February 8, 2012

MEMORANDUM TO: AFPB File

FROM: Alexander R. Klein, Chief**/RA/**
Fire Protection Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: CLOSE-OUT OF NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805 FREQUENTLY ASKED QUESTION 08-0053, "KERITE-FR CABLE FAILURE THRESHOLDS"

Frequently Asked Question (FAQ) 08-0053 was proposed through the Nuclear Energy Institute (NEI) National Fire Protection Association (NFPA) 805 Task Force, to clarify the Kerite-FR[1] cable failure thresholds. It proposed that Kerite-FR cable should be treated as a thermoset material cable, consistent with the original guidance in NUREG/CR-6850, Appendix H, contrary to the treatment of Kerite-FR cable as amended in the Errata sheet for NUREG/CR-6850, dated August 30, 2007, and in IMC-0308, Attachment 3, Appendix F, Section 6.2.3.3.

The FAQ proposed that the existing industry guidance for the treatment of Kerite-FR cable as amended in the Errata sheet not be implemented. That is, the amendment to treat Kerite-FR cable as a thermoplastic instead of thermoset cable should be revoked based on reanalysis of the referenced test data.

Background

IMC-0308, Attachment 3, Appendix F, "Technical Basis, Fire Protection Significance Determination Process (Supplemental Guidance for Implementing IMC 0609, App F) at Power Operations," February 28, 2005, Section 6.2.3.3, Task 2.3.3; "Identify Nearest Ignition and Damage Targets," specifies the nearest ignition and damage temperature for Kerite-FR cable. Based on NUREG/CR-5655, "Submergence and High Temperature Steam Testing of Class 1E Electrical Cables," the Fire Protection Significance Determination Process (SDP), Section 6.2.2.3, Task 2.3.3, recommended the failure criterion for Kerite-FR be 307 °F, i.e., thermoplastic cable.

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[1] Kerite-FR is a trademark cable insulation product that is no longer available in the marketplace. The material was marketed by the manufacturer (Kerite) as a "cross-linked polyolefin (XLPO) material." Kerite identified their material as Fire Resistive (FR) insulated and jacketed.

To resolve this discrepancy in the failure thresholds reported in NUREG/CR-5655 and the Fire Protection SDP, vs. the proposal in FAQ 08-0053, the U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation requested that the Office of Nuclear Regulatory Research (RES) test samples of Kerite-FR cables in an ongoing RES experimental cable test program to evaluate fire induced failure thresholds. Other formulations of Kerite, FR-II, FR-III, and HT were also tested, while primary focus of this testing program was the Kerite-FR cable insulation thermal failure threshold.

1. Suggest that this statement be more specific and say that Kerite-FR damage threshold is 247°C (using thermoplastic at 205°C is overly conservative). From 7102:
"Given the relative consistency of the observed behavior, it is recommended that a temperature of 247°C be assumed as the minimum threshold of electrical failure for Kerite FR cables. This is the minimum temperature at which signs of electrical degradation were detected during the Penlight tests."
2. This Closure memo is silent on fire growth and propagation. To avoid confusion suggest including a summary of results from 7102: "Testing has verified that Kerite FR is a thermoset material (as opposed to a thermoplastic) as are the other three insulation formulations noted above. There were no signs in any of the tests that the Kerite insulation or jacketing materials themselves were melting, which is one defining characteristic of thermoplastic polymers. That is, thermoplastic materials will melt on heating and re-solidify on cooling. Thermoset materials will not melt, but if heated to high enough temperatures, will instead char and burn. All four Kerite formulations behaved like a thermoset in this regard."

of 307°F (153°C), it is still consistent with the failure temperature of thermoplastic cable. The other three Kerite cable insulation formulations, FR-II, FR-III, and HT, did not show substantive signs of electrical degradation until they reached temperatures more typical of thermoset cable insulation performance limits. All three of the alternate formulations also displayed higher thermal damage limits than did the Kerite-FR material. Of the three alternate formulations, the Kerite-FR-II material showed the lowest damage threshold at about 646 °F (341°C). This is consistent with the lower bound estimates of thermoset cable failure thresholds. The NUREG/CR-7102 also discusses previous industry testing and results for Kerite-FR cables.

Conclusion

Based on the experimental evidence from NUREG/CR-7102 that Kerite-FR insulated cables might be substantially more vulnerable to thermal damage than other thermoset materials, it is recommended that cables insulated with Kerite-FR be analyzed using failure criteria typical of thermoplastic, rather than thermoset, materials based on NUREG/CR-7102 testing. Therefore, this confirms that the existing guidance for the treatment of Kerite-FR cable assuming a damage threshold consistent with thermoplastic properties as amended in the Errata sheet for NUREG/CR-6850, dated August 30, 2007, should be used to analyze Kerite-FR cable failure threshold criteria.

It is recommended that for future fire PRA applications and fire SDP analysis, Kerite-FR, FR-II, FR-III, and HT cable insulation thermal failure thresholds should be used from NUREG/CR-7102 not from IMC-0308, Attachment 3, Appendix F.

References

For details regarding this FAQ, please see the following:

- FAQ 08-0053, Revision 0 (Agency-wide Documents Access and Management System (ADAMS) accession number ML082660021)
- NUREG/CR-7102, "Kerite Analysis in Thermal Environment of FIRE (KATE-Fire): Test Results," (ADAMS accession number ML11333A033)
- NUREG/CR-6850/EPRI 1011989, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," Volume 1: "Summary and Overview," Volume 2: "Detailed Methodology," September 2005. (ADAMS accession numbers ML052580075 and ML052580118)
- NUREG/CR-6850/EPRI 1011989, Errata sheet, dated August 30, 2007. (ADAMS accession number ML072680691)
- IMC-0308, Attachment 3, Appendix F, "Technical Basis, Fire Protection Significance Determination Process (Supplemental Guidance for Implementing IMC 0609, App F) at Power Operations," February 28, 2005. (ADAMS accession number ML050700153)
- NUREG/CR-5655, "Submergence and High Temperature Steam Testing of Class 1E Electrical Cables," May 1991. (ADAMS accession number ML041280279)
- South Carolina Electric & Gas Company, Virgil C. Summer Nuclear Station, Engineering Services Technical Report, "Kaowool Triple Wrap Raceway Fire Barrier Test for Conduits and Cable Trays," TR07870-001, Omega Point Laboratories, May 2000. (ADAMS accession number ML092080126)
- NFPA 805 FAQ Process Document, Revision 1 (ADAMS accession number ML061660105)
- RIS 2007-19 (ADAMS accession number ML071590227)

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