Assessment of Safety Effect Due to the Change of the Assumptions Related to ECCS for Safety Analysis of Wolsong Unit 1

Sung-Min Kim [a*], Dong-Sik Jin [b], Jong-Hyum Kim [b]
[a]Korea Hydro and Nuclear Power Co., Ltd., Central Research Institute, Yuseong-gu, Daejeon, Korea
[b]*Atomic Creative Technology Co., Ltd., Yuseong-gu, Daejeon, Korea*
[*]*Corresponding author:kimsungmin@khnp.co.kr*

1. Introduction

In recent safety analysis of wolsong unit 1, the thermalhydraulic analysis was performed using the CATHENA code[1,2] and some parts of assumptions and initial conditions applied in this thermalhydraulic analysis were set as limiting conditions for operation (LCOs) of wolsong unit 1. The temperature condition of high pressure-emergency core cooling water (HP ECC) among these LCOs is limited to 27.8℃ due to the assumption (30.0℃) applied in safety analysis, therefore the water temperature in the tank of HP ECC may exceed this limit condition in summer season as a result of the global warming phenomena [3]. Also, because some parts of the system response times related to ECCS were not considered in safety analysis of wolsong unit 1, the related LCOs were changed, which are different with the original design [4]. Therefore, for the modification of these LCOs, the assessment of safety effect due to the change of the assumptions for safety analysis of wolsong unit 1 as described in Table 1 was performed.

Table 1: The change of the assumptions for safety analysis of wolsong unit 1 [5]

Items	W1 FSAR	Re-analysis
HP ECC Temperature	30℃	45℃
Loop response time related ECCS	0.0 s	1.0 s
MSSV valve stroking time for crash cooldown	0.1 s	2.0 s

2. Methods and Results

2.1 Accidents for Assessment

The assessment of safety effect due to the change of safety analysis assumptions of Table 1 was performed for the loss of coolant accidents and main steam line break which lead to ECCS injection and steam generator crash cooldown signal.

- Large Loss of Coolant Accident(LBLOCA)
- Small Loss of Coolant Accident(SBLOCA)
- Pressure Tube Rupture(PTR)
- Channel Flow Blockage(CFB)
- End Fitting Failure(EFF)
- Feeder Break(FB)
- Multiple Steam Generator Tube Rupture(MSGTR)
- Main Steam Line Break(MSLB)

2.2 The Assessment Methods and Assumptions

The assessment methods and assumptions for each accident are same with those applied in safety analysis of wolsong unit 1 excluding the items described in Table 1.

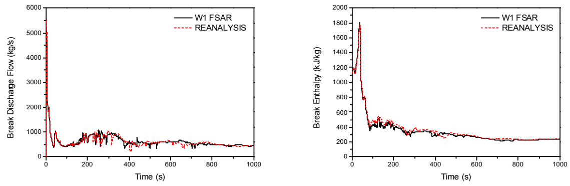
2.3 The Assessment Results

For LBLOCA, even though the change of safety analysis assumptions of Table 1 is applied in safety analysis, the limiting accidents for each break location are same with the existing results of wolsong unit 1. That is, in respect of the fuel temperature and fuel failure number, 35% reactor inlet header break, 55% pump suction break and 100% reactor outlet header break are still limiting accidents for each break location (Refer to Table 2). Also, in thermalhydraulic results of these limiting accidents, there are not noticeable differences as shown in Fig. 1.

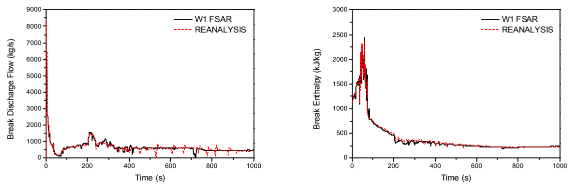
Table 2: Numbers of fuel element failures and maximum sheath temperatures for each break location

Accident cases	Failed fuel element number		Maximum sheath temperature	
	W1 FSAR	Re-analysis	W1 FSAR	Re-analysis
30RIH	3,690	3,690	1289.9	1299.2
35RIH	3,690	3,690	1310.0	1364.2
40RIH	3,132	3,690	1316.3	1363.8
50PS	3,690	3,690	1287.7	1320.0
55PS	3,690	3,690	1308.5	1332.3
60PS	3,132	3,690	1221.7	1293.5
100ROH	3,132	2,016	1036.0	1026.6
95ROH	2,016	2,016	994.3	998.4

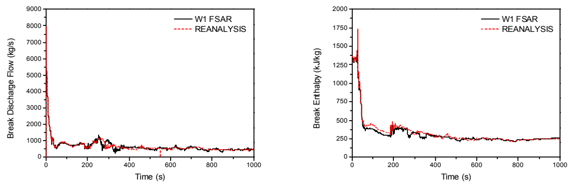
The maximum pressure and temperature in reactor building for the 100% reactor outlet header break are slightly increased due to the change of safety analysis assumptions (Refer to Fig.2). But the maximum pressure is sufficiently below the design pressure of 124 kPa(g), therefore this does not affect the integrity of the reactor building.



a. 35% reactor inlet header break



b. 55% Pump Suction Break



c. 100% reactor outlet header break

Fig. 1. Break discharge flows and enthalpies of limiting accidents for each break location

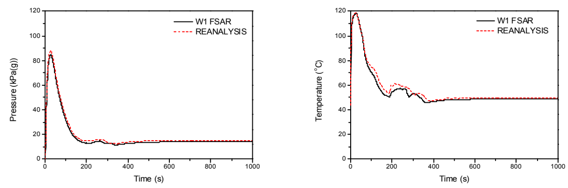


Fig. 2. The pressure and temperature of the reactor building in 100% reactor outlet header break.

For the dose for LBLOCA, as shown in Table 3, the whole body dose is slightly increased due to the increase of pressure in reactor building as shown in Fig.2 and thyroid dose is a little decreased due to the increase of the spray duration time according to the increase of pressure in reactor building. But these values are still low in comparison with the dose limits.

Table 3: The individual doses in 100% reactor outlet header break

Items	Whole body dose		Thyroid dose	
	W1 FSAR	REAN LYSIS	W1 FSAR	REAN LYSIS
Personal Dose(mSv)	0.69	0.81	2.65	1.82
Dose Limit	5		30	

Therefore, in case of LBLOCA, the effect on safety analysis results due to the change of safety analysis assumptions of Table 1 is very small and the all acceptance criteria of this accident are satisfied.

These results for LBLOCA are similar with the cases of SLBOCA including single channel accidents and multiple SG tube rupture accident and MSLB. That is, the effect on safety analysis results due to the change of safety analysis assumptions of Table 1 for each accident is very small and the all acceptance criteria for each accident are satisfied.

3. Conclusions

The assessment of safety effect due to the change of the assumptions for safety analysis of wolsong unit 1 as described in Table 1 was performed. As result, since the effect is very small and the all acceptance criteria for each accident are satisfied, the increase of the temperature limiting condition of HP ECC and the modification of the system response times related to ECCS is considered to be possible.

REFERENCES

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[3] KHNP, Wolsong Unit 1 ITS 3.5.1
[4] KHNP, Wolsong Unit 1 ITS 3.3.3
[5] D.S. Jin, "CATHENA Emergency Core Cooling System Model", 59RF-03500-AR-012, Rev.2, November 2014.