

Briefing On Potential Common-mode Failures of Medium Voltage Underground Cables



NRC PUBLIC MEETING WITH NUCLEAR ENERGY INSTITUTE
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PURPOSE

To engage the nuclear industry in an issue that the staff has identified regarding the potential common-mode failure of medium voltage underground cables



AGENDA

- Cable Failure Problems
- Safety Concerns
- Risk Insights
- Regulatory History
- Past Efforts
- Request to Industry
- Cable Monitoring Techniques



CABLE FAILURE PROBLEMS

- MV cables in inaccessible locations such as conduits, cable trenches, cable troughs, duct banks, underground vaults or in other direct buried installations can fail due to insulation degradation resulting from continued submergence.
- Since 1988, 23 License Event Reports (LERs) have been identified as failures of buried MV cables where water treeing appears to be the common cause.



SAFETY CONCERNS

MV underground cables supply power to several loads and the ones that are not generally energized may remain dormant with failure.

- Some of the cable failures could cause the following
 - Loss of offsite power to safety buses
 - Loss of service water
 - Loss of emergency service water



RISK INSIGHTS

As the cables continue to age, the probability of more than one cable failure during an accident becomes high.

- Loss of offsite power causing a plant trip and loss of two cables from EDG to safety buses CCDP 10^{-2} to 10^{-1} (Loop, Plant Trip, and 2 EDG cable failures)
- Loss of service water and ESW with reactor trip CCDP 8.2×10^{-2} (SW and ESW unavailable after reactor trip)
- Loss of offsite power through the loss of feeders to safety buses CCDP mid 10^{-5} to 10^{-4} (Loop with EDGs remaining available)
- Loss of power feed to service water pump with a reactor trip CCDP 2.3×10^{-6} (Reactor Trip and Loss of power to Service water pumps)

The above Conditional Core Damage Probability (CCDP) assumes reasonable recovery times of about 1-2 hours. If grid conditions prohibit a normal offsite power recovery, the risks will increase.



REGULATORY HISTORY

Information Notice 2002 - 12

Addressed the cable failures at Oyster Creek and Davis Besse as well as several other plants that had long term flooding problems in manholes in which safety related cables were submerged.



Chronology of the Medium Voltage Cable Issues

- 02/99 Davis Besse 1, 4160V Okonite cable failure (Service Water Pump #2)
- 12/99 Calvert Cliffs renewal application requesting an aging management program for in-scope medium voltage cables subject to water treeing failures
- 12/00 Duke Power (Oconee) describing an aging management program for in-scope medium voltage cables subject to water treeing failures
- 04/01 The proposed aging management program was incorporated into NUREG-1801 (GALL)(XI E.3)
- 2003 ACRS concerns on technical adequacy of the GALL aging management program (XI E.3) for medium voltage cables was to be evaluated by NRR as a Part 50 issue instead of Part 54 issue
- 06/03 Confirmation of subject issue applicable under Part 50 for operating reactors
- 02/11-2/04 NRR (EEIB) & RES participated in EPRI Cable Condition Monitoring technology meeting and received unsolicited comments on February 2004 staff letter to NEI



REQUEST TO INDUSTRY

In light of the potential of more than one cable failing, the industry was requested to develop and present any proposals to resolve this issue. (ML 040370628)



CABLE MONITORING TECHNIQUES

- Partial discharge test
- Dissipation factor testing
- Very low frequency AC testing
- Time domain reflectometry
- DC step-voltage test

The technology continues to evolve with better methods to detect degradation of cable insulation