

December 3, 2013

MEMORANDUM TO: APLA Files

FROM: Hossein G. Hamzehee, Branch Chief /RA/  
PRA Licensing Branch  
Division of Risk Assessment  
Office of Nuclear Reactor Regulation

SUBJECT: CLOSE-OUT OF FIRE PROBABILISTIC RISK ASSESSMENT  
FREQUENTLY ASKED QUESTION 13-0004 ON  
CLARIFICATIONS REGARDING TREATMENT OF SENSITIVE  
ELECTRONICS

### **BACKGROUND**

During industry peer reviews and NRC review of Fire Probabilistic Risk Assessment (FPRA) applications to implement National Fire Protection Association "Performance-Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants" (NFPA 805), methods and approaches that were different from the accepted methods were encountered. U. S. Nuclear Regulatory Commission (NRC) staff collaborated with the Nuclear Energy Institute (NEI) and the nuclear industry to identify these methods, approaches, and factors in current FPRA applications (including but not limited to NFPA 805 applications) that are different from the NRC accepted methods, and to address them by providing clarification through a frequently asked question (FAQ) process. Other differing methods and approaches were also identified to be addressed outside the FPRA FAQ process by development of new methods through the Memorandum of Understanding between the Office of Nuclear Regulatory Research and Electric Power Research Institute.

Sections 8.5.1.2 and H.2 of NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," dated September 2005, provide guidance that includes heat flux damage criteria of 3 kW/m<sup>2</sup> and temperature damage criteria of 65°C for solid-state control components. The discussion provided in NUREG/CR-6850 Appendix S, Section S.2 refers to these criteria in the context of sensitive electronics but only for the purposes of treatment of fire propagation between two adjacent electrical cabinets which suggests that the concern is limited to heating due to sources where only a small air gap exists. The guidance in NUREG/CR-6850 includes various discussion related to sensitive electronics but never defines the meaning or scope that is intended. Appendix H provides a screening damage threshold for solid state control components. There is no readily available consistent industry definition of sensitive electronics or temperature sensitive electronics. FPRA FAQ 13-0004, "Clarifications on Treatment of Sensitive Electronics," was identified to provide supplemental guidance for application of the damage criteria provided in Sections 8.5.1.2 and H.2 of NUREG/CR-6850, Volume 2, for solid-state components.

CONTACT: Harold Barrett, NRR/DRA  
(301) 415-1402

Mehdi Reisi Fard, NRR/DRA  
(301) 415-3092

**CONCLUSION**

Since November 2012, the NRC staff and nuclear industry held a series of public meetings to discuss resolution of FPRA FAQ 13-0004 along with other FPRA FAQs. Technical exchange between the NRC staff and the industry led to the resolution of this FAQ, which is documented in the Enclosure to this memorandum.

The guidance in FPRA FAQ 13-0004 is acceptable for use by licensees. This guidance will be endorsed in the next revision to Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

Enclosure:  
As stated

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**CONCLUSION**

Since November 2012, the NRC staff and nuclear industry held a series of public meetings to discuss resolution of FPRA FAQ 13 0004 along with other FPRA FAQs. Technical exchange between the NRC staff and the industry led to the resolution of this FAQ, which is documented in the Enclosure to this memorandum.

The guidance in FPRA FAQ 13 0004 is acceptable for use by licensees. This guidance will be endorsed in the next revision to Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

Enclosure:  
As stated

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| NAME   | MReisiFard | HBarrett  | HHamzehee |
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FAQ Number 13-0004

FAQ Revision 1

FAQ Title Clarifications on Treatment of Sensitive Electronics

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Plant: NextEra Energy  
ERIN Engineering  
EPM, Inc.

Date: June 26, 2013

Contact: Vinny Rubano  
Kiang Zee  
Mark Schairer

Phone: (561) 691-7809  
(925) 943-7077  
(508) 532-7137

Email: [Vinny.Rubano@fpl.com](mailto:Vinny.Rubano@fpl.com)  
[klzee@erineng.com](mailto:klzee@erineng.com)  
[mvs@epm-inc.com](mailto:mvs@epm-inc.com)

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FPRA TF     BWROG     PWROG

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**Purpose of FAQ:**

The purpose of the FAQ is to clarify the treatment requirements for solid state and sensitive electronics.

