- The superior tree retardant properties inherent in CableCURE® fluid retards future tree growth.
- Service life of even badly aged cable is warranted for an additional 20 years.
- CableCURE® service is typically 3 to 6 times more productive than cable replacement.
- CableCURE® service is substantially less expensive than traditional cable replacement.
- The process is clean, quiet, and not intrusive to electric customers.
- Enables you to cost-effectively preempt interruptions due to cable faults.
CableCURE® Facts

- Over a 25-year period, 36350 km of the worst performing cable in the world have been treated with CableCURE® fluid.
- Customers worldwide have utilized CableCURE® technology to improve reliability.
- Typically, 70-80% of targeted cables are treatable.
- CableCURE® technology has allowed our customers to save two billion dollars in replacement costs!