Nuclear Safety First,
Last and Always

PSAM14 Estimation of Ignition Frequencies in LPSD fire PRA

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Introduction

- Fire Frequency
  - Definition : Probability of the fire induced accident
  - Characteristics : Same role as initiating events in internal event PRA

- Purpose of the paper
  - Suggestion of calculation method of LPSD fire frequency
  - Inspiration about de-energized equipment in fire frequency calculation

Methodology

◆ Calculation of Fire Frequency

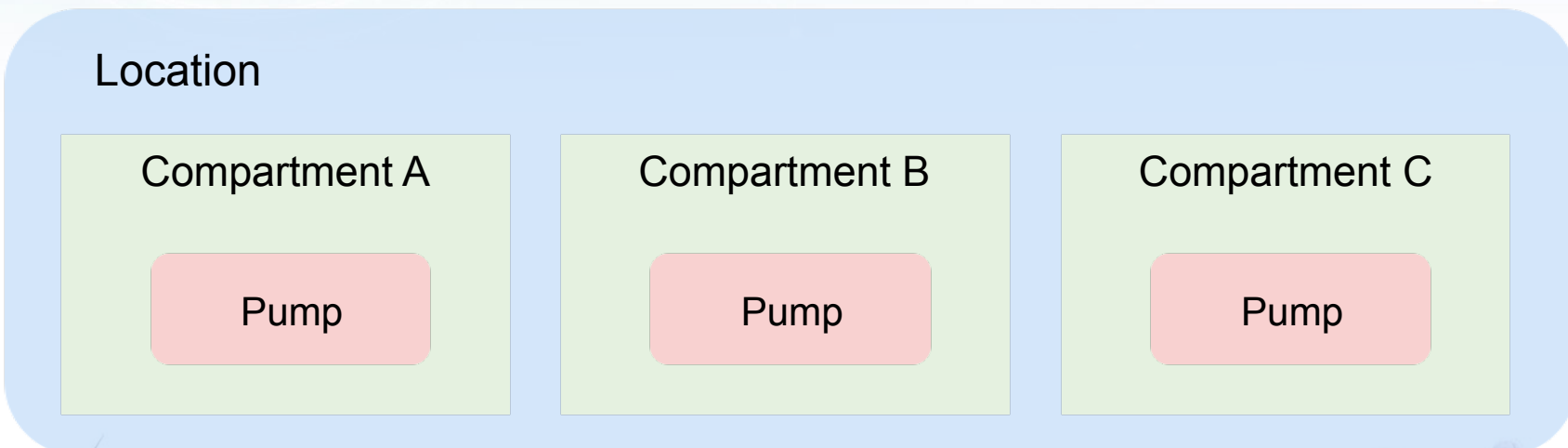
$$\lambda_{IS,J} = \lambda_{IS} W_L W_{IS,J,L}$$

$\lambda_{IS,J}$: Fire frequency of ignition source IS in Compartment J

λ_{IS} : Plant-level fire frequency of ignition source IS

W_L : Location weighting factor

$W_{IS,J,L}$: Ignition source weighting factor = N_J / N_L



Methodology

- POS(Plant Operating States)
  - Classification of operation modes
  - Classified in terms of system configuration and equipment alignment

POS NO.	Duration(hr)	Description
3B	37.6	Cooldown with Shutdown Cooling System to 140℉
4A	1.3	Reactor Coolant System drain-down(pressurizer man way closed)
4B	20.3	Reactor Coolant System drain-down(pressurizer man way open)
5	16.8	Reduced Inventory operation and nozzle dam installation
6	54.9	Fill for refueling
10	85.7	Reactor Coolant System drain-down to Reduced Inventory after refueling

Methodology

- Calculation of Fire Frequency

$$\lambda_{IS,J,LPSD} = \lambda_{IS,J} T_{LPSD}$$

$\lambda_{IS,J,LPSD}$: **Fire frequency associated with ignition source IS in LPSD**

T_{LPSD} : **Outage fraction**

$$\lambda_{POS-IS,J} = \lambda_{IS,J,LPSD} T_{POS}$$

$\lambda_{POS-IS,J}$: **Fire frequency in specific POS**

T_{POS} : **POS duration fraction**

Methodology

◆ Calculation of Fire Frequency

Compartment A

Equipment A

Compartment B

Equipment B

Compartment C

Equipment C

Compartment D

Equipment D
(Maintenance)

$$W_{IS,J,L} = {}^{N_J}/_{N_L}$$

N_J : # of ignition source in Compartment J

N_L : # of ignition source in all location

	Case 1	Case 2
N_L	4	3

Methodology

◆ Equipment State

POS	CHP		DG		CSP		SCSP	
	A	B	A	B	A	B	A	B
3B	R	S	S	M	RO	RO	R	S
4A	R	S	S	M	RO	RO	R	S
4B	R	S	S	M	RO	RO	R	S
5	R	S	S	M	RO	RO	R	S
6	R	S	S	M	RO	RO	R	S
10	S	R	M	S	RO	RO	S	R

R : Running
S : Standby
M : Maintenance
RO : Racked out

Analysis Result

◆ Calculation of Fire Frequency

POS	DG Room A				N_L (Case 1)	N_L (Case 2)	N_J
	Frequency (Case 1)	Frequency (Case 2)	Increase	Equipment State			
3B	2.68E-05	3.40E-05	27%	Standby	4	3	1
4A	9.28E-07	1.18E-06	27%	Standby	4	3	1
4B	1.45E-05	1.84E-05	27%	Standby	4	3	1
5	1.20E-05	1.52E-05	27%	Standby	4	3	1
6	3.92E-05	4.97E-05	27%	Standby	4	3	1
10	1.16E-05	1.16E-05	0%	Maintenance	4	3	0

Analysis Result

◆ Calculation of Fire Frequency

POS	DG Room B				N_L (Case 1)	N_L (Case 2)	N_J
	Frequency (Case 1)	Frequency (Case 2)	Increase	Equipment State			
3B	5.09E-06	5.09E-06	0%	Maintenance	4	3	0
4A	1.76E-07	1.76E-07	0%	Maintenance	4	3	0
4B	2.75E-06	2.75E-06	0%	Maintenance	4	3	0
5	2.28E-06	2.28E-06	0%	Maintenance	4	3	0
6	7.44E-06	7.44E-06	0%	Maintenance	4	3	0
10	6.12E-05	7.76E-05	27%	Standby	4	3	1

Analysis Result

- Case 1
  - Convenience of analysis
    - Same Denominator(N_L) for all POS
    - Consistent fire frequency distribution for all compartments(not including maintenance equipment)
  - Slightly lowered value of fire frequency
- Case 2
  - More Conservative value of fire frequency
  - Inconvenience of analysis
    - Different Denominator(N_L) for each POS
    - Variable fire frequency distribution for all compartments(not including maintenance equipment)

Summary

- Calculation of fire frequency for LPSD is suggested
- Adopt POS classification
- Consider 2 cases depending on including de-energized equipment for calculation
  - Opposite characteristics in terms of convenience and conservatism

Thank you

Q&A