FAQ Number 14-0009 **FAQ Revision** E

FAQ Title **Treatment of Well Sealed MCC Electrical Panels Greater than 440V**

Plant: Various Date: October 20, 2014

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Purpose of FAQ:

FAQ provides clarification for the treatment of fire propagation from well-sealed MCC electrical panels with voltage levels at or greater than 440V

> **Comment [A1]:** The origin of the problem arose from well sealed MCC panels. NRC's intent was to maintain the problem statement and expand the solution offered to a particular nuclear power plant for their NFPA 805 transition.

Relevant NRC document(s):

NUREG/CR-6850
NUREG/CR-6850, Supplement 1 (NFPA 805 FAQ 08-0042)

Details:

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

See list of relevant NRC documents.

Circumstances requiring interpretation or new guidance:

NFPA 805 FAQ 08-0042 provides guidance and clarification for the treatment of fire propagation from Bin 15 electrical cabinets. When a~~n~~ well-sealed electrical cabinet at or above 440V is considered, some ambiguity exists with respect to the wording in Chapter 6 of NUREG/CR-6850, its applicability to fire scenario development, and the clarification provided in NFPA 805 FAQ 08-0042. Notably, treatment of propagation probability for a well-sealed electrical cabinet is not explicitly addressed.

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

The clarification to NFPA 805 FAQ 08-0042 was intended to reaffirm the intended treatment for MCCs. The treatment for MCCs operating at or above 440V that satisfy the guidance provided in 11.5.1.7.3 of NUREG/CR-6850 as modified by NFPA 805 FAQ 08-0042 need not include fire propagation.

The NRC has ~~suggested~~ indicated that the Chapter 6 wording should be used as criteria for addressing fire propagation, in addition to that provided in NFPA 805 FAQ 08-0042.

Potentially relevant existing FAQ numbers:

NFPA 805 FAQ 08-0042

Response Section:

Proposed resolution of FAQ and the basis for the proposal:

The treatment of postulated fires originating at MCCs should follow the guidance in NUREG/CR-6850 as modified by NFPA 805 FAQ 08-0042. The guidance provided in NFPA 805 FAQ 08-0042 identifies two attributes to be considered. Those two attributes are the adequacy of the sealing of openings and the robustness of the door attachments. NFPA 805 FAQ 08-0042 provides criteria and discussions to address these issues. However, questions have arisen regarding the behavior and risk implications ~~i~~of well-sealed MCCs operating at 440VAC or higher and their capability ~~were to be treated as capable~~ of propagating a fire to external targets. These questions are based on wording in Chapter 6 of NUREG/CR-6850 that states that panels housing circuit voltages of 440V or higher should be counted because an arcing fault could compromise panel integrity.

In order to address this, additional details and methodological treatment are necessary beyond that already published in NUREG/CR-6850 or the Supplement. A simplified approach is proposed as an interim treatment pending completion of ongoing industry and NRC research activities. This simplified approach involves the consideration of two factors.

$$F = F_E \times F_B$$

Where:

F = fraction of fires originating from a well-sealed~~n~~ MCC that damages external targets

F_E = fraction of MCC fires that are energetic enough to breach the well-sealed MCC enclosure

F_B = fraction of MCC fires that damage targets above the well-sealed MCC based on fire modeling (SF)

As indicated above, the fires energetic enough to breach a well-sealed cabinet are arcing fires. These fires, while not energetic enough to be considered HEAFs, still exhibit an arcing characteristic and generally exhibit energy greater than thermal fires.

Given that a fire has occurred at an MCC, it is not realistic or appropriate to assume that all such events would be capable of breaching the MCC. In order to address this consideration, it is necessary to consider empirical evidence from industry fire events for MCCs. This work was previously completed, and there is an available report prepared by an independent panel that can be used.(1) ~~The NRC formal response to the panel report did not identify any technical flaw or error in the document.(2)~~ Based on the assessment from this work, a fire frequency modification factor (F_E) of 0.19 can be used to treat the fraction of MCC fire events that are assumed to be capable of breaching an MCC [Reference 1, Attachment 1, Page 11]. It should be recognized that the factor was not developed by industry with arcing fires alone in mind, nor well-sealed cabinets. However, due an NRC evaluation performed on arcing fires in MCC cabinets with the new fire events database including fires occurring from 2000-2009, the staff accepts 0.19 as the fraction of arcing fires in MCCs, arcing fires being those which have the potential to breach a well-sealed MCC cabinet.

Given that a postulated fire scenario has breached an MCC, fire modeling can then be applied to treat the fire scenario. The fire modeling should rely on already established methods, treatments, and data as provided in NUREG-1824 and Appendix E of NUREG/CR-6850.

