Sensitivity Analysis of Dousing Spray Trip on Radioactive Release in Pressure Tube Rupture Accident with Both End Fitting Failures

M-S Jang [*], H-S Kang, S-R Kim
NESS, No.704, 96 Gajeongbuk-ro, Yuseong-gu, Daejeon, Korea

[*] *Corresponding author: msjang@ness.re.kr*

1. Introduction

Radioactive releases from the containment building is related to containment air pressure, which increases by the coolant discharge from loss of coolant accident and the actuation conditions of dousing spray and so on.

In LOCA analysis, the dousing spray trip conditions are set for the analysis objectives; for peak pressure (PP), for pressure signal (PS), for radioactive release (RR) and etc. In RR analysis, we would determine the dousing spray trip condition to increase radioactive release to the public for conservatism. Therefore, we carried out the sensitivity analysis of dousing spray trip condition on radioactive release from containment building using GOTHIC and SMART program for CANDU.

2. Methods and Results

2.1 Analysis Code

There are two codes, GOTHIC-IST and SMART-IST, for the sensitivity of dousing spray trip on radioactive release.

GOTHIC-IST(Generation of Thermal-Hydraulic Information for Containments-Industry Standard Toolset, version 7.2a) is an integrated, general purpose thermal-hydraulic software package for design, licensing, safety and operating analysis of nuclear power plant containment and other buildings[1].

SMART-IST(Simple Model for Activity Removal and Transport-Industry standard Toolset, ver-0.321) is to model the transient behavior of radionuclides in a nuclear reactor containment following LOCA[2].

2.2 Accident Scenario

The accident scenario analyzed is the pressure tube rupture(PTR) with both end fitting failures(EFF)[3]. After operating of low pressure emergency cooling system(LPECC), we assumed the loss of coolant to be discharged from same break position as before operating of LPECC.

2.3 Dousing Spray Trip Conditions

There are two dousing spray trip conditions. Set 1 is the slower dousing spray condition than design condition and set 2 is the faster condition. Generally, we choose set 1 for PP or PS analysis and set 2 for RR. However, set 1 would be selected for RR analysis with containment building impairments.

Table 1. Dousing spray trip conditions [4]

System Description	Set 1(PP, PS)	Set 2(RR)
Dousing spray “Start”	18.8 kPa(g)	8.8kPa(g)
Dousing spray “Stop”	11.9kPa(g)	1.9kPa(g)
Number of operating spray headers	4 of 6	6 of 6

2.4 Outline of Noding Diagram

Figure 1 is the outline of GOTHIC noding diagram for radioactive release analysis in pressure tube rupture accident with both end fