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General Comment

See attached file(s)

Attachments

08-29-22_NRC_HEAF NUREG comments

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August 29, 2022

Michele Kaplan
Director, Division of Resource Management and Administration
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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Industry Comments on Draft NUREG-2262, "High Energy Arcing Fault Frequency and Consequence Modeling," Docket ID NRC-2022-0130

Submitted via Regulations.gov

Project Number: 689

Dear Ms. Kaplan:

The Nuclear Energy Institute (NEI),[1] on behalf of its members, submits the following comments on draft NUREG-2262, "High Energy Arcing Fault Frequency and Consequence Modeling," Docket ID NRC-2022-0130. We appreciate the opportunity to comment on this important draft NUREG, as the contents of this first report represent the results of collaborative work that will provide more detailed insights on plant risk presented by potential High Energy Arcing Fault (HEAF) events.

This draft NUREG is based on validated models and represents an improvement to the realism in methods available for development and refinement of Fire Probabilistic Risk Assessment (PRA) models. As with all PRA methods and data, it is important to support continuous improvements to realism in modeling HEAF events, and NEI therefore suggests that several areas of conservatism be addressed prior to finalization of this NUREG. Specifically, the approach to target mapping at transition points retains conservative assumptions, the bus duct type bins do not support mixed treatment, and ensuring fire treatment remains conservative in many ways. Detailed comments on these conservatisms, as well as additional detailed comments, are included in the attachment to this letter.

[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.

Additionally, NEI would like to ensure clarity regarding the use of any NRC-issued documents on modeling HEAF events in PRAs. Specifically, while licensees may choose to use these new methodologies, they are under no obligation to do so by any voluntary or compulsory regulatory program. Existing methodologies for modeling HEAF remain adequate for support of licensee PRAs, and there is no indication that the methodology in this draft NUREG would substantively change the results from a Fire PRA model. The existing methodologies used in licensee PRAs are therefore adequate for use and in accordance with Regulatory Guide 1.200, "Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities," which provides guidance for PRA technical acceptability for PRAs supporting licensing applications.

We encourage NRC to consider and address all stakeholder comments on this draft NUREG. Please contact me at vka@nei.org or (202) 739-8101 with any questions about the content of this letter.

Sincerely,

Victoria K. Anderson

Attachment

c: Mr. Mark Salley, RES
Mr. Gabriel Taylor, RES

Page	Section	Statement from Report	Comment
Various	Various	"15 MJ/m2 target fragility" & "30 MJ/m2 target fragility"	Throughout the document, "15 MJ/m2 target fragility" & "30 MJ/m2 target fragility" should be changed to use the more common terms "thermoplastic" and "thermoset."
Various	Various	Thermoplastic and thermoset cable	All references to thermoplastic cable or thermoset cable should specify if referencing the jacket or insulation material. Recommend consistently using “thermoplastic jacketed cable,” as an example.
ix	Executive Summary	General	The scope of the overall report seems to ignore a design configuration wherein an additional transformer exists between Zone 1 and Zone 2. In such configurations the size of the associated transformer (e.g., 13kv – 4kv) can be relatively small and consequently the maximum available fault current can be well below the designed capability of the switchgear. It is unclear whether such a configuration was considered or addressed within the framework of this NUREG. It would be beneficial if some discussion for such a configuration could be provided.
x	Executive Summary	"Section 6 provides general guidance on the energetic portion of the HEAF ZOI, how to determine fault clearing times, and characteristics of the post-HEAF ensuing fire.	State that the energetic portion of the HEAF ZOI discussed in Chapter 6 is specific to switchgear and load centers.
x	Executive Summary	The overall discussion on Section 8 regarding fragility.	Use of "and" for defining the 15 and 30 MJ/m2 target types may be misleading in lines 38-47. For example, as written it reads that 15 MJ/m2 should be used when you have thermoplastic targets AND aluminum enclosed bus ducts. One solution here would be to use commas separated values in the parenthesis with an "etc." at the end since there are more than 2 criteria to apply each fragility level.
	2	None	“Target Fragility” should be a defined term in Section 2 Terminology.

Page	Section	Statement from Report	Comment
	3.6.3	General	The discussion of switchgear main bus bar faults does not address the design configuration wherein a bus differential is applied. The discussion in the report should acknowledge that if such a design exists and the breaker(s) actuated by such a differential relay successfully opens (trips), then a HEAF event would not occur. This conceptual approach should apply to all instances where an 87 device is applied.
3-32	3.6.5	*Figure 3-14*	The 9th branch down (supply side of supply breaker, fails/stuck, SAT, with zone of differential (87), one switchyard breaker fails/sticks) should be light grey text since the duration is less than or equal to 0.2s, and therefore wouldn't be expected to cause a HEAF.
3-34	3.7.1	*Figure 3-16*	The last branch should have a duration of 0.4 to 5.2s instead of 0.4 to 5s.
5-9 to 5-11	5.2.3	It is possible to use both the known transition point and the unknown transition point method in the same analysis if the frequency is conserved within the respective NSBD bin.	Section 5.2.3 discusses the development of the ignition frequency weighting factors applied to Zone 1 and Zone 2 MV switchgear. These are based on OE, and thus appear to implicitly include the breaker protection failure likelihood for the Zone 2 events. It is not exactly clear that modeling a Zone 2 event should not (or should) multiply the Zone 2 HEAF ignition frequency by the probability of upstream supply breaker failures (as illustrated in Figure 6-5). A statement could be added to clarify the intent.
5-10	5.2.3.1	In addition to the transition points, fire PRA targets in locations with a propensity to allow for degradation of the bus bar insulation – vents, hatches, or wall penetrations – should be captured and included with scenarios structured around the nearest transition points.	Inclusion of bus duct vent/drain/pens/hatch targets with the closest transition point could result in capturing targets from both Engineered Safety Feature trains in one scenario, even though the train targets are well separated and farther apart than the bus duct ZOI. It is not clear if the OE indicated that events related to vents/drains/pens/hatch occur at that location or at the nearest transition point? If at the vent/... location, then recommend including the vents/drains/pens/hatches in the count, and mapping targets exclusive to

Page	Section	Statement from Report	Comment
			those locations. Inclusion of the additional targets at the nearest transition is more conservative than the method provided for unknown transition points, which does not address vents/drains/pens/hatches (Page 5-16, Example 2).
	5.2.3.3	General	As written, the guidance does not allow a mixed treatment within a bus duct type bin. For example, assume a plant has 500 feet of non-segregated bus duct and the location of transition points are not readily apparent. Therefore, the approach described in 5.2.3.2 is used. However, during analysis development and/or refinement it is discovered that a key critical target is within the ZOI for a ‘short length’ of bus duct. If it can be determined there are no transition points or features described in Section 5.2.3.1 within that ‘short length,’ the guidance would not allow the HEAF event to be precluded using the guidance in Section 5.2.3.1. Section 5.2.3.3 should be modified to allow a mixed treatment within a bin – i.e., the HEAF event can be excluded provided the frequency for the ‘short length’ is re-apportioned to the remaining lengths of bus duct.
5-20	5.3	Table 5-8 Fire ignition frequency distribution for HEAF ignition sources	It would be beneficial to include the frequency previously assigned for a quick assessment of increases or decreases in the generic frequency.
5-21	5.3.1	*The value of 3.5E-05 associated with the air-blast type GCB bounds the failure results for the three different GCB technologies. Credit for the GCB interrupting the faulted conditions can be applied when the fault is within the GCB zone of differential protection. This credit can be applied to the following fault zones:*	Application of 1-GCB factor is not discussed here. The other frequency modifiers in this document function like split fractions, where applicable, and add up to 1.0. The difference here should be clarified to avoid issues where it will appear frequency is not conserved.

Page	Section	Statement from Report	Comment
5-23	5.4	*The primary difference is the number events counted for the determination of the suppression rate results from the inability to count events with no suppression time (self-extinguish), automatic suppression, or unknown suppression times.*	If there are known fire events where self-extinguishment occurred, this could be developed into a split fraction where no ensuing fire occurs. This would benefit the overall results given that the HEAF suppression curve has historically been one of the most challenging. Additionally, “number events” should read “number of events.”
	6	General	The guidance provided earlier in Section 5 of the NUREG modifies the counting for switchgears such that each switchgear is counted as a unit. The guidance provided in Section 6 seems to suggest that the HEAF must be assumed to originate anywhere along the ‘footprint’ of the entire switchgear. While the guidance in Section 5 provides some guidance in varying the treatment of incoming versus outgoing breakers, it is unclear how the assigned frequency is to be partitioned for each of the HEAF scenarios for the switchgear. It is also unclear if the EDG supply breaker is considered a ‘load’ or ‘supply’ breaker in the context of this NUREG.
6-1	6.1	Figure 6-1	Figure 6-1 (as well as others) illustrates HEAF ZOIs and implies that no damage occurs in the areas extending from the corners between the front/back zones and the side/side zones or the top zone, as opposed to bus duct ZOI shape of “rounded corner square.” As an example, in Figure 11-19 (page G-8), imagine that cable A penetrates the floor at “u” in the title “Figure 11-19,” and Cable C penetrates the floor at “y” in the title “supply,” these cables would be outside the HEAF front or side ZOIs. If this is not intended, this should be corrected.

