

Revision of IMC 0609 Appendix F, Fire Protection Significance Determination Process

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Purpose of Revision

- Revise the IMC to ensure that the fire protection guidance used in the IMC is consistent with current methods and guidance.
- Specifically, this revision incorporates updated fire protection guidance from the following NUREGs:
 - NUREG/CR-6850, Vol 2, “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology”
 - NUREG-2178 Vol. 2, “Fire Modeling Guidance for Electrical Cabinets, Electric motors, Indoor Dry Transformers, and the Main Control Board”
 - NUREG-2232, “Heat Release Rate and Fire Characteristics of Fuels Representative of Typical Transient Fire Events in Nuclear Power Plants,”
 - NUREG-2233, “Methodology for Modeling Transient Fires in Nuclear Power Plant Fire Probabilistic Risk Assessment”
 - NUREG-2262, “High Energy Arcing Fault Frequency and Consequence Modeling”

Documents Revised

- IMC 0609 Appendix F, “Fire Protection Significance Determination Process” (ML24150A359 or package [ML24241A154](#))
 - Attachment 1, “Fire Protection Significance Determination Process Worksheets” (ML24145A028)
 - Attachment 2, “Degradation Rating Guidance” (ML24145A029)
 - Attachment 3, “Guidance for Identifying Credible Fire Scenarios” (ML24145A030)
 - Attachment 4, “Guidance for Determining Fire Ignition Frequency” (ML24145A031)
 - Attachment 5, “Characterizing Fire Ignition Sources” (ML24145A032)
 - Attachment 6, “Guidance for Identification of Targets and Their Ignition and Damage Criteria” (ML24145A033)
 - Attachment 7, “Guidance for Non-Suppression Probability Analysis” (ML24150A357)
 - Attachment 8, “Tables and Plots Supporting the Phase 2 Risk Quantification” (ML24150A358)
- IMC 0308 Attachment 3, Appendix F, “Technical Basis for the Fire Protection Significance Determination Process” (ML24150A361)

Major Changes

- Adopted heat soak method and adjusted solid flame model in the zone of influence (ZOI), time to damage, and severity factor (SF) calculations (NUREG-6850 Vol 2 and NUREG-2232).
 - In general, this change results in smaller ZOIs and SFs and a longer time to damage than the previously used point source model.
 - The heat soak method was not used for the hot gas layer calculations.
- Incorporated new guidance for high energy arching fault (HEAF) ZOIs, heat release rates (HRRs), non-suppression probability, counting rules, and fire ignition frequencies (FIFs) (NUREG-2262).

Major Changes - Continued

- Updated ignition source categories for pumps, motors, dry transformers, and electrical enclosures (NUREG-2178 Vol 2).
 - Dry transformers have their own category and are no longer motors.
 - Pumps are now motors and defined by motor size.
- Incorporated new HRRs for dry transformers and class A, B, and C electric motors (NUREG-2178 Vol 2).
- Revised HRRs and categories of transient fires (NUREG-2233).
 - Transients are either generic or in a transient combustible control location (TCCL).
- Updated FIF and non-suppression probability curve for main control board fires (NUREG-2178 Vol 2).

Questions



Backup Slides

Ignition Source and HRR Changes

HRRs for Fixed Ignition Sources		
Ignition Source	2018 Revision HRR (kW)	2024 Revision HRR (kW)
Class A Motors (>5-30 hp)	69	15
Class B Motors (>30-100 hp)		37
Class C Motors (>100 hp)		100
Pumps	211	Use motor size
Class A Dry Transformers (>45-75 kVA)	Use motors 69	30
Class B Dry Transformers (>75-750 kVA)		70
Class C Dry Transformers (>750 kVA)		130
Group 1 Switchgear and Load Center (TP, Closed)	170	170
Group 2 MCCs and Battery Chargers (TP, Closed)	130	130
Group 3 Power Inverters (TP, Closed)	200	200
Group 4a Large Enclosures [>50 ft ³] (TP, Closed)	400	400
Group 4a Large Enclosures [>50 ft ³] (TP, Open)	1000	1000
Group 4b Medium Enclosures [>12 ft ³] (TP, Closed)	200	200
Group 4b Medium Enclosures [>12 ft ³] (TP, Open)	325	325
Group 4c Small Enclosures [≤12 ft ³] (All)	45	45

Transient HRR Changes

HRRs for Transient Ignition Sources		
Ignition Source	2018 Revision HRR (kW)	2024 Revision HRR (kW)
Loose/Generic Transient	317	278
Contained/TCCL Transient	317	143

Fire Ignition Frequencies for HEAFs

HEAF Type	Counting Unit	Zone-Wide FIF
Load Centers (≤ 1000 V)	HEAF fault zone 3	5.3E-04**
Zone 1 Switchgear (> 1000 V)	HEAF fault zone 1	1.7E-03**
Zone 2 Switchgear (> 1000 V)	HEAF fault zone 2	2.8E-04**
Non-segregated Bus Ducts	zones BDUAT & BDSAT	2.6E-03**
	zones BD1, BD2 & LVBD	9.0E-04**
Iso-Phase Bus Ducts	per bus duct end	5.0E-04
** To determine the per unit fire frequency the analyst should make an estimate of the affected fraction zone-wide and use this to apportion.		

Zone of Influence for HEAFs

Screening ZOIs for HEAFs		
	Radial ZOI	
Switchgear	4.5 ft for TP (15 MJ/m ²) Target	3.5 ft for TS (30 MJ/m ²) Target
Iso-Phase Bus Bar	5 ft	

Table A3.1 – Screening ZOIs for Load Center HEAFs				
Circuit Breaker Location and Target Fragility	Back and Front	Side (ft.)	Top (ft.)	
End location, upper elevation: 15 MJ/m ² (TP)	None	2.5	2	
End location, upper elevation: 30 MJ/m ² (TS)	None	1.5	1	
End location, lower elevation: 15 MJ/m ² (TP)	None	2.5	None	
End location, lower elevation: 30 MJ/m ² (TS)	None	1.5	None	
Interior, upper elevation: 15 MJ/m ² (TP)	None	None	2	
Interior, upper elevation: 30 MJ/m ² (TS)	None	None	1	
Interior, lower elevation: 15 MJ/m ² (TP)	None	None	None	
Interior, lower elevation: 30 MJ/m ² (TS)	None	None	None	

Non-Segregated Bus Duct HEAF ZOIs

Table A3.2 – Screening ZOIs for Non-segregated Bus HEAFs (in ft.)					
Bus Duct HEAF Fault Zone	Steel Encl. 15 MJ/m ² (TP) Target	Steel Encl. 30 MJ/m ² (TS) Target	Aluminum Encl. 15 MJ/m ² (TP) Target	Aluminum Encl. 30 MJ/m ² (TS) Target	
BDUAT	2.5	1.5	3.0	2.0	
BDSAT	3.0	2.0	3.5	2.0	
BD1–UAT*	4.5	3.0	5.0	3.0	
BD1–SAT**	3.0	2.0	3.5	2.0	
BD2	1.0	0.5	1.5	1.0	
BDLV	1.0	0.5	1.5	1.0	

* Normally powered by UAT

** Normally powered by SAT