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**Details:**

**NRC document needing interpretation (include document number and title, section, paragraph, and line numbers as applicable):**

None

**Circumstances requiring guidance interpretation or new guidance:**

New guidance

**Detail contentious points if licensee and NRC have not reached consensus on the facts and circumstances:**

None

**Potentially relevant existing FAQ numbers:**

None

Enclosure

**Response Section:****Proposed resolution of FAQ and the basis for the proposal:****INTRODUCTION**

The purpose of Fire PRA FAQ 13-0004 is to provide supplemental guidance for application of the damage criteria provided in Sections 8.5.1.2 and H.2 of NUREG/CR-6850, Volume 2, for solid-state components.

**BACKGROUND**

Sections 8.5.1.2 and H.2 of NUREG/CR-6850 provide guidance that includes heat flux damage criteria of 3 kW/m<sup>2</sup> and temperature damage criteria of 65°C for solid-state control components. The discussion provided in NUREG/CR-6850 Appendix S, Section S.2 refers to this criteria in the context of sensitive electronics but only for the purposes of treatment of fire propagation between two adjacent electrical cabinets which suggests that the concern is limited to heating due to sources where only a small air gap exists.

The guidance in NUREG/CR-6850 includes various discussion related to sensitive electronics but never defines the meaning or scope that is intended. Appendix H provides a screening damage threshold for solid state control components. There is no readily available consistent industry definition of sensitive electronics or temperature sensitive electronics.

**DISCUSSION**

The following is provided as additional guidance for identifying the scope of plant equipment to be treated using the lower damage threshold specified in Section H.2 of NUREG/CR-6850.

- Electro-mechanical devices are not considered sensitive electronics.
- Integrated circuits employing any of the variants of pin-grid arrays should be treated as sensitive electronics unless they satisfy the item below.
- Sensitive electronic components that are mounted inside a control panel (cabinet) such that the cabinet walls, top, front and back doors shield the component from the radiant energy of an exposure fire may be considered qualified up to the heat flux damage threshold for thermoset cables, provided that:
  - The component is not mounted on the surface of the cabinet (front or back wall/door) where it would be directly exposed to the convective and/or radiant energy of an exposure fire.
  - The presence of louvers or other typical ventilation means do not invalidate the guidance provided for here.

The proposed treatment for components mounted inside a control panel (cabinet) is based on qualitative judgment that is supported by fire modeling analyses. In general, any component that should be evaluated using the lower damage threshold specified in Section H.2 of

NUREG/CR-6850 is likely to be located within a ventilated panel (cabinet) or some other robust enclosure. The presence of that robust enclosure essentially shields the component from direct radiant exposure. Consequently, the actual exposure temperature would be based on the temperature response of the enclosure to the incident heat flux and the thermal response of the air within the enclosure.

The fire modeling analysis used the Fire Dynamics Simulator (FDS) to measure the heat flux and temperatures within a metal cabinet exposed to a fire. The objective of the analysis was to determine whether conditions within a panel (cabinet) would remain below the damage threshold specified in Section H.2 of NUREG/CR-6850 for sensitive electronic equipment (3 kW/m<sup>2</sup> and 65°C) when the exterior surface was subjected to a heat flux equal to or exceeding the generic screening damage threshold for thermoset cables. The specific fire that was considered had a heat release rate of 317kW. The fire was placed such that its centerline was one meter from the panel (cabinet) surface. This distance is typical of a horizontal ZOI for thermoset cables.

FDS simulations for this analysis found that the heat flux and temperature experienced by components within the enclosure remained below that specified in Section H.2 of NUREG/CR-6850 for sensitive electronic equipment (i.e., 3 kW/m<sup>2</sup> and 65°C), while the exterior surface heat flux exceeded the generic screening damage threshold for thermoset cables, as specified in Table H-1 of NUREG/CR-6850 (i.e., 11 kW/m<sup>2</sup>). These results support the recommendation that a generic screening heat flux damage threshold for thermoset cables, as observed on the outer surface of the cabinet, can be used as a conservative surrogate for assessing the potential for thermal damage to solid-state and sensitive electronics within an electrical panel (cabinet). Since the conclusions of the FDS analysis are based on heat flux exposure to the cabinet, the 65°C temperature damage criterion must still be assessed for other types of fire exposures to the enclosed sensitive electronics.