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Refining and Characterizing Heat Release Rates From Electrical Enclosures During Fire

**Document:** NRC-2019-0118-DRAFT-0002
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## General Comment

Industry Comments on Draft NUREG-2187 Volume 2, Refining and Characterizing Heat Release Rates from Electrical Enclosures during Fire Volume 2: Fire Modeling Guidance for Electrical Cabinets, Electric Motors, Indoor Dry Transformers, and the Main Control Board

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## Attachments

08-26-19_NRC_NEI Comments NUREG-2187 Volume 2

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NUCLEAR ENERGY INSTITUTE

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Office of Administration
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U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

**Subject:** Industry Comments on Draft NUREG-2187 Volume 2, "Refining and Characterizing Heat Release Rates from Electrical Enclosures during Fire – Volume 2: Fire Modeling Guidance for Electrical Cabinets, Electric Motors, Indoor Dry Transformers, and the Main Control Board;" 84 FRN 31125-31126; Docket ID NRC-2019-0118

**Project Number: 689**

Dear Ms. Jennifer Borges:

The Nuclear Energy Institute (NEI)[1], on behalf of its members, submits the following comments on the draft NUREG-2187 Volume 2, "Refining and Characterizing Heat Release Rates from Electrical Enclosures during Fire – Volume 2: Fire Modeling Guidance for Electrical Cabinets, Electric Motors, Indoor Dry Transformers, and the Main Control Board." The technical work documented in this draft NUREG represents an important advancement in making Fire Probabilistic Risk Assessment (PRA) models more realistic. Current models of electrical cabinet fires represent a substantial portion of the known conservatism in Fire PRAs. Integration of this new technical work will enable licensees to significantly improve the realism in their models and ultimately allow them to use these models in making operational decisions. Overall, NEI finds this work to be of high quality, and offers minor comments to enhance clarity. NEI urges the NRC to incorporate the comments received on this draft NUREG as soon as practical to support near-term finalization of this important work.

We trust that NRC staff will find these comments useful and informative, while continuing to give priority to finalization of the document. Please contact me at vka@nei.org or (202) 739-8101 with any questions or comments about the content of this letter or the attached comments.

[1] The Nuclear Energy Institute (NEI) is responsible for establishing unified policy on behalf of its members relating to matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect and engineering firms, fuel cycle facilities, nuclear materials licensees, and other organizations involved in the nuclear energy industry.

Sincerely,

Victoria K. Anderson

Attachment

c: Mr. Michael Cheok, RES, NRC
Mr. Mark H. Salley, RES, NRC
Mr. David Stroup, RES, NRC

**Attachment: Detailed Comments on Draft NUREG 2178 Volume 2**

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| 1 (pdf pg 30) | "HRRs for electric motors and dry transformers: Appendix G of NUREG/CR-6850 recommended ***bounding/conservative values for HRRs*** associated with electric motors and dry transformers based on the values assessed for electrical cabinet fires. " | HRRs from 6850 were not bounding/conservative in all instances, as compared to the values presented in 5, recommend rephrasing this statement. |
| 1 (pdf pg 30) | The section for Non-suppression floor value doesn't end with a period. | Add a period to the end of the section on 'Non-suppression floor value'. |
| 1 (pdf pg 30) | The discussion on 'Non-suppression floor value' doesn't indicate that it is only applicable to MCR fires, however the discussion within the report does limit the applicability. | Recommend including some discussion about the non-suppression floor value change being applicable only to the MCR. |
| 1.3 (pdf pg 31; lines 18-25) | "The terms "electrical enclosures" and "electrical cabinets", as used in this report, are inclusive of cabinets, panels, and relay racks as those terms are used in NUREG/CR-6850 and other related FPRA documents and standards.<br><br>In NUREG/CR-6850 the term "enclosure" is used in two other contexts—namely, the regulatory issue of cables and components that share a "common enclosure" (e.g., cables routed in the same cable tray), and the modeling of ***"enclosure fires" (i.e., fires that occur within a room as opposed to fires that occur in an open unconfined space).*** The reader is cautioned not to confuse these unrelated uses of the word "enclosure." | This discussion implies that when used, the term "enclosure fires" does not relate to "electrical enclosures" or "electrical cabinets" but instead means a fire occurring in a room. However, in many places of this report the term "enclosure fire" is directly used to refer to a fire in an electrical cabinet (most often in Section 4).<br><br>This section should be revised to clarify that "enclosure fire" is used in 2178, Vol 2 to mean an electrical cabinet fire. |
| 1.4 (pdf pg 31; line 39) | "Section 4 provides additional guidance beyond that in NUREG/CR-6850 Appendix S" | Include comma "NUREG/CR-6850, Appendix S" |
| 2 | | If available, provide FDS results for obstructed radiant runs in excel format. This will limit the use of interpolation the analyst needs to perform and therefore reduce uncertainty. |
| 2 and 3 | | Provide statement on whether or not obstructed radiation factors can be used if using the point source method. |