Page	Section	Statement from Report	Comment
6-2	6.1	Note that the ensuing fire ZOI may expand beyond the ZOI associated with the HEAF if secondary combustibles are involved, a damaging hot gas layer forms, or adjacent electrical enclosure sections are ignited.	Per Section 6.5, the ensuing fire is required to utilize a 170kW fire. The ZOI from the 170kW fire is larger than the majority of the HEAF specific ZOIs when utilizing NUREG-1805 FDTs. The statement in question implies that the ensuing fire ZOI will only be larger than the HEAF ZOI if the ensuing fire involves secondary combustibles, creates an HGL, or ignites adjacent sections. If this is true, Section 6.5 should be revised to be consistent with this statement in Section 6.1.
6-5	6.2	have bents with louvers or filters	Change "bents" to "vents"
6-12	6.3.2	Figure 6-8	There is no stated justification for the non-credit for the Zone 1 load breaker feeding the faulted Zone 2 bus supply breaker (refer to Figure 6-8). This justification should be included, or the credit explicitly described.
	6.4	General	For fault clearing time, guidance should clarify if both relay operating time and breaker operating time should be accounted for
6-17	6.4	Obtain the available short-circuit (ASC) at each Zone 1 MV switchgear. ASC may be provided on the TCC curve or determined from a separate station short-circuit current calculation.	Guidance should clarify which fault current needs to be used to determine FCT. Is it arcing or 3 phase bolted fault current? Guidance should clarify if this needs to be done for both minimum and maximum fault conditions.
6-19	6.4.2	Section 3.2.3 summarizes a review performed for a sample of United States NPPs and an upper bound of 4 seconds was determined for the time it takes for the Zone 1 MV switchgear bus supply circuit breaker to operate.	Section 3.2.3 has an apparent additional step, in that the 3 phase bolted fault current was used to determine arcing current before determining FCT. Section 3.2.3 step 3 references use of IEEE 1584-2018 to estimate the corresponding arcing fault current from the ASC current in step 2. Then the arcing current was used to determine FCT. This is different from 3 phase bolted fault. Please resolve the disparity between 6.4.1 and 6.4.2.

Page	Section	Statement from Report	Comment
6-19	6.5	Fire elevation for ensuing fire	The fire elevation to be used in the ensuing fire should be addressed. It is not clear where the ensuing fire should start for a cabinet in a lower section, or if the cubicle height be utilized in some way.
6-19	6.5	General comment on the ensuing fire guidance.	The application of this guidance calls for the ensuing fire having a maximum HRR at time 0 for switchgear and load-centers creates a zone of influence that exceeds the majority of the energetic ZOIs (Sections 7 & 8) immediately. Much of this guidance identifies HEAF events that will be significantly smaller than previously expected. Assuming, for all cases, that the ensuing fire will immediately reach the 98th% HRR significantly limits the use case for this new guidance. Less conservative guidance around the application of the ensuing fires should be pursued.
6-21	6.5.1	This is because the HEAF is considered a more severe ignition factor and the side breach pattern for medium voltage switchgear is generally symmetric [46].	Reference 46 (NUREG-2178, Volume 2) doesn't appear to be the correct reference for this statement. NUREG-2178, Volume 2 doesn't discuss HEAF breaching patterns.
6-21	6.5.1	General comment on adjacent cabinet propagation.	The referenced HEAF events in Appendix A of this draft report mention damage to adjacent sections, however, they do not make any inference of sustained ignition to the adjacent cabinet sections. These events are Incident Numbers 434 (Page A-2), 106, and 112 (Page A-7). These incident reports do not support considering propagation to adjacent cabinet sections for the ensuing fire.
6-21	6.5.1	General comment on adjacent cabinet propagation.	The assumption that a HEAF above 101 MJ allows for sustained ignition, and requires ignition of both adjacent vertical sections that must be modeled as a 98th% HRR is overly conservative based on the guidance and provided testing data.