A simplified and bounding fire model for thermoplastic cable targets can be used to illustrate the integration of fire modeling results to obtain the value of F_B. This simplified treatment was developed using the plume centerline temperature correlation from NUREG-1805 and the NUREG/CR-6850, Appendix E, Table E-4 heat release rate probability distribution applicable to an MCC (per NUREG/CR-6850, Appendix G, p. G-25, including Figures G-6 and G-7). The fire is treated with a characteristic surface area of 3 ft^2 (based on an MCC cubicle stack characteristic dimensions of 1.5 ft wide by 2 ft deep) with a cable tray target assumed to be located 6” above the top of the MCC. The MCC was assumed to be configured with four equal sized cubicles in each stack each 18 inches tall. The fire in each cubicle was assumed to be located at the horizontal centerline of the cubicle. The fire in the first cubicle was assumed to be located at a distance of 1.75 ft below the cable tray (6” between top of MCC and cable tray, 6” wireway at the top of the MCC and 9” distance from top of the cubicle to the center of the cubicle). Each subsequent cubicle fire was assumed to be 18” below the location of the fire of the cubicle above it. The resulting spacings between each of the 4 MCC cubicles and the cable tray were 1.75 ft, 3.25 ft, 4.75 ft, and 6.25 ft.

This resulted in four cases to be evaluated for the MCC stack. For each assumed cubicle fire, the required heat release rate (HRR) to cause the plume centerline temperature at the cable tray location to be equal to the thermoplastic cable damage temperature (205 ^{o}C) was determined. The severity factor associated with the HRR was then determined using the Gamma distribution parameters of 1.6 and 41.5 for alpha and beta, respectively, from NUREG/CR-6850, Table E-1. This calculation was done as a steady state analysis with no credit for fire growth, decay, suppression, or time to damage.

This simplified treatment determined the fraction of postulated fires that could create centerline plume temperatures equal to or greater than 205 ^{o}C. This was repeated for each of the assumed cubicle fires. Each successive case increased the spacing between the postulated MCC cubicle fire and the postulated cable tray target above the MCC based on the dimensions noted earlier (18 inches greater than the spacing for the cubicle above). The results are summarized below.

MCC Cubicle Position	Spacing to Tray	Critical HRR	SF [1]	SF_{crit} [2]
Topmost Cubicle	1.75 ft	19 kW	0.153	0.847
2nd Cubicle	3.25 ft	44 kW	0.418	0.582
3rd Cubicle	4.75 ft	83 kW	0.711	0.289
Bottom Cubicle	6.25 ft	137 kW	0.902	0.098

Note 1 SF is the fraction of postulated fires that have an intensity less than the critical HRR

Note 2 SF_{crit} is the fraction of postulated fires that could damage the target and is taken as being equal to 1 – SF

The resulting four severity factor values were then each weighted by 0.25 to reflect the equal likelihood of fire occurrence and then summed to obtain an aggregate effective severity factor for the entire MCC stack. The resulting aggregate severity factor, F_B, was calculated to be 0.45 and represents the fraction of MCC fires that could damage the overhead target located 6 inches above the top given that it had already breached the MCC. This 0.45 severity factor is then combined with the previously calculated 0.19 term to yield a value for F of 0.086.

It is noted that other combinations MCC and target characterizations could exist. These combinations are:

- MCC contains non-qualified cables and targets are thermoset
- MCC contains qualified cables and targets are thermoplastic
- MCC contains qualified cables and targets are thermoset

The analysis presented earlier that yielded the 0.45 factor was repeated for the three combinations above. For the case where the MCC contains qualified cables, the NUREG/CR-6850, Appendix E, Table E-2 heat release rate probability distribution was used instead of that provided in Table E-4. For thermoset targets, a damage threshold of 330 ^{o}C was used instead of 205 ^{o}C applicable for thermoplastic targets. All other terms and inputs remained unchanged.

The resulting factors and integration with the multiplier noted above are provided below.

Combination	F_E	F_B	F_E x F_B
Non-Qualified in MCC – TP target	0.19	0.45	0.086
Non-Qualified in MCC – TS target		0.27	0.051
Qualified in MCC – TP target		0.33	0.063
Qualified in MCC – TS target		0.19	0.036

The conservative and bounding values above can be generically applied based on the plant specific combination of the wiring characterization within the MCC (qualified vs. non-qualified) are the target cable characterization (TS vs. TP). When applied, the fraction of fires that are assumed to have breached the MCC should be assumed to have damaged the first overhead cable tray. Because this simplified analysis does not consider timing, no credit for fire suppression should be taken unless separately addressed by additional analyses not addressed or discussed herein. In the absence of such further analyses, it should be assumed that target damage occurs with no delay. Further vertical and horizontal fire propagation should be considered using existing guidance including any applicable credit for fire suppression based on the available timing. If manual fire suppression is credited, the applicable suppression rate term is the same as that which would have been applicable for electrical cabinet fires.

This FAQ does not prohibit or otherwise preclude the use of accepted fire modeling methods to take advantage of actual target spacing when greater than 6 inches. For example, if for a particular installation the nearest overhead target is 2 feet from the top of the MCC instead of 6 inches, the resulting values would be 0.048, 0.019, 0.032, and 0.013 instead of 0.086, 0.051, 0.063, and 0.036, respectively.

If appropriate, provide proposed rewording of guidance for inclusion in the next Revision:

None – a more complete treatment will be available prior to the next NUREG 6850 revision.

REFERENCES

1. B. Bradley, NEI to D. Harrison, NRC, Recent Fire PRA Methods Review Panel Decision: Treatment of Electrical Cabinets, June 4, 2012
2. J. Giitter, NRC to B. Bradley, Recent Fire PRA Methods Review Panel Decisions and EPRI 1022993, “Evaluation of Peak Heat Release Rates in Electrical Cabinet Fires”, June 21, 2012, ML12171A583