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| 2, 3, and Appendix B | | Obstruction factors greater than 1 will result in ZOIs larger than those predicted by the FDTs. Clarify whether or not the analyst must use ZOIs larger than those produced by the FDTs. |
| 2, 3, and Appendix B | | A simplified approach to obstructed radiant ZOI when using damage threshold method would be to apply the 98th% obstruction factor of a given source to all percentiles of the fire since the 98th% obstruction factor will always be bounding. Suggest including this method as a suggested approach. |
| 2, 3, and Appendix B | | A simplified approach to obstructed radiant ZOI when using damage threshold method would be to apply the 98th% obstruction factor of a given source to all percentiles of the fire since the 98th% obstruction factor will always be bounding. Suggest including this method as a potential approach. |
| 2, 3, and Appendix B | | Chapter 2 establishes that the adjusted FDT is the suggested radiant ZOI model for unobstructed radiation. However, in the main body sections pertaining to obstructed radiation, the values presented use the unadjusted FDT and the adjusted FDT values are maintained in App. B rather than the main report. Furthermore, the information provided in App. B is limited compared to that in the main report. Suggest that for the damage threshold approach documented in the main report, the adjusted FDT be used and App. B should document the unadjusted FDT. Both methods should include full analysis (e.g., obstruction factors, max severity factors, Groups 1-3 approach, etc.) |
| 2.2.2 (pg 38) | Equation 2-2 | The surface, S, is dependent on $L_F$ and D, not height of target above fire base, H. Equation 2-4 correctly shows this. Update equation 2-2 to replace H with $L_F$. Ensure the graph in Figure 2-4 is using the correct equation. |

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| 2.3.2 (pg 46) | ...size for the cabinet size and door status based on NUREG-2178, i.e., 325 and 1,000 MW for medium and large cabinets, respectively. | Change units from MW to kW. |
| 2.3.3 (pg 50) | Vented / unvented face – A vented cabinet face is a face where there are openings to support substantial air flow in or out of the cabinet. These would include louvers for passive or mechanical ventilation, areas of wire mesh, large areas with no panel present, or a face with an access panel / door that is not robustly secured. | The final criteria implies that any panel that does not meet the definition of robustly secured is to be considered vented. Define robustly secured (e.g., guidance from FAQ 08-0042). |
| 2.3.3 (pg 50) | A vented cabinet face is a face where there are openings to support substantial air flow in or out of the cabinet. These would include louvers for passive or mechanical ventilation, areas of wire mesh, large areas with no panel present, or a face with an access panel / door that is not robustly secured. An unvented face is a face with no significant openings to support substantial air flow in or out of the cabinet. | The final criteria for a vented face implies that a panel that is well sealed, but not necessarily robustly secured (e.g., has a simple twist-handle style top-and-bottom-latches), is to be considered vented. However, the next sentence suggests that if the face is unvented (i.e., well sealed), the panel can be considered unvented. Provide clarification on the treatment of well sealed panels that do not meet the definition of well secured. |
| 2.3.3.2 (pg 54) | For the south and west faces the FDS predicted ZOIs are less than the adjusted FDTs ZOIs for 85% to 92% of the results. 3% to 8% of the FDS ZOIs are greater<br>19 than 110% of the adjusted FDTs ZOIs. | These statistics also apply to the east wall. Update wording to include the east wall. |
| 3 (pg 33) | … a solid flame model [3], or the use of field model such as the Fire Dynamics Simulator (FDS) [4, 5]. | Update wording:<br>… a solid flame model [3], or the use a of field model such as the Fire Dynamics Simulator (FDS) [4, 5]. |
| Figure 3-1 | | Figure 3-1 implies that there is no benefit on the vented cabinet face, but it should be implying less benefit. The green and red lines should be separated on the vented face. |
| 3.1.1 | | Provide definitions of Threshold Approach ZOI Factor or Damage Integral Approach ZOI Factor prior to Table 3-1 or point to Section 2.3.3.4. |
| 3.1.1 (Table 3-2) | The values within Table 3-2 for TP cables result in less severe consequences than TS cables for large, closed (0.76 vs 0.78) and medium, open (0.9 vs 0.98) cabinets. | Thermoset is worse than TP for Medium Open and large closed for default loading. Confirm this is correct and recommend including a note below the table to verify. |

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| 3.1.2 (pg 74) | | Provide all inputs necessary to determine the ZOI of the example sources. |
| 3.1.2 (pg 74) | | Identify if the Threshold Approach ZOI Factor or Damage Integral Approach ZOI Factor is being used in the example. |
| 3.2.2 (3-7) | "Consider a TP electrical cable that is located 0.25 m (0.8 ft) from the **unvented face of large, closed cabinet**. For this cabinet Table 3-3, has a maximum severity factor of 0.10. The actual severity factor for the cable could not be larger than 0.1; however, it could be less. If the detailed tables from Section 2 were used, the severity factor for this cable would be 0.07. | This example states the maximum severity factor is 0.10 or 0.07. This is for **low fuel loading** large cabinets, which is not stated in the example. For default fuel loading cabinets, the maximum is 0.25/0.20.<br><br>Specify the appropriate fuel loading in the example. |
| Tables 3-3 and 3-4 | | Typically, severity factors less than 0.02 are screened. These tables have values of less than 0.02 (e.g. 0.01). Recommend using a screen abbreviation when there is no external impact (e.g. SCRN). This could also be used in Tables 3-1 and 3-2 for clarity. |
| 4.1.4 (pdf pg 88) | "No modifications are intended to the existing guidance for determination of functional damage to equipment due to fire affecting cables and components inside the electrical enclosures." | Recommend addressing the following portion of cabinet to cabinet damage approach discussed in Section S.2 of NUREG/CR-6850: "*Assume no damage in the second adjacent cabinet occurs until after the fire propagates to the adjacent cabinet. Assume damage can occur earlier if there are large openings in a wall and plenum areas in which a hot gas layer is likely to form.*"<br><br>If damage is not postulated until after ignition, and the rules for ignition are now changing, confirm that the new rules for ignition do not invalidate the previous rule for damage based on ignition. |
| 4.1.4 (pdf pg 88) | "3) The guideline and methods described here are not intended to apply to high energy arc fault (HEAF) fire scenarios." | Can this be elaborated on? As in, what guidance should be followed for HEAF scenarios or is this information expected to be included in future testing? |

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| 4.2.2.1, 4.2.3, & 9.2 (Various pages) | 4.2.2.1: "Double Wall"<br><br>9.2: "Cabinet to cabinet fire propagation can be screened for the following configurations:<br>• Double wall air gap" | Section 9.2 configuration classification should be changed from "Double wall air gap" to "Double Wall" for clarity and consistency with Sections 4.2.2.1 & 4.2.3. |
| 4.2.2.2 (pdf pg 90) | "As a result, for open-top enclosures fire spread along horizontal cable runs is considered unlikely." | This statement seems to be referring to fire spread along horizontal cable runs from one cabinet to another, however that is not explicitly clear and could be misconstrued to mean open top enclosures wouldn't ignite horizontal runs of cable that are outside the cabinet. Recommend adding some clarifying words to this statement. |
| 4.2.3 (pdf pg 94) | Recommend revising the terminology of the following enclosure classifications, as listed in 4.2.2.1 and/or 4.2.3:<br>•Small Enclosure<br>•Switchgear | For consistency and additional clarity revise the enclosure classifications to match between Sections 4.2.2.1, 4.2.3, and 9.2.<br>•Group 4c: Small Enclosure<br>•Switchgear & Load Centers<br>Otherwise, "small enclosure" could be mistakenly be thought to be engineering judgment. |
| 4.4.2 (pdf pg 99) | 43 "If additional resolution of HRR is required for the exposed cabinet, the exposed cabinet have HRRs sample from the upper 50 % of the exposed cabinet distribution. For example, if the exposed cabinet is a large, open, thermoplastic (TP) enclosure it could be represented by a 1000 kW fire with a severity factor of 1 or as a 1000 kW fire with a severity factor of 0.25 and 392 kW fire with a severity factor of 0.75 (where 392 represents the upper 75 % of the upper half of the distribution or the 87.5th percentile fire)." | As written, this is difficult to understand. It is not clear what is meant by 'if additional resolution of HRR is required.' Recommend rewording to better clarify that the user has the flexibility to apply any HRR to the exposed enclosure HRR as long as the HRR is greater than the 50th percentile HRR using the gamma distributions assigned in 2178.<br><br>Also, consider including an example of this into Appendix D for additional clarity on the application. |
| 4.4.2 | | NUREG-2230 growth profiles should be mentioned as an option. The exposed cabinet growth should begin 10 minutes after growth starts in the exposing cabinet |
| 4.5 (pg 4-16) | Assume the peak fire intensity for the exposing enclosure corresponds to the 98th percentile of the peak HRR distribution applicable to the exposing enclosure (i.e., based on size, function, and/or fuel loading conditions). | As written, this sentence states that the peak fire HRR from the exposing enclosure corresponds to the HRR of the exposing enclosure, which is redundant. Consider rephrasing to remove the redundancy. |

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| 5.1 | The guidance and analysis presented and described in this section apply only to the determination and analysis of electrical fires in electric motors (bins 2, 14, 21, 26, and 32). | Suggest adding Bin 9 (air compressors) as part of the analysis for electric motor heat release rate and fire growth. |
| 5.1.5.1 (pg 104) | Only a small fraction, 2 events, describe fires that caused extensive damage to the ignition source. | If the intent of this sentence is to convey "extensive damage to the ignition source" as grounds for assuming threat of external damage to targets outside the ignition source, it should be clearly noted. |
| 5.1.5.2 (pg 105) | Figures 5-1, 5-2, and 5-3 | Include the "<" symbol within the figures to denote less than the stated HP values on the axes. Include axis bars on figure 5-3. |
| 5.1.6.1 (pg 110) | The wiring used in the rotor and stator are insulated with a coating that is assumed to be flammable. that is assumed to be flammable. | Typo - Remove second " that is assumed to be flammable." |
| 5.1.6.1 (pg 110) | Based on a review of pictures showing the internal components of electric motors, the cables within an electric motor do not run the entire length of the motor casing is assumed to contain the cables and conductors. | Sentence is unclear. |
| 5.1.6.1 (pg 113) | Similar to the HRRs presented in NUREG/CR-6850 [1] and NUREG-2178 [2] utilize a gamma distribution is selected for two reasons: | Similar to the HRRs presented in NUREG/CR-6850 [1] and NUREG-2178 [2], this method utilizes a gamma distribution which is selected for two reasons: |
| 5.1.6.1 (pg 113) | 2. It produces a good fit to the data while maintaining a similar technical approach as previously used. | Suggest more technical wording to replace "good fit" within this justification. |
| 5.1.6.1 (pg. 111) | In some cases, these temperature ratings are greater than the steady state failure criteria for thermoplastic electrical cables, therefore it is considered appropriate to treat the insulation as having superior performance relative to a thermoplastic cable. | If the intent of this sentence is for the analyst to assume thermoset cable criteria, it should be clearly noted. |
| 5.1.7 (pg. 118) | The feeder cable to the adjacent motor is routed directly behind and adjacent to the ignition source. | It is unclear as to the purpose of this sentence. If the intent is to provide evidence that no external damage occurred during the described event, it should be clearly stated. |
| 5.1.7 (pg. 119) | This is confirmed by investigation of… | Stray paragraph break between lines 12 and 13 of this page. |

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| 5.1.8 (pg 5-18)<br>9.3.1 (pg 9-2) | 5.1.8: "Growth: ***2*** minutes, t-squared growth"<br>9.3.1: "Growth: ***3*** minutes, t-squared growth" | Fire growth duration of electric motors in Section 9.3.1 does not match what is provided in Section 5.1.8 |
| 5.2 (pg 120) | The scope of this evaluation does not impact the treatment of fires in oil filed transformers which are expected to have substantially different burning characteristics due to the liquid fuel. | The scope of this evaluation does not impact the treatment of fires in oil filled transformers which are expected to have substantially different burning characteristics due to the liquid fuel. |
| 5.2.6.1 (pg 130) | 2. It produces a good fit to the data while maintaining a similar technical approach as previously used. | Suggest more technical wording to replace "good fit" within this justification. |
| 5.2.6.1 (pg 132) | Any increase in the ZOI due to the increase in the HRR following the guidance provided in Table 5-8 compared to the peak HRR following the guidance provided in NUREG/CR-6850 of 69 kW will be on the order of inches. | Specifically with the increase from 69kW to 130 kW peak HRR, the plume ZOI for thermoplastic targets increases by ~1.8 ft and the radiant ZOI increases by ~9 inches. Likewise, the thermoset plume ZOI increases by ~ 1.4ft and the radiant ZOI increases by ~6 inches. Suggest clarification, plume ZOI changes by more than a matter of inches.. |
| 6 | | Up until this point in the report, fire diameter has been calculated using the guidance found in Section 4.2 of NUREG-2178 Volume 1 (i.e., enclosure footprint or assigning the characteristic fire diameter). It is not clear how equation 6-3 of this report was derived nor is it clear what the heat flux value represents. Suggest using the guidance found in Section 4.2 of NUREG-2178 Volume 1 OR provide reference for equation and define what the heat flux variable is meant to represent and if a radiative fraction needs to be included. |
| 6 (pg. 6-2; Equation 6-3) | | The location factor is typically not used for calculating the fire diameter. Remove location factor from fire diameter equation. If location factor is necessary, provide justification. |
| 6 (pgs. 6-5, 6-6, and 6-7) | "...different bias using both the traditional image method fire location factor and the modified fire location factor.." | Define traditional image method fire location factor or just state "traditional fire location factor". Update key in Figures 6-3 and 6-4 to include location factor in the description of each data set or figure titles to include mention of location factor. |

