

Very Early Warning Fire Detection System Modeling April 3, 2019



Overview

Goal:

- To continue developing the state of the art for modeling very early warning fire detection systems (VEWFDS) in nuclear power plant fire PRA.
- To further the state of knowledge in NUREG 2180

• Presentation Outline:

- Intended Path
- Expert Elicitation Results
- Path Forward

Intended Path

Plan:

- 1. Use Shearon Harris Nuclear Plant (HNP) as testbed/pilot for refined incipient modeling, as it has VEWFDS installed and has a great deal of the industry experience with the technology.
- 2. Conduct an expert elicitation as suggested in Section 8.2 of NUREG-2180 to inform further development of prevention strategy modeling
- 3. Using the insights provided by the expert elicitation, develop a refinement of the NUREG-2180 event trees and apply to HNP.
- 4. Publish the expert elicitation report and methodology through NEI.
- 5. Develop a generic approach from the HNP-specific method and publish for use.

Expert Elicitation Effort

- Conducted on the week of November 12th, 2018 at HNP
- Posed two questions to consider:
 - a) What is the expected duration of time between an incipient event reaching a detectable level, and it progressing to a potentially challenging fire.
 - b) What is the expected probability that an incipient event, if left unaddressed, might progress to a potentially challenging fire.

Participant	Expertise	Organization	
Francisco Joglar (Lead)	Fire PRA/Fire Modeling	JENSEN HUGHES	
Paul Way	Forensics/Root Case Analysis	JENSEN HUGHES	
Josh Dinaburg	Fire Testing/Fire Detection	JENSEN HUGHES	
Danny Brinkley	Component Degradation and Failure	Duke Energy	
David Miskiewicz	PRA and Fire PRA	Engineering Planning and Management, Inc	
Tim Groch	Fire Protection/Fire Modeling	Duke Energy	

Conclusions of the Expert Elicitation Panel

- Two days was determined as the expected mean duration between detectable incipient stage and progression to flaming.
- 0.01 was determined as the expected probability that a given thermally failing electrical component will progress to flaming ignition if unaddressed.



Figure 7-1: Beta probability distribution characterizing the incipient phase duration

Path Forward

- Develop revised event tree for calculating nonsuppression probability for VEWFDS, which includes a branch for application of a fire prevention strategy.
 - Inform HRA modeling of performance of prevention strategy using available time from expert elicitation.
- Apply refined event tree to the HNP Fire PRA
- NEI to publish HNP implementation of revised VEWFDS quantification methodology for public information.
- Develop a generic approach from the HNP implementation.

Additional Questions ?

Back Up Slide – FAQ 08-046 Event Tree

Fire Initiating Event S	n that Have pient Phase ctable by ystem	Successful Operator Response to Alert	Technician Successful in Preventing Fire In Incipient Stage	Fire Suppressed	End Point
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Back Up Slide – NUREG-2180 Event Tree



Incipient Event Frequency	Detection System Availability, Reliability	System Effective Detecting Incipient Stage	MCR Response to Identify Cabinet	Prevention Strategy	Targeted Suppression	Enhanced Suppression	Conventional Detection / Suppression	End State	
λ	1-β	1-т	1-µ1	1-ξ _{de-ss}				- No Fire	Δ
				ξ _{de-ss}	1-π' ₁			No Fire Damage Beyond	В
					π'1	1-π1		Fire Damage Limited to	с
						π1	1₋ŋ₃(SF)	Fire Damage Limited to	D
							η₃(SF)	Fire Damage to Targets Outside Cabinet	E
			μ ₁				1-ŋ ₁ (SF)	Fire Damage Limited to Targets Inside Cabinet	F
							η ₁ (SF)	Fire Damage to Targets Outside Cabinet	G
		т					1₋η₂(SF)	Fire Damage Limited to Targets Inside Cabinet	н
							η ₂ (SF)	Fire Damage to Targets Outside Cabinet	1
	β						1₋η₁(SF)	Fire Damage Limited to Targets Inside Cabinet	J
							η ₁ (SF)	Fire Damage to Targets	к