RES & EPRI Team Response to FAQ 06-0016
NUREG/CR-6850, EPRI TR-1011989

Final – 2/7/2007

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FAQ 06-0016 requests clarification regarding electrical panel / electrical cabinet counting guidance. A copy of the original FAQ as reviewed by the team is attached to the end of this response.

The first point to observe is that panel counting impacts only the fire frequency assigned to an individual panel or group of panels. Hence, the ultimate criterion for partitioning of the fire frequency is the relative number of ignition sources present. The counting guidance does not, in particular, have anything to do with the potential for fire spread between vertical sections or out of a panel, a factor that will impact our response to some of the examples posed in the FAQ.

In practice, it was considered impractical to count ignition sources (e.g., circuit cards, relays, cable terminations and junctions, etc.) directly because (1) the number of ignition sources present in an entire plant is quite large and (2) in most cases the analyst will not be free to open multiple panels for routine inspection of contents. Hence, the guidance was written in such a way that the analyst is *not* expected to examine the contents of every panel in the plant as a part of the counting process. Examining a sample of representative panels will likely prove useful to the analyst, but the guidance presumes that this will be possible for, at most, a small sample of panels.

As an alternative, the guidance is based on the counting of "vertical sections" as a surrogate for the counting of ignition sources. The overall objective is to strike a balance such that two banks of panels with a similar number of ignition sources would result in a similar panel count. As a result, the team agrees with some of the examples provided in the FAQ but disagrees with others.

The team agrees in full with the three examples provided on Page 3 of the FAQ and their results (i.e., the switchgear, load center and MCC examples resulting in counts of 9, 4 and 9 vertical sections respectively).

There are then eight examples on page 4 of the FAQ. We will refer to these as examples 1-8 based on numbering from the top to the bottom of page 4. Our assessment of these examples is as follows:

- Examples 1 and 2: The team agrees with these two examples. The distinction between these two examples appears to be that the example 2 panel is a slightly smaller panel than example 1. The team agrees that both examples could be counted as a single panel given that these are "not outliers".

- Examples 3 and 4: The team disagrees with example 3 but agrees with example 4. The distinction between these two examples is that the dividers are not solid in example 3 but are solid in example 4 ('solid' *is* defined in the FAQ). The solidity of the section dividers has *absolutely nothing* to do with counting for fire frequency purposes. This may be a consideration in fire spread analysis, but given that other factors are similar (i.e., the panel contents are similar) then these two examples should result in the same panel count, namely, six vertical sections.

- Example 5: The team agrees with this example.

- Examples 6 and 7: The team generally agrees with these two examples. The intent of the guidance is to allow analyst judgment in outlier cases. Such cases should be sharply limited in number, but are expected to occur. These are reasonable examples of what might constitute outliers. The judgment used in assigning a panel count to such outliers should be documented. To reiterate, panel counting is ultimately intended to reflect the relative number of ignition sources present. If the *density* of components, connections, and cable terminations roughly matches that of other panels in the plant, counting based on a representative panel length would be reasonable.

- Example 8: The team disagrees with this example. The number of cables present is not necessarily a good indication of the ignition frequency. If panel contents are considered, then all potential ignition sources should be considered. In particular, rather than the number of cables present, the relative number of cable junctions, cable terminations and other electrical components would be a better indicator of fire frequency than the simple bulk of cables. Cables that simply pass through a cabinet would not, for example, be significant ignition sources in general compared to cables that terminate at a cabinet. However, the consideration of panel contents might well be legitimate, especially where one encounters a rather large but essentially empty electrical panel.

NOTE: The pages which follow show the FAQ as it was presented to the RES & EPRI team for review and comment.

FAQ Number	06-0016, Revision 0

Plant: Harris Nuclear Plant (HNP) FAQ # 06-0016 Rev. 0
Submittal Date: 11-6-06
Licensee Contact: David Miskiewicz Tele/email 919-546-7588
NRC Contact: Tele/email

Distribution: Check all that apply *(NEI Internal Use)*

□ **FPWG** □ **RIRWG** □ **NSSS OG** □ **NFPA 805 TF** □

Subject: Clarification/enhancement of Ignition Source counting guidance for Electrical Cabinets in NUREG/CR-6850, supporting NFPA-805 Fire PRA application.

