Independent Best Estimate Calculation and Uncertainty Evaluation of LBLOCA in KSNP

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1. Introduction

The purpose of this study is to discuss an independent best estimate analysis of LBLOCA in KSNP. The KREM(KEPRI Realistic Evaluation Methodology) has been adopted as the methodology for LBLOCA analysis of Westinghouse 3-Loop type reactor[1], it has not been applied for the analysis of one in KSNP. For the purpose of verifying the applicability of KREM for KSNP, KINS-REM[2] was attempted in the present calculation. The KINS-REM is a method to quantify the uncertainty using best estimate plant nodalization and 3rd order Wilk formula for statistical treatment. The analysis code of KINS-REM is RELAP5/MOD3.3[3]. All plant conditions are set to be the same with those of the topical report applied by the license. Currently, the biases related to the ECC bypass and steam binding are not considered.

2. Selection of Uncertainty Variable & Principal Input Variable

2.1 Uncertainty Variable

Table 1: Selection of Uncertainty Variable

No	Parameter	Distribution	Mean	Uncertainty
1	Fq (Peaking factor)	Uniform	2.253	0.325
2	Gap conductance	Uniform	1.15	0.35
3	Fuel conductivity	Normal	1.0	0.05
4	Core Power	Normal	1.0	0.01
5	Decay heat	Normal	1.0	0.033
6	Groeneveld CHF dial	Normal	1.0	0.379
7	Chen nucleate boiling dial	Normal	1.0	0.2
8	T_{min} Dial	Uniform	1.0	0.46
9	Dittus Boelter liquid dial	Normal	1.0	0.1275
10	Dittus Boelter vapor dial	Normal	1.0	0.1275
11	Bromley dial	Normal	1.0	0.185
12	Break CD	Normal	0.947	0.218
13	Pump K factor	Uniform	0.41	0.39
14	Pump Head Multiplier	Uniform	0.5	0.5
15	Pump Torque Multiplier	Uniform	0.5	0.5
16	Pressurizer Pressure	Normal	155.1(bar)	1.034(bar)
17	SIT Pressure	Uniform	42.45(bar)	2.14(bar)
18	SIT water volume	Uniform	52.63(m^3)	1.94(m^3)
19	SIT water Temp	Uniform	302.5(K)	19.5(K)
20	SIT line K factor	Uniform	7.5	2.5
21	SIP flow multi	Uniform	0.5	1.0
22	RWST water Temp	Uniform	299.5(K)	23.5(K)

All uncertainty variables applicable to RELAP5/Mod3.3 among 28 variables used in KREM are considered in the present calculation.

2.2 Principal Input Variable for Base Calculation

Table 2: Major Input variable for base calculation

Plant variable	Base condition
Core	
1. Core Power	2815MWt
2. Fq	2.253
3. Fuel type	16×16
4. Decay heat	ANS 79 model
5. Core flow(kg/hr)	52.72×10^6
Pressurizer	
1. pressure	2249.53 psia
S/G	
1. Feed water temperature(F)	450
2. Pipe plugging rate(%)	0
SI System	
1. Accumulator coolant volume(m^3)	52.63
2. Accumulator gas pressure(bar)	42.45
3. Accumulator coolant temperature(K)	302.5
4. Accumulator pipe K-factor	7.5
5. RWST temperature(K)	299.5
Containment	
1. Initial pressure(bar)	1

The 'best-estimated' condition was applied for realistic LBLOCA simulation. This condition is achieved by combination of mean values of uncertainty variables. The principal plant conditions used in base calculation are summarized in Table 2. Each value is obtained by referring to FSAR for Ulchin3&4.

3. Results and Discussion

For the first, we obtained the each value of 22 variables by simple random sampling. The range of each variable is listed in Table1. Then, 124 RELAP5/MOD3.3 calculations are performed using the each variable set given by the random sampling.

Fig.1 shows the RELAP5 Nodalization of KSNP used in calculations. And Fig.2 shows calculated Fuel Clad Temperature at each axial position in Base Case.

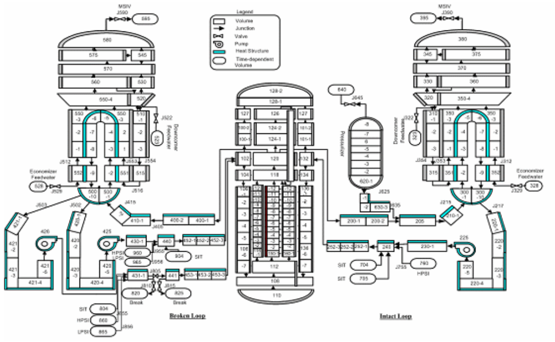

Figure 1: RELAP5 Nodalization of KSNP

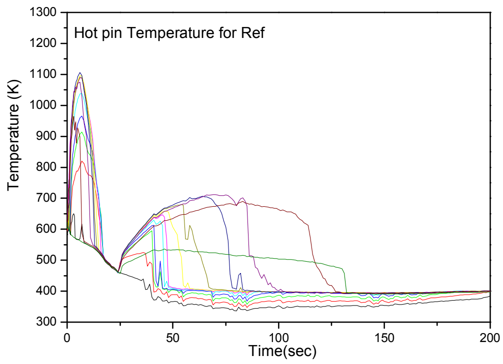

Figure 2: Cladding Temperature Results

In Fig.1, the axial profile of the temperature of hot pin for the base calculation is shown.

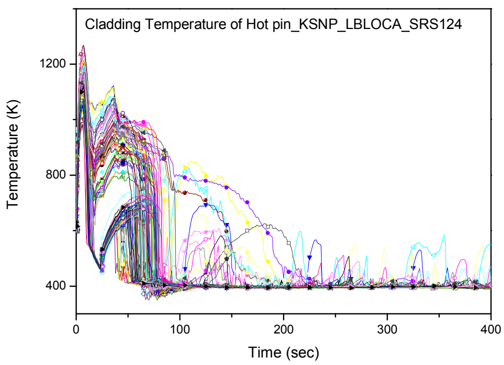

Figure 3: behavior of cladding Temperature (SRS124)

The results of 124 Simply Random Sampling calculations by KINS-REM are shown in Fig.3. The highest blowdown peak temperature is determined about 1268K with a 95% probability of a 95% reliability.

4. Conclusion

The 95/95% peak cladding temperature by KINS-REM is calculated as 1268K. Although the final peak cladding temperature is expected to increase when the biases due to ECC bypass and steam binding will be considered, it is low enough and the safety margin is about 209K compared with 1477K in regulatory standard.

Even if the reflood peak behavior shown above is slightly different from behavior of KREM, the behavior of PCT and quenching time is in almost similar range compared to the results of KREM. These differences are thought to be caused by the differences of the analysis codes, the uncertainty variables and those ranges.

The result from this independent assessment of this paper can be an important material for evaluation of applicability of KREM for KSNP.

REFERENCES

[1] Topical report, LBLOCA Safety Analysis Methodology for KSNP, TR-KHNP-0010, KEPRI/KHNP, 2005.

[2] Young S. Bang , Improvement of the ECCS Best Estimate Methodology and Assessment of LOFT L2-5 Experiment, KINS/RR-279, Jan, 2005.

[3] RELAP5/MOD3.3 CODE MANUAL, USNRC, December 2001