May 28, 2009

MEMORANDUM TO: AFPB File

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

SUBJECT: PUBLIC RELEASE OF DRAFT INTERIM POSITION REGARDING NATIONAL FIRE PROTECTION ASSOCIATION 805 FREQUENTLY ASKED QUESTION 08-0049 CABLE TRAY FIRE PROPAGATION

The purpose of this memorandum is to release for comment the enclosed draft interim position regarding National Fire Protection Association (NFPA) Standard 805 Frequently Asked Question (FAQ) 08-0049 to the public and the Nuclear Energy Institute NFPA 805 Task Force. Comments on the enclosed draft interim position are due by July 2, 2009. Comments should be sent to one of the contacts below.

The enclosed draft interim position was previously sent for comment under the joint U. S. Nuclear Regulatory Commission's (NRC) Office of Nuclear Regulatory Research (RES) / Electric Power Research Institute (EPRI) Memorandum of Understanding process. No comments were received on the enclosed position, and it represents a consensus position on this FAQ between RES, EPRI, and the NRC's Office of Nuclear Reactor Regulation.

Enclosure:
As Stated

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FAQ 08-0049: Cable Tray Fire Propagation

Guidance for Use of Model for Cable Tray Fire Propagation in NUREG/CR-6850

Background:

Frequently Asked Question (FAQ) 08-0049 was proposed by the Nuclear Energy Institute (NEI), through its NFPA 805 Task Force, to clarify the guidance on cable fire propagation provided in NUREG/CR-6850 (EPRI 1011989), "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," for use in developing Fire Probabilistic Risk Assessments (PRAs). The FAQ authors believed that the empirical cable tray fire propagation model in NUREG/CR-6850 has led to conservative estimates of cable fire growth rates and unrealistically short room burn out times when used outside the zone of influence (i.e., outside the fire plume that extends above the ignition source).

In order to achieve closure of this FAQ in a timely manner, the U. S. Nuclear Regulatory Commission (NRC) developed an interim NRC staff position, as discussed below. This position was developed using currently existing information, databases, and experimental results, and should not be seen as prejudicing the NRC's view of future developments in this area. The staff's interim position clarifies the limits of the cable tray fire propagation model provided in NUREG/CR-6850 and provides guidance on how to model cable fire spread beyond those limits, e.g., in a cable spreading room where cable trays may run the entire upper half of the room in close proximity and in all directions.

Discussion:

Predicting cable tray ignition, fire propagation (flame spread), and heat release rate is a complex endeavor due to the multiple phenomena that are involved. The NRC's interim position is as follows.

The empirical cable tray fire propagation model, as specified in NUREG/CR-6850, when applied within the zone of influence above the burning fuel, provides times to ignition of horizontal cable trays, and angles of flame spread, immediately above the ignition source that are representative of the test results from Section 3.4 of the NUREG/CR-5384, "A Summary of Nuclear Power Plant Fire Safety Research at Sandia National Laboratories, 1975-1987," for use in fire PRAs when applied within the limits of those tests' validity. The NRC recommends that the tray-to-tray fire spread rates and angles be used only in cases that are similar in nature to these tests upon which they are based, i.e., within the configurations specified in NUREG/CR-5384. Care must be exercised whenever applying this model.

The experiment upon which this rule set in NUREG/CR-5384 is based included only cross-linked polyethylene (XPE) cables, which were constructed using thermoset materials that were not protected in any way. Therefore, if the configuration in question includes other than XPE cables, especially thermoplastic cables, that are not protected, a different rule set would be appropriate. Tests have shown that thermoplastic cables have higher heat release rates and lower damage thresholds than XPE. However, if the configuration includes cables with flammability and electrical performance characteristics that are more robust than XPE cables, or cables that are protected in some way, this rule set may be conservative, also depending on the ignition source heat release rate, etc.

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An additional important aspect that needs to be considered to evaluate the application of the rule set is the separation distance between cable trays. The testing used separation distances of 8 inches of horizontal separation and 10.5 inches of vertical separation between cable trays. If the configuration in question has separation distances greater than these, the rule set may be conservative.

The following discussion provides a means to understand the analysis of cable tray fires. In a very basic, first order analysis, one can assume thermal damage occurs the instant the target reaches its minimum failure temperature. For example, if the target is an electrical cable and it is known that the cable (thermoplastic) fails at 400 °F (204 °C), the analyst can assume failure as soon as the cable is exposed to a 400 °F (218 °C) hot gas layer (the corresponding threshold for a thermoset cable is 625 °F [329 °C]). For ignition to occur, the cable insulation must be heated sufficiently to vaporize and form a flammable pre-mixed system. We know, from thermal detector and sprinkler response, that all materials have a mass that must be heated before they can reach a target temperature. This thermal inertia is quantified as the response time index for detection and suppression devices. The same principle applies to electrical cables, however with a number of complications. For example, where is the cable located in the tray; top, bottom, against a side rail, or in the center of the cable mass? Does the cable have any fire retardant coating? If so, which brand? Cables that are thermally stable are difficult to ignite and exhibit higher ignition temperature. A cable or coated cable can ignite when its surface is hot enough to generate flammable gas, unless the level of oxygen available is insufficient for ignition. Then the gas can often accumulate elsewhere and burn later.

These are just a sampling of the possible variables that complicate the thermal impact on cable tray fire propagation. Many of these factors are unknown; and could affect the time to the onset of ignition/gasification and flame spread of cable tray insulation, especially when considering locations elsewhere in the room (i.e., not immediately above the ignition source). These factors would tend to complicate the analysis and are not generally amenable to inclusion in a generic treatment. A detailed analysis would likely capture some of these aspects of the cable tray fire scenario. For example, NUREG/CR-6850, Section H.1.5.2 (Tables H-5 and H-6), provides time to failure of thermoplastic and thermoset cable insulation when exposed to hot gas layer temperature. Beyond the configurations identified above, the NRC recommends that detailed fire modeling be performed. Zone fire models and Computational Fluid Dynamics (CFD) codes are known to provide target thermal response modeling capabilities within or outside of the fire plume (zone of influence). A combination of engineering correlations and computer fire modeling also can apply to these types of scenarios.

The empirical tray-to-tray fire spread rule set is intended for use only in cases that are similar in nature to the test upon which it is based. The NRC recommends that the empirical cable tray fire propagation model, as specified in NUREG/CR-6850, only be used to predict cable tray fire propagation within the following two configurations:

Configuration 1: a single vertical stack of horizontal cable trays separated nominally in accordance with Regulatory Guide 1.75 where the tray stack is located directly above a fire source.

Configuration 2: two adjacent vertical stacks of horizontal cable tray separated nominally in accordance with Regulatory Guide 1.75 where both of the tray stacks being modeled are located directly above a fire ignition source such that both trays would be either fully or at least partially immersed in the fire plume.

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NRC recommends that these spread rate models, as applicable to the two configurations above, not be used outside the original Zone of Influence for the reasons previously cited.

For NFPA 805 applications, the licensee will need to develop and justify plant-specific, configuration-specific models if they are to be used outside the original Zone of Influence. These models will be an area of detailed staff review.

References:

1. Revision 0 to FAQ 08-0049, March 31, 2008, Accession No. ML081200309

2. NEI 04-02, Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program Under 10 CFR 50.48(c), Revision 1, Accession No. ML052590476

3. NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition (available through the Public Document Room or NFPA)

4. Regulatory Guide 1.205, Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants, Accession No. ML061100174

5. NRC Regulatory Information Summary 2007-19, Process for Communicating Clarifications of Staff Positions Provided in Regulatory Guide 1.205 Concerning Issues Identified During The Pilot Application of National Fire Protection Association Standard 805, Accession No. ML071590227

6. NUREG/CR-5384, December 1989, Accession No. ML062260226

7. NUREG/CR-6850 (EPRI 1011989), Accession Nos. ML050940183 (Vol. 1) and ML050940189 (Vol. 2)

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