Interpretation of guidance? Yes

Proposed new guidance not in NEI 04-02? Yes

Details:

NEI 04-02 Guidance needing interpretation (include section, paragraph number, and line number):

New attachment on interpretation issues

Circumstances requiring guidance interpretation or new guidance:

The guidance provided in NUREG/CR-6850 for Task 6, Fire Ignition Frequency (Section 6.5.6, Bin 15), states:

> *Bin 15 – Electrical Cabinets (Plant-Wide Components):* Electrical cabinets represent such items as switchgears, motor control centers, DC distribution panels, relay cabinets, control and switch panels (excluding panels that are part of machinery), fire protection panels, etc. Electrical cabinets in a nuclear power plant vary significantly in size, configuration, and voltage. Size variation range from small-wall mounted units to large walk-through vertical control cabinets, which can be 20' to 30' long. The configuration can vary based on number of components that contribute to ignition, such as relays and circuit cards, and combustible loading, which also affects the fire frequency. Voltages in electrical cabinets vary from low voltage (120 V) panels to 6.9 kV switchgears. Even though it is expected that these features affect the likelihood of fire ignition, from a simple analysis of the event data involving the electrical cabinets, it was determined that the variation by cabinet type did not warrant separate frequency evaluation. Therefore, one fire frequency was estimated for the electrical cabinets.

This guidance infers that cabinet size is not a factor for ignition source counting. However, additional guidance states that electrical cabinets "… should be counted by their vertical segments ...". During the presentation of Pilot Project results it was determined that differences related to the definition of 'segments' could result in notable inconsistency between individual users of NUREG/CR-6850.

The discussion of this issue found that this issue affects only general electrical cabinets and panels. In the case of switchgears, load centers, unit substations, and motor control centers the term 'segment' was uniformly interpreted to be equal to the individual vertical sections that define these types of components. As applied to general electrical cabinets and panels, the term 'segments' could be interpreted to mean different metrics.

- A segment could be defined as an enclosed element that is generally independent of size or volume (also referred to as a vertical section).
- A segment could be defined as an individual section of an enclosure regardless of whether it was fully enclosed.
- A segment could be defined based on a 'standard' or reference sample panel size.

Depending on the metric being used, the counting of electrical cabinets would result in varying results and consequently, different fire ignition frequency values. While NUREG/CR-6850 allows the establishment of plant specific criteria for counting of electrical cabinets, additional guidance is required to achieve a consistent basis for determining the ignition frequencies.

Detail contentious points if licensee and NRC have not reached agreement

This topic has impact on the NFPA-805 pilots, non-pilots and other users of NUREG/CR-6850.

Potentially relevant existing FAQ numbers:

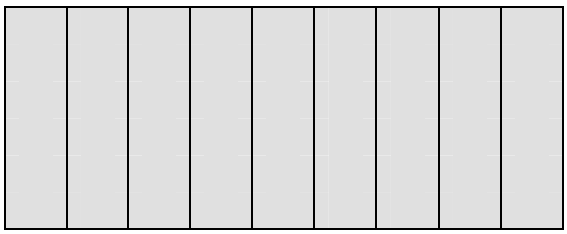
This guidance is specific to the characterization of electrical cabinets for Bin 15 ignition frequency determination. The characterization of switchgear and load center segments for the purposes of high energy arcing faults is addressed by FAQ 06-0017.

Response Section

A generalized counting criterion for general electrical cabinets and panels is proposed. This proposed criterion would involve two elements.

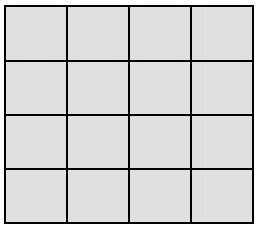
For switchgears, load centers, unit substations, and motor control centers the counting for the purposes of NUREG/CR-6850, Task 6, Bin 15 would be based on vertical section. This counting is illustrated in the following examples.

FAQ Number	06-0016, Revision 0



Medium Voltage Switchgear

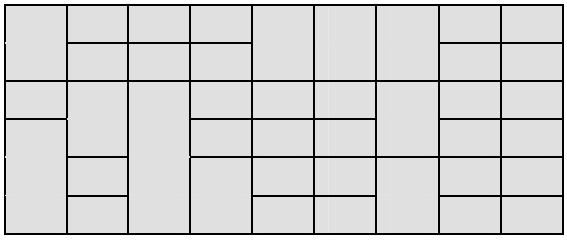
9 Breakers and Sections
Count = 9 for Bin 15



Load Center or Unit Substation

16 Breakers in 4 Sections

Count = 4 for Bin 15



Motor Control Center

41 Breakers/Starters in 9 Sections

Count = 9 for Bin 15

For general electrical cabinets and panels, it is proposed that the counting be based on a physically enclosed element. A physically enclosed element means that that the cabinet or panel is fully enclosed by 6 solid elements with the provision that a non-combustible floor or ceiling may represent the bottom or top. The term 'solid' element is not intended to mean that the element is substantially continuous. Consequently, breeches or unsealed penetrations could still be treated as 'solid'. The term 'solid' is intended to prevent a panel that is divided by an element that is substantially open from being treated as two separate panels.

