A Study on Fire Ignition Frequency of UCN 3 during Shutdown

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1. Introduction

A fire ignition frequency of UCN 3 during shutdown, i.e., during POS 3, 4, 5, 6 was calculated by using the new fire PSA method suggested in NUREG/CR-7114 [1]. As the fire ignition frequency during full power is calculated by the fixed ignition source and the transient ignition source, the one during shutdown is also calculated by the fixed and the transient ignition source. Since the fixed ignition source was already verified through the walkdown although the walkdown is for the fixed ignition source during full power, additional walkdown for the one during shutdown is not necessary. In the paper, how the fire ignition frequency of UCN 3 during shutdown was calculated is described.

2. Methods and Results

2.1 Fire ignition frequency of UCN 3 during Shutdown

As mentioned in NUREG/CR-7114, if the mode basis is 'All' in NUREG/CR-6850[2], the ignition fire frequencies can be also used in LPSD. However, the ignition fire frequencies were changed in NUREG/CR-6850, supplement 1[3], the ones in NUREG/CR-6850, supplement 1 are used in LPSD.

If the mode basis is 'Split' in NUREG/CR-6850, the values cannot used in the LPSD. Instead, the values offered in NUREG/CR-7114 are used in LPSD.

Also, since NUREG/CR-7114 does not changed the HEAF BIN although HEAF BIN was complicatedly changed in NUREG/CR-6850, supplement 1, HEAF BIN in LPSD categorized as mentioned in NUREG/CR-6850, supplement 1.

In the ignition source DB, the following buildings or areas are also excluded in LPSD since the risk of the building is low; Fuel handling building, office building, maintenance shop, warehouse, etc.

2.2 Transient Ignition Fire Frequency

We assume that transient ignition fire frequency of each BIN could change depending on POS. We assumed that the transient ignition fire frequency of each BIN varies according to the daily work order of each POS. The daily work order of each POS is calculated as shown in Table 1, and used as a weighting factor with which the average transient ignition fire frequency of each BIN becomes varied on each POS. Since influencing factors such as occupancy, maintenance, and storage are different in each compartment, the transient ignition fire frequency of each BIN on each POS can be again calculated according to the compartment.

2.3 Fixed Ignition Fire Frequency

As POS changes, the configuration of equipment also changes. The feedwater pumps are out of service during POS 3~6. Therefore, the fixed ignition fire frequency caused by the feedwater pump should be changed. However, since the cause of the ignition fire is oil, the number of feedwater pumps should not be changed even though it is in POS 3~6 as shown in in Table 1.

As you can see in Table 3 and Table 4, the fixed ignition fire frequency of room 100-T01 slightly changes from POS 3 to POS 6 since the number of available electrical cabinets changes.

2.4 Results

A fire ignition frequency of UCN 3 during shutdown, i.e., during POS 3, 4, 5, 6 was calculated, and the example of the result is shown in Table 5.

3. Conclusions

A fire ignition frequency of UCN 3 during shutdown, i.e., during POS 3, 4, 5, 6 was calculated by using the new fire PSA method suggested in NUREG/CR-7114. We make the transient ignition fire frequency of each BIN vary according to the daily work order of each POS.

Acknowledgements

REFERENCES

[1] US NRC, "A Framework for Low Power/Shutdown Fire PRA, NUREG/CR-7114, Nuclear Regulatory Commission, Washington, DC, (2013).

[2] EPRI/NRC-RES, "Fire PRA Methodology for Nuclear Power Facilities," NUREG/CR-6850, Nuclear Regulatory Commission, Washington, DC, (2005).

[3] EPRI/NRC-RES, "Fire Probabilistic Risk Assessment Methods Enhancements" NUREG/CR-6850 Supplement 1, Nuclear Regulatory Commission, Washington, DC, Sept 2010.

Table 1. Daily Work Order of Each POS

TOTAL	Work Order (a)	POS Work Day (b)	Daily Work Order (=(a/b)	Weighting Factor ((a/b)/AVG)
POS 1	120	0.3	360	53.1%
POS 2	363	0.3	1089	160.7%
POS 3	243	0.3	729	107.6%
POS 4	638	1	638	94.1%
POS 5	961	1	961	141.8%
POS 6	1317	1.5	878	129.5%
POS 7	817	0.5	1634	241.1%
POS 8	15529	18.5	839	123.9%
POS 9	1995	5	399	58.9%
POS 10	178	0.5	356	52.5%
POS 11	178	0.5	356	52.5%
POS 12	180	0.4	450	66.4%
POS 13	180	0.4	450	66.4%
POS 14	354	0.4	885	130.6%
POS 15	326	2.3	142	20.9%
AVG	1558.600	33 Day	678	100%

Table. 2. The # of Feedwater Pump Does Not Change During POS 3~6

BLDG	ID	Room No.	계산	Room Name	IGNITION SOURCE	Qty
TB	32	100-T01		TURBINE BUILDING GROUND FLOOR	MTR DRIVEN FW PP	1
TB	32	100-T01		TURBINE BUILDING GROUND FLOOR	TBN DRIVEN FW PP	1
TB	32	100-T01		TURBINE BUILDING GROUND FLOOR	TBN DRIVEN FW PP	1
TB	33	135-T01		TURBINE OPERATING FLOOR	T/G EXCITOR	1
TB	34	100-T01		TURBINE BUILDING GROUND FLOOR	HYDROGEN COOLING SYS	1
TB	35	073-T12		TURBINE LUBE OIL CONDITIONER ROOM	TURBINE LUBE OIL SYSTEM	1

Table 3. The Fixed Ignition Fire Frequency of Room 100-T01 on POS 3.

1. Description						
FIRE AREA		000-TBB				
FIRE Room No		100-T01				

2. Calculation

NUREG/CR-6850 Method

ID	Location	Ignition Source	(A)	(B)	(A)/(B)	(FF)	(FISF)
10	Plant-Wide	Battery Chargers	2	14	1.43E-1	1.18E-3	1.7E-4
14	Plant-Wide	Electric Motors	3	49	6.12E-2	3.4.E-3	2.09E-4
15.1	Plant-Wide	Electrical Cabinets-Non-HEAF	140	1251	1.12E-1	2.36E-2	2.64E-3
…	…	…		…	…		
32	T/B BLD	Main Feedwater Pumps	3	3	1.00E+0	0.019	1.9E-03

3. Result

NUREG/CR-6850 Method	Value
Fire Frequency for Plant Wide Ignition Sources=F^{PW}_T=$\sum F^{PW}_{IF}$ (Except Transient)	1.03E-2

Table 4. The Fixed Ignition Fire Frequency of Room 100-T01 on POS 4.

1. Description						
FIRE AREA		000-TBB				
FIRE Room No		100-T01				

2. Calculation

NUREG/CR-6850 Method

ID	Location	Ignition Source	(A)	(B)	(A)/(B)	(FF)	(FISF)
10	Plant-Wide	Battery Chargers	2	14	1.43E-1	1.18E-3	1.7E-4
14	Plant-Wide	Electric Motors	3	49	6.12E-2	3.41E-3	2.09E-4
15.1	Plant-Wide	Electrical Cabinets-Non-HEAF	118	1205	4.00E-2	2.36E-2	9.4E-4
…	…	…		…	…		
32	T/B BLD	Main Feedwater Pumps	3	3	1.00E+0	0.019	1.9E-03

3. Result

NUREG/CR-6850 Method	Value
Fire Frequency for Plant Wide Ignition Sources=F^{PW}_T=$\sum F^{PW}_{IF}$ (Except Transient)	9.89E-3

Table 5. The Example of Ignition Fire Frequency for UCN 3 During POS 3.

Room	Name	Fixed	Transient	Total
055-C01	REACTOR CAVITY	0	2.82E-03	2.82.E-03
058-C01	TENDON AREA	0	4.23E-04	4.23.E-04
058-C02	BUTTRESS ENCLOSURE	8.11E-05		8.11.E-05
086-C01	CONTAINMENT ANNULUS AREA	3.54E-04	4.24E-03	4.59.E-03
086-C02A	SG A CAVITY	3.37E-03	4.24E-03	7.61.E-03
086-C02B	SG B CAVITY	3.30E-03	4.24E-03	7.54.E-03
100-C01	CONTAINMENT ANNULUS AREA	1.68E-04	4.24E-03	4.41.E-03
100-C02	PRESSURIZER SPARY VALVE ROOM	0	4.23E-04	4.23.E-04
114-C01	REGENERATIVE HX ROOM	0	4.23E-04	4.23.E-04
122-C01	CONTAINMENT ANNULUS AREA	2.16E-04	4.24E-03	4.46.E-03
122-C02	PRESSURIZER CAVITY	0	4.23E-04	4.23.E-04
142-C01	OPERATING AREA	7.19E-04	4.25E-03	4.97.E-03
058-A03A	GENERAL ACCESS AREA	1.48E-05	6.33E-05	7.81.E-05
058-A04A	SHUTDOWN COOLING HX ROOM	4.13E-06	4.67E-05	5.08.E-05