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| 6 (pg. 6-4, line 12) | "The temperature profile presented in Figure 6-1 remains primarily steady at various distances from a wall surface" | There is a dip in the temperature profile in Figure 6-1 and it is not addressed in the text. Include statement from NIST test which addresses this dip. |
| 7.4 (7-3) | The first step uses the MCR suppression rate in Table 8-6 for calculations of the Pns with a floor value of 1E-03. This results in fires that are suppressed prior to approximately 18 minutes using a suppression rate of 0.385. The second step captures all remaining MCR fire durations up to the proposed floor of 2.4E-07 by making use of the ignition source bin specific suppression rate. For example, a fire in a cabinet located within the MCR will use the Interruptible and Growing suppression rates presented in NUREG-2230 [62] for fire durations in excess of 18 minutes. | Specify that the two-step method is to be used for sources in the MCR besides the main control board |
| 8.6 (pg 8-34) | | In Table 8-15 there are values for in-cabinet detection is credited that are worse than values in Table 8-14 where there is no in-cabinet detection credited for the same enclosure type, which seems counterintuitive. |
| 8.6 (pg 8-34) | | The data in Tables 8-14 and 8-15 appears to suggest that the "Fraction of Fires that Spread to an Adjacent Panel ($\mathbf{1-\delta}$)" is more severe for Thermoset cabinets than Thermoplastic cabinets, (e.g., 0.114 (TS) vs 0.078 (TP) in Table 8-14 for 4a-Closed MCBs). This seems counterintuitive given that NUREG/CR-6850 and NUREG-2178 Volume 1 Suggest Thermoplastic fire HRRs/Severity factors are more severe than those of thermoset fires. |
| 8.9 (8-39) | The manual suppression rate is defined as 0.385 min-1 from Table 8-7. | The manual suppression rate is mentioned in Table 8-6 |
| 9.3.1 (9-2) | The following growth, steady burning, and decay durations should be used for motor fires.<br>● Growth: 3 minutes, t-squared growth<br>● Steady burning: 20 minutes<br>● Decay: 3 minutes, linear decay | Update statement to match Section 5.1.6.2, which states the fire growth for electric motors is:<br>● Growth: 2 minutes, t-squared growth<br>● Steady burning: 13 minutes<br>● Decay: 2 minutes, linear decay |

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| 9.5<br>(9-4) | Section 7 discusses the background on the NSP floor and provides a basis for lowering the floor to 2.4E-7 for fire scenarios in single unit MCRs. A revised floor value for dual unit MCRs of 3.5E-07 is also recommended based on a sensitivity analysis for multi-unit control rooms. | Add statement discussing two-step method for calculation manual non-suppression for non-MCB fires over 18 minutes in the MCR |
| Appendix A | Tables A-3, A-4, and A-5 refer to NUREG/CR-6805. | All references to NUREG/CR-6805 should be changed to 6850. |
| Appendix B | | Do these values apply to Groups 1, 2, and 3 as well as Groups 4a and 4b? There does not appear to be enough information to determine which groups these apply to. Please clarify which groups these apply to and if not Groups 1, 2, and 3 then include updated tables for those groups. |
| D.2.2 (pdf pg 242) | 6 "Ignition in the Exposing enclosure (Enclosure 5) will be assumed to take places at time = 0. The **peak HRR of 325 kW** will be reached after 12 minutes following a t2 growth profile per NUREG/CR-6850." | Enclosures 4, 5, and 6 are discussed in this section, each of which are said to be 2178, Group 4b enclosures with default loading and based on Figure D-1, ***these enclosures would represent closed door configurations***. However, the HRR that is identified is 325kW, which is the HRR for Group 4b, default loading ***with open doors***.<br>Either fix this by updating the HRR used in the example to match closed door configuration, or update the cabinet to specify that the cabinet has open doors. |
| Page 8-16 | Given the new NSP floor described in Section 7, the numerical results for the Control Room suppression curve are presented in Table 8-7. | It is unclear how this should be applied relative to the growing/interruptible fires described in section 7.4. If this version is strictly for Bin 4, this should be noted. |
| Page 8-22 | Based on this ZOI, the recommended process consists of identifying targets within “circles” of approximately 0.09 m2 (1.0 ft2) throughout the surface of the panel. | It would seem more practical for application of this guidance to allow for a grid or square approach of the same size to be used to ensure all area of the board is covered and simplify the process. |
| Page 8-24 | recall that small fires under 20 kW are explicitly modeled in earlier branches of the scenario progression event tree | 20 kW is never explicitly stated as the limit in the discussion of previous branches. If this is an equivalent based on the 1.0 ft2 ZOI, the inputs for this should be given such as TP or TS cable assumed, radiatvie or plume target assumed, etc. |

