Technical Basis for Treatment of Potential Propagation from MCCs

The treatment of postulated fires originating at motor control centers (MCCs) should follow the guidance in NUREG/CR-6850 as modified by FAQ 08-0042 (see NUREG/CR-6850 Supplement 1 Section 8). The guidance provided in 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. FAQ 08-0042 provides criteria and discussions to address these issues. Despite the guidance issued in FAQ 08-0042, questions have recently arisen regarding the behavior and risk implications if robustly sealed MCCs operating at 440VAC or higher were to be treated as capable of propagating a fire to external targets. In order to address this, additional details and methodological treatment are necessary beyond that already published in NUREG/CR-6850 or the Supplement. Given the lack of any identifiable consensus method, a simplified approach that involves the counting of cable/wire terminations within an MCC cubicle was performed.

In order to maximize the number of connections at 440VAC or higher (as compared to connections of the control circuit typically operating at 120VAC) a typical reversing starter for a motor operated valve (MOV) was considered. The results are shown in Table 1. It is recognized that plant- and application-specific variables would affect the counts shown in the table. However, it is believed that values presented that ignore the additional connections associated with control logic and at the pull-apart terminal block would tend to underestimate the number of connections at 120V and yield a conservative bias in the results. While conservative biases in a risk assessment are generally not desirable, this approach would eliminate the need to undertake extensive cubicle specific assessments.

$$23 / (23 + 26) = 0.47$$

It is noted that the results would be different for a typical non-reversing motor starter. For a non-reversing motor starter, the second starter contactor is not present nor are the contacts from the MOV (limits switches and torque switches). If these are removed, the fraction becomes:

$$17 / (17 + 12) = 0.59$$

In both cases, the assessment assumes that the control circuit for the driven load is manually controlled; this assumption would tend to minimize the number of 120V connections. From a practical standpoint, it is unlikely that any MCC would contain only such circuits. Therefore, the values above represent an upper bound limit rather than a mean or median value.

Table 1 – MCC Cubicle Connections

Device	Connections		Notes
	440VAC	120VAC	
Molded Case Circuit Breaker or Power Fuse	3		
Starter Contactor 1	6	6	NO, NC, and coil contacts

Starter Contactor 2	6	6	NO, NC, and coil contacts
Thermal Overload Block	6	4	Assume only two NC contacts
Control Power Transformer	2	2	
Open Position Switch		2	
Close Position Switch		2	
Open Torque/Limit Switch		2	
Close Torque/Limit Switch		2	
TOTAL	23	26	

The fraction developed is taken to be representative of an upper bound estimate of the fraction of MCC fire events that occur on conductors/connections at 440VAC or higher. Given that a fire has occurred on such a conductor/connection, it not realistic nor appropriate to assume that all such events would be capable of breaching an otherwise robustly secured enclosure. In order to address this latter consideration, it is necessary to consider empirical evidence from industry fire events.

It is recognized that use of empirical evidence is very subjective and inherently introduces a source of uncertainty. Rather than undertake an effort to present and evaluate the available data, previously completed work performed by an independent panel was used [(1)]. The participants on this independent panel included both industry and NRC representatives. It is acknowledged that while the panel report does include a dissenting opinion, the underlying basis for the dissent is not based on any technical flaw or error in the results nor the characterization of the industry fire events. The NRC formal response to the panel report also did not identify any technical flaw or error in the results [(2)]. The dissent was based on the belief that the developed factor is unnecessary and a concern that the results may conflict with other developing work that was occurring at that time. Since the dissent did not identify any issues or concerns with the documented assessment of the individual fire events, that element of the assessment should be useable in this assessment without further challenge. The independent panel [(1)] found:

- The total number of MCC fire events included in the set used to generate the generic fire frequency was 53
    - Eight (8) events were excluded from further consideration in the Panel Factor Report so as to not dilute the results by inflating the denominator of the fraction being generated
    - 21 events were assigned a weight of 0.50 for determination of the total population count
    - 24 events were assigned a weight of 1.0 for determination of the total population count
    - The net of the above is an event count of 34.5 which represents the denominator of a fraction
- The 45 events with a non-zero population weight were reviewed

    - Of the events with a counting weight of 0.50, one (1) had an assigned factor of 0.50 (net count of 0.25)
    - The remaining 20 events were judged to be incapable to propagating to external targets and therefore, could not be capable of breaching a robustly secured enclosure
    - Of the events with a counting weight of 1.0, two (2) had an assigned factor of 0.50 (net count of 1.0) , and five (5) had an assigned factor of 1.0, for a net count of 5.0
    - The remaining 17 events were judged to be incapable to propagating to external targets and therefore, could not be capable of breaching a robustly secured enclosure
    - This results in only eight (8) events to be examined to determine if there was evidence that it could have breached an otherwise robustly secured enclosure
- The event descriptions and summary of review notes were reviewed for the eight (8) events noted above
    - Events 2314 and 2336 each had a counting weight of 1.0 and had clear evidence that the enclosure was breeched. For event 2314, the nature of the event was such that a breech would have occurred regardless of the robustness of the enclosure. For event 2336, the event description included a narrative using the words "door had blown open"
    - Events 177 and 1135 each had a counting weight of 1.0 but were inconclusive and were conservatively assigned a value of 0.50
    - The remaining four events were not judged to have characteristics consistent with an event capable of breaching a robustly secured enclosure
    - The net of above is a count of 3.0

A simple ratio of the events that breeched or could have breached the enclosure versus the total number of events yields a factor of 0.087 (3.0/34.5). This value is then combined with the previously developed fraction of 0.59 (0.47) to produce a final factor.

$$0.087 \times 0.59 \sim 0.05 \quad \text{or} \quad 0.087 \times 0.47 \sim 0.04$$

Based on the assessment presented above, a fire frequency modification factor of 0.05 should be used to treat the fraction of MCC fire events that can be assumed to be capable of breaching an otherwise robustly secured enclosure. Given that a postulated fire scenario has breached a robustly secured enclosure, 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.

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