Page	Section	Statement from Report	Comment
6-21	6.5.1	Testing by Sandia [53] indicate that sustained ignition after a HEAF requires energy fluxes greater than 30 MJ/m².	The basis for the methodology to ignite the adjacent vertical section does not seem to be in alignment with the referenced documents. The referenced Sandia testing was performed on open box enclosures, and with no secondary combustibles adjacent to them. The conclusions of this draft report are focused on the characteristics of a HEAF (i.e., thermal energy, mass loss, air conductivity, surface conductivity, and electromagnetic interference), not on propagation. While there is some severe damage to the enclosures for HEAFs over ~22MJ (e.g., Test OBMV06, Section 4.2.4), it doesn't consider that the vertical sections could have more than one layer of steel between them, and none of the tests looked at secondary combustibles or the possibility of ignition in adjacent cabinet vertical sections. Therefore, how this testing was used to develop the basis for requiring 30 MJ/m² is unclear. Recommend revising the guidance to allow screening the possibility of adjacent cabinet spread.

Page	Section	Statement from Report	Comment
6-21	6.5.1	Fire propagation is likely in the adjacent vertical sections.	None of the testing performed for this issue supports the conclusion that adjacent cabinet propagation is realistic, and this statement should be removed. Per NUREG-2178, Volume 2, Section 4.2.2.7, switchgears and load centers have limited fuel loads (low/very low) and are normally ventilated. Propagation to adjacent cabinet sections is not considered for HEAF scenarios since the mechanical force associated with the HEAF event will cause the cabinet doors to blow open. This will result in venting in the cabinet preventing an internal hot gas layer from forming which is what NUREG/CR-6850 states is the basis for adjacent cabinet spread. Section 4.2.2.2 of NUREG-2178, Volume 2 states that cabinets with open top configurations allow the heat generated by the fire to be transferred outside of the enclosure reducing the likelihood of propagation. This would also be true for a cabinet whose doors have been blown open by the HEAF. Also, many Switchgear cabinets have open vents at the top, by design, which would also support venting and meet RF2 criteria for screening adjacent cabinet propagation. The cables within switchgear cubicles are typically a larger diameter which would be difficult to ignite from radiant energy. There is usually a double wall with an air gap between the switchgear sections as well. Even if the HEAF provided a greater than 5% opening between adjacent vertical sections, there is no combustible continuity between the vertical sections for the ensuing fire to spread. All of these factors would exclude propagation to adjacent vertical sections under normal circumstances.

Page	Section	Statement from Report	Comment
7-1	7.1	None	Provide definitions of the types of circuit breakers that are discussed in Section 7 if they impact the application of the analysis. For instance, "load center supply circuit breakers" and "load breakers" are not defined in Section 2, but could change the location where a HEAF is postulated. These terms should be explicitly defined to ensure the user understands the terminology adequately.
7-3	7.2 & Table 7-1	*Include guidance about how to apportion the frequency of a fire occurring at the different circuit breaker locations.*	There is no specific instruction about how to apportion the frequency of the fire if incorporating the Table 7-1 guidance. For example, if a vertical section has 3 cubicles, two would be "lower elevation" and one "upper elevation." It is not clear if the ZOI from Table 7-1 would apply to 2/3 of the vertical section's frequency and 1/3 to the upper elevation's frequency.
7-3	7.3	None	It would be helpful to state in this section that spread between adjacent vertical sections should not be applied to load centers. While this is stated in Section 6.5.1, consider also including it in Section 7 for clarity.
7-3	7.3	"A supply circuit breaker in the mid or lower elevation, location E or F in Figure 7-2, does not have a ZOI external to the switchgear. For this case, an ensuing fire should still be postulated at the supply circuit breaker. See Section 6.5 for modeling the ensuing fire."	This bullet specifies that an ensuing fire should still be modeled for this situation, however the ensuing fire is not addressed for the previous three bullets. Should the ensuing fire therefore not be modeled for the situations in the previous three bullets?
8-8	8.4	*"… (shown in Figure 8-2 and Figure 8-3) The screening…"*	A period should be placed after "…Figure 8-3)." to end the sentence.
10-5	10.2.2	Do not ***postulated*** fire propagation for arc energies of 101 MJ and below.	Editorial: Change to "Do not ***postulate*** fire propagation for arc…"
A-2, A-4, A-11, A-12	Table A-1	"ensuring"	There are multiple instances where there is a typo for "ensuing" fires where it's spelled "ensuring."

Page	Section	Statement from Report	Comment
G-6	G.1.4	*Row 20:* *"For the post-HEAF ensuing fire, the first cable tray ignites* ***dur*** *to the ensuing fire and eventually propagates to the third tray in the cable tray stack."*	Typo: "dur" should be "due"
G-11	G.2.4	*The ignition frequency for each scenario is split between the supply sections and supply breaker limited fault in* ***Error! Reference source not found****. (shown below as Figure 11-23).*	Correct the reference error