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| Page 8-3 | Calculation of fire ignition frequencies for each panel within the MCB. The ignition frequency for this screening process is a multiplication of | Does this include the location weighting factor from 6850? i.e. factor of 2 for a 2 unit plant with 1 MCR. |
| Pages 8-12 - 8-14 | 8.3.2.2 Frequency Apportionment Example 2 | For this example, since the rear MCB panels are counted separately, it would be useful to have an image of what the rear side looks like to illustrate the point. The current images in Figure 8-6 and 8-7 are only front side images. |
| Section 2.2.3.1 (pg 38) | The ratio of these two is 2.2. | The ratio of the two is 2.1 (57.5/27.3). The 2.2 value may have mistakenly been taken from the area of the cylinder. Update paragraph to use 2.1. |
| Section 2.3.1 (pg 44) | This results in horizontal ZOIs of 1.65 m (5.4 ft) and 0.93 m (3.1 ft) from the edge of the fire respectively for the TP (6 kW/m2) and TS threshold damage fluxes (11 kW/m2). | It is not clear how the ZOI is to be calculated once an adjusted emissivity is calculated. Clarify that when using method 2 of Section 2.2.3.1 (i.e., heat flux ratio), the analyst should use the Solid Flame 2 tab of FDT 05.1 and assume the target is located at a height of 1/2 the flame height (i.e., bounding case). |
| Section 7.4, Figure 7-1, and Table 7-2 (7-3, 7-4, and 7-5) | The first step uses the MCR suppression rate in Table 8-6 for calculations of the Pns with a floor value of 1E-03. This results in fires that are suppressed prior to approximately 18 minutes using a suppression rate of 0.385. The second step captures all remaining MCR fire durations up to the proposed floor of 2.4E-07 by making use of the ignition source bin specific suppression rate. For example, a fire in a cabinet located within the MCR will use the Interruptible and Growing suppression rates presented in NUREG-2230 [62] for fire durations in excess of 18 minutes. | Provide equations so the values in Table 7-2 can be replicated. Statement is unclear how to apply the two-step calculation |
| Table 2-1 (pg35) | | The number of significant figures shown varies within a column. For example, the flame height of the small cabinet reports the measurement in meters to the hundredths place and the 378.5 liter oil spill only reports to the ones place. Make number of significant figures shown within a given column consistent. |

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| Table 2-1 (pg35) | | The Distance for Heat Flux values presented do not take into account the fire diameter, D. Based on the equation presented in Figure 2-1 and FDT 05.1, the values calculated should have D/2 subtracted. Update values OR add assumption that the area is assumed 0.<br><br>If fire diameter is included, update Section 2.2.1 pertaining to Distance Ratio to discuss highest ratio of 1.93 following the update to Figure 2-1. |
| Table 2-5 (pg 67) | | The Adjusted FDT ZOI values given for the 1000kW fire do not match with those provided in Section 2.3.1. Make values consistent. |
| Table 3-3 and Table 3-4 (pg 76) and Table 3-9 (pg 82) | | It is not clear which FDT (i.e., adjusted or unadjusted) was used to populate the numbers in Table 3-3, Table 3-4 and Table 3-9. Provide documentation of which FDT was used.<br><br>If unadjusted FDT is used, provide Maximum Severity Factors for adjusted FDT in Appendix B. |
| Table 8-10 | 0.3 \|Typical fire radiant fraction | Since this an MCB specific analysis, reference to the radiative fraction of typical cable materials should be made to ensure this radiant fraction is acceptable. |
| Table 8-17 and 8-18 | Manual suppression rate constant from Section 8.3.2 | Update statement to reference Section 8.3.3 |