

inspectors will be on conductor-to-conductor shorts within a multiconductor cable, since risk insights gained from cable fire testing demonstrated that intra-cable shorting is the most probable cause of spurious actuations. Thermoplastic-cable-to-thermoplastic cable interactions are also highly probable and should be considered. To focus on the most risk-significant aspects, inspectors will assume a maximum of two concurrent spurious operations for each scenario evaluated. The details of this inspection are in the attached draft inspection guidance.

Backfit Discussion

This RIS requires no action or written response and is, therefore, not a backfit under 10 CFR 50.109. Consequently, the NRC staff did not perform a backfit analysis.

Federal Register Notifications

For some time the NRC staff has worked with NEI, members of the public, and other stakeholders to develop the technical input necessary to risk-informed the associated circuit inspection guidance referenced in this RIS. On February 19, 2003, the NRC staff held a facilitated public workshop in Rockville, MD, where public participation was solicited. A notice of the workshop was published in the **Federal Register** on December 27, 2002 (Vol. 67, No. 249, p. 79168).

The draft RIS including the draft inspection guidance was published in the **Federal Register** to solicit public comments.

Paperwork Reduction Act Statement

This RIS does not request any information collection.

Attachment: Draft Guidance for Risk-Informing NRC Inspection of Associated Circuits

Background

In 1997, the NRC noticed that a number of licensee event reports (LERs) identified plant-specific problems related to potential fire-induced electrical circuit failures that could prevent operation or cause maloperation of equipment necessary to achieve and maintain hot shutdown in the event of a fire. The staff documented this information in Information Notice 99-17, "Problems Associated With Post-Fire Safe-Shutdown Circuit Analysis." On November 29, 2000, inspection of associated circuits was temporarily suspended (ML003773142). During this period, the Nuclear Energy Institute (NEI) developed NEI 00-01, "Guidance for Post-Fire Safe Shutdown Analysis"

Rev. D (ML023010376). The staff contracted Brookhaven National Laboratory (BNL) to develop a post-fire safe shutdown analysis guidance letter report (ML023430533). The Electric Power Research Institute (EPRI) assembled an expert panel and issued "Spurious Actuation of Electrical Circuits due to Cable Fires: Results of an Expert Elicitation" (Report No. 1006961, May 2002). Using the above-referenced documentation as background, the NRC conducted a facilitated public workshop on February 19, 2003, in Rockville, MD. The transcript of the meeting is available in ADAMS (ML030620006). Based on the information above, especially the facilitated workshop discussions, the staff developed the technical input for draft risk-informed inspector guidance. This guidance, initially transmitted in a memorandum to Cynthia Carpenter from John Hannon dated March 19, 2003 (ML030780326), is essentially the same as the guidance provided below with two notable exceptions. First, additional technical review of the probability of hot-shorts indicated thermoplastic cable-to-cable interactions should have been located in Bin 1 rather than Bin 2. Second, the statement "Inspectors will not consider the impact of degraded control room instrumentation and indication circuits that might confuse operators pending additional research" can be easily misinterpreted and has been deleted. A new section on instrumentation has been added in place of this statement. These changes have been made in the following guidance.

Discussion

The discussion summarizes the general guidance that would be needed to develop an inspection procedure.

Basic Risk Equation

The risk due to associated circuits can be evaluated using the following basic risk equation:

$$\text{Risk} = (\text{fire frequency}) \times (\text{likelihood of fire effects \& cable attributes that contribute to failure}) \times (\text{likelihood of undesired consequences})$$

The three factors in this equation are defined as follows:

1. *Fire Frequency.* The fire frequency is based on a statistical analysis of nuclear power plant (NPP) operating experience. The fire protection significance determination process (SDP) provides a method and bases for estimating fire frequencies for plant areas. One unique aspect of circuit analysis is the potential need for evaluation of multiple areas (*i.e.*, areas

through which a cable or common set of cables is routed).

2. Likelihood of Fire Effects & Cable Attributes that Contribute to Failure.

There needs to be a credible fire threat in the area under review to damage the cable of concern. This threat may consist of *in situ* combustibles, or the actual or maximum allowable amount of transient combustibles as controlled by plant-specific procedures, or a combination thereof. The fire protection SDP provides methods and bases for the identification and analysis of these fire scenarios. The NRC has published fire dynamics tools (*i.e.*, Draft NUREG-1805) which can be used to approximate the fire and its effects when more than a qualitative analysis is necessary. The cable attributes should also be considered in assessing the likelihood of cable failure. Failures due to thermal insult from the fire result from heating in the hot gas layer, immersion in the plume, immersion in the flame zone (direct flame impingement), or radiant heating. All modes of heat transfer should be considered as appropriate to a given fire scenario.

A. Thermoplastic Cables.

Thermoplastic cables (typically non-IEEE 383 qualified) should be assumed to fail if exposed to the hot gas layer or plume temperatures of 425°F or greater for a minimum of 5 minutes. In the case of radiant heat transfer, the cable should be assumed to fail if exposed to a minimum 5kW/m² for 5 minutes. When a thermoplastic cable is within the flame zone of the fire (direct flame impingement) or in a cable tray that is burning, damage should be assumed to occur in 5 minutes.

B. Thermoset Cables. Thermoset cables (typically IEEE 383 qualified) should be assumed to fail if exposed to hot gas layer or plume temperatures of 700°F or greater for a minimum of 10 minutes. In the case of radiant heat transfer, the cable should be assumed to fail if exposed to a minimum 10kW/m² for 10 minutes. When a thermoset cable of concern is in the flame zone of the fire (direct flame impingement), or in a cable tray that is burning, damage should be assumed to occur in 10 minutes.

C. Cable Failure Modes. For multiconductor cables testing has demonstrated that conductor-to-conductor shorting within the same cable is the most common mode of failure. This is commonly referred to as "intra-cable shorting." It is reasonable to assume that given failure, more than one conductor-to-conductor short will occur in a given cable. A second primary mode of cable failure is conductor-to-conductor shorting between separate