This proposed counting for electrical cabinets and panels is to be applied for a wide range of panel sizes. However, recognizing that the ignition frequency is more a function of the cabinet contents than the cabinet size, a basis is needed to address outlier conditions. It is proposed that each user be required to establish criteria for identifying the outliers and the basis for counting them. As an example, they can be counted by establishing a nominal 'standard' or reference cabinet size. The count could also be based on evaluating the cabinet internals relative to a defined 'standard' or reference configuration.

For example, a particular user may define a cabinet with any horizontal dimension more than 8 feet as an outlier, and a 'standard' cabinet as being nominally 4 feet in length x 3 feet deep. (cabinet height is not generally an issue based on the use of vertical sections). Using this example, the following cabinet and panel examples would be counted as follows:

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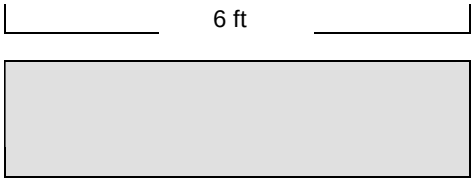
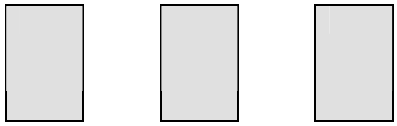


Cabinet is not an outlier –
Count = 1

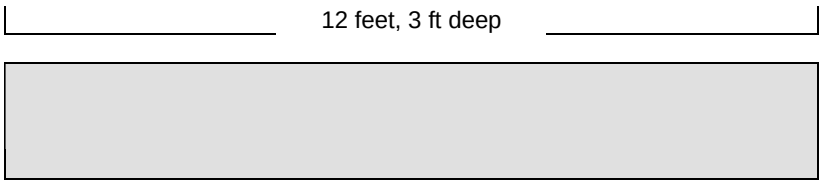
Cabinet is same as standard
Count = 1

Internal dividers are not solid
Count = 1

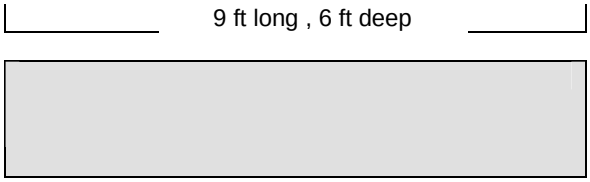
Internal dividers are solid
Count = 6



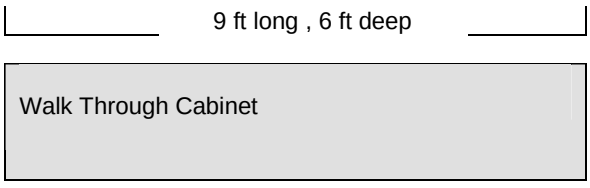
Three independent cabinets
Count = 3



Panel is an outlier,
using a 4' standard
cabinet -
Count = 3



Cabinet is an outlier, no evaluation of contents, based on reference cabinet
Count = 3 – due to both variation from the standard length and width..



Cabinet is an outlier, evaluation of contents shows low cable loading typical of the standard cabinet -
Count = 1

The intent is that a basis for the counting of outliers is required. A volumetric comparison is not required. Also, to prevent any appearance that this treatment is intended to be based on physical measurements, the proposed approach allows only integer counting. The assignment of fractional values would not be allowed. In addition, the proposed methodology retains the option for screening small cabinets resulting in a count of zero for them (as discussed in NUREG/CR-6850). As applied in this case, the user would be allowed to screen cabinets or panels based on defined criteria and exclude them from the overall population count. When performing detailed fire modeling, the fire should be applied to the actual cabinet footprint by vertical section, including outliers.

Basis:

The existing guidance in NUREG/CR-6850 is based on industry data which has only been provided with fidelity adequate to support plant level ignition frequencies for electrical cabinets. Although the guidance does address the broad applicability of the data, it leaves room for variability that can create issues with PRA quality. It is important that the ignition frequency results be of sufficient quality to support not only NFPA-805 transition but also the more broad scope of regulatory inspection and enforcement issues.

The guidance proposed will provide more consistency when determining plant specific electrical cabinet ignition frequencies while working within the bounds of the exiting data provided by the NUREG. This should facilitate the review and acceptability of the results.