Containment Response Analysis for Equipment Qualification of Kori Nuclear Power Plant Unit 3 and 4

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1. Introduction

Equipment that is used to perform a necessary safety function must be capable of maintaining functional operability under all service condition postulated to occur during the installed life for the time it is required. The pressure and temperature analyses for loss of coolant accident and main steam line break accident provide the bounding test envelope inside containment for the operability evaluation of safety equipments in harsh environmental. This paper describes the results of the containment pressure and temperature analysis for the equipment qualification (EQ) envelopes of Kori unit 3 and 4.

2. Methodology

The methodology to determine the containment environmental response is similar to that of the containment pressure and temperature analysis for the containment integrity. However, more realistic approach is also permitted as follows[1];

- Vaporization of 8% heat sink condensate
- To use the entrainment phenomena in the MSLB mass and energy analysis if it is verified.

When the atmosphere is superheated, a maximum of 8 percent of the condensate may be assumed to remain in the vapor region and vaporized by the superheated atmosphere. This vaporization process makes lower the containment temperature. On the other hand, the entrainment of liquid drops in upper steam generator during MSLB makes the vapor status to be saturated condition. This reduces the superheat condition of mass and energy release.

CONTEMPT LT-028/H[2] is used in this analysis but Bechtel's COPATTA was used in the original design and the power uprating project of Kori unit 3 and 4.

Because of code difference, the benchmarking analyses to COPATTA are performed by using the mass and energy release data from power uprating project for the LBLOCA and MSLB. Form this evaluation, it is known CONTEMPT to be more conservative than COPATTA[3].

2.1 LBLOCA

The containment pressures and temperatures for LBLOCA which were calculated in the power uprating project are used in determining EQ envelope without reanalysis.

2.2 SBLOCA

Table 1 shows the SBLOCA scenarios considered in this analysis. The containment responses are calculated for two cases of no-single failure and diesel generator failure. Therefore, 24 cases in total are considered in determining EQ envelope.

Table 1 SBLOCA scenarios

scenario	Break Size
Hot Leg Break	3", 4", 6", 8"
Cold Leg Break	3", 4", 6", 8"
RCP Suction Leg Break	3", 4", 6", 8"

2.3 MSLB

Table 2 shows the MSLB scenarios considered in this analysis. The containment responses are calculated for two cases of single failures, diesel failure and one main steam isolation valve failure. Therefore, 32 cases in total are considered in determining EQ envelope.

Table 2 MSLB Cases

Scenario (power : 0, 30, 70, 120%)		Single failure	
Full Double Ended Rupture		DG	MSIV
Small Break	w/ entrainment	DG	MSIV
	w/o entrainment	DG	MSIV
Split Break		DG	MSIV

2.4 Thermal analysis

The original test envelope for Kori unit 3 and 4 was determined by LBLOCA scenario and thermal analysis for MSLB. NUREG-0588 approves to use the results from thermal analysis for MSLB if it shows that the peak surface temperature of the component to be qualified does not exceed the LOCA qualification temperature by the conservative method as follows;

- Four times condensation heat transfer
- Forced convection heat transfer during blowdown stage, which Reynold's number should be determined by the velocity, V = 25 ×blowdown rate/containment volume

CONTEMPT code is changed for the forced convection and 6 heat conductors in total simulating safety components including power cable, fan cooler and valve actuator, etc. are modeled in addition.

3. Results

Figure 1 and 2 shows EQ envelopes recommended in this analysis. Blue and green lines represent the pressures and temperatures from SBLOCA and MSLB, respectively. As seen in Figure 2, the bulk temperatures in case of MSLB exceed the temperature envelope recommended in this analysis as well as current FSAR envelope.

However, the surface temperatures of safety equipment calculated from thermal analysis do not exceed the 300°F envelope ceiling as seen in figure 3. Therefore, the recommended envelope can be used as the test envelope for Kori NPP 3 and 4.

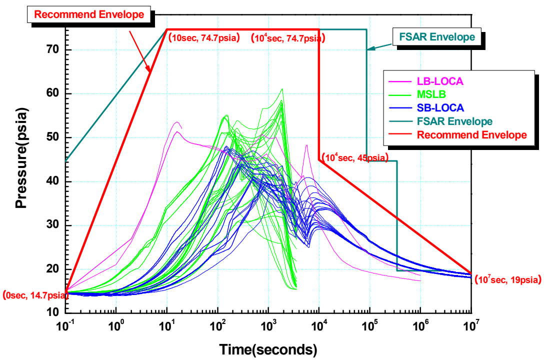

Figure 1 Containment Pressure Envelope for Equipment Qualification of Kori NPP 3&4

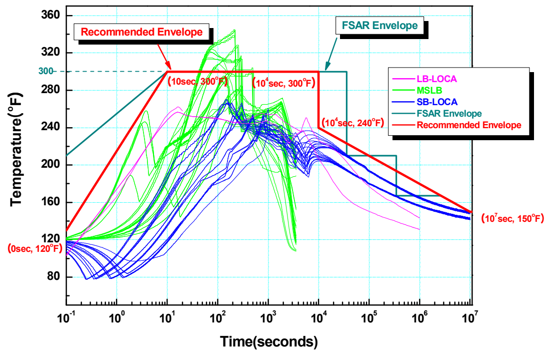

Figure 2 Containment Temperature Envelope for Equipment Qualification of Kori NPP 3&4

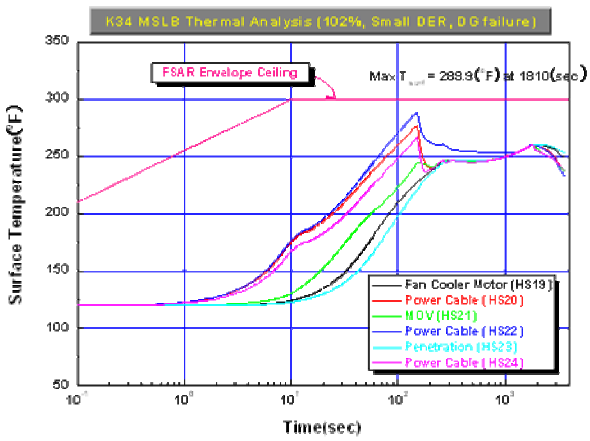

Figure 3 Surface temperature of safety equipment calculated from thermal analysis.

4. Conclusion

In this paper, the test envelopes are recommended from the containment response analysis for spectrum of SBLOCA and MSLB scenario of Kori NPP 3 and 4. The recommended envelopes are similar to the original FSAR envelope except longterm tailing due to SBLOCA.

REFERENCES

[1] NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment, Rev.1, NRC, Nov. 1980.

[2] CONTEMPT LT/028-H, "User's Manual : Computer program for predicting containment pressure-temperature", INEL, Jan. 1983.

[3] Kwi Hyun. Seo, et. Al., "Benchmarking Analysis between CONTEMPT and COPATTA Containment Codes", KNS, spring