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 08-0043 ELECTRICAL CABINET FIRE LOCATION

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) 08-0043 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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ADAMS Accession No.: ML091470266 *via email

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FAQ 08-0043: Location of Fires within Electrical Cabinets

Clarification of NUREG/CR-6850 (EPRI 1011989) Guidance on the Location of Fires within Electrical Cabinets, Supporting NFPA-805 Fire PRA Application

Background:

Lessons from National Fire Protection Association (NFPA) 805 pilot plants and review of the Fire Probabilistic Risk Assessment (PRA) Standard indicates that the assumed locations for fires within electrical cabinets, as specified in NUREG/CR-6850, may be conservative. Conservative assumptions of cabinet fire locations can greatly affect the end results.

NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology," Section G.3.2, provides two possible approaches to the location for a fire within an electrical cabinet that is used for fire modeling calculations. In the introductory paragraph, the method suggests opening the cabinet to determine the location of the fire based on the location of the cable bundles. In the itemized bullets, the method suggests locating the fire at the top of the cabinet.

In practical applications, the fire is always assumed to start at the top of the cabinet. This assumption is applied even for cabinets that are sealed on the top (without horizontal top vents or openings). However, the Fire Protection Significance Determination Process (SDP) (NRC Inspection Manual Chapter 0609, Appendix F), Page F-21, recommends assuming that the location of an electrical cabinet fire is one foot below the top of the cabinet. The basis for this guidance was derived from experimental observations, as discussed below.

In order to achieve closure of this FAQ in a timely manner, the NRC developed a draft interim 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.

Discussion:

Testing[1] has shown that early fire development begins heating the cables and other combustible materials within the cabinet. Once those internal combustibles get hot enough to generate significant pyrolyzates (combustion products), the fire will transition to oxygen-limited behavior ("oxygen-limited fire") within the cabinet. Under these conditions, burning continues within the cabinet (cables develop deep seated fire), but is limited by the availability of oxygen (i.e., air that flows into the lower sections of the cabinet through ventilation grills, gaps between cabinet panels, gaps around the cabinet doors, or gaps opened by warping of the cabinet panels and doors). Significant unburned pyrolyzates are also generated which are then vented from the upper portion of the cabinet.

As these unburned pyrolyzates leave the cabinet, they come into contact with ambient air

[1] Note that these insights are based on the same cabinet fire test programs referenced in NUREG/CR-6850, EPRI TR 1011989; namely, those from Sandia National Laboratory/NRC, IRSN (*Institut de Radioprotection et de Sûreté Nucléaire* [Institute for Radioprotection and Nuclear Safety (France)]*)* and VTT (*Valtion Teknillinen Tutkimuskeskus* [Technical Research Centre of Finland]).

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(oxygen) and burn at or near the exit point (e.g., the upper ventilation grills or other openings). Hence, assuming that the fire origin is near the base of the upper vertical ventilation openings in an electrical cabinet is a reasonable predictor of typical cabinet fire location under large-scale burning conditions. In general, such vertical grills will typically be located within one foot of the electrical cabinet top so that the general application of the proposed "one-foot rule" from the Fire Protection SDP will be representative of the anticipated behavior for the vast majority of closed-top electrical cabinets.

It is recommended that the assumed fire location used for screening and detailed fire modeling calculations *for electrical cabinets sealed on the top* (without horizontal top vents or openings) be one foot below the top of the cabinet. This assumption should be applied until detailed review of the cabinet contents can be performed for additional location determination, per Section G.3.2 of NUREG/CR-6850.

The assumed fire location *for a fire within a cabinet that is not sealed at the top* be the top of the cabinet (see additional guidance below). As a point of clarification, it should be noted that in the above description on penetrations, "sealed at the top of the cabinet" was not intended to imply "fire-rated." Rather the intent was that penetrations into a cabinet would be sealed such that they would not readily allow for the passage of air.

For vented cabinets, where the vent is either located on the side of the cabinet (vertical) or top of the cabinet (horizontal), the analysis can (as an alternative to the above assumed location) locate the fire at the uppermost vent. For example, if a cabinet includes two vertical vents on the side, the fire should be assumed to be located at the elevation of the upper vertical vent. Similarly, if there is a vent in the top corner of the cabinet, the fire should be assumed to be in the center of the corner vent. When two or more vents are located at the same height, then the analysis should conservatively assume the fire is located at the vent closest to any targets. If this last assumption greatly affects the results, additional refinement may be needed either by more accurate modeling of the fire size expected to occur at each vent or by using the general guidance discussed above from NUREG/CR-6850.

For cabinets that are neither vented nor considered sealed per FAQ 08-0042, the fire location would be assumed at the top of the door or opening which is expected to fail when fire damage occurs. If multiple doors or openings could possibly fail, the analysis should conservatively assume the fire is located at the uppermost door or opening. Additional refinement may be needed if this last assumption greatly affects the results.

NUREG/CR-6850 should be revised to reflect the guidance provided above for the assumed fire location to be used for screening and detailed fire modeling for electrical cabinets.

References:

1. Revision 0 to FAQ 08-0043, March 13, 2008, Accession No. ML081500507

2. Revision 1 to FAQ 08-0043, December 4, 2008, Accession No. ML083540152

3. 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

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4. 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)

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

6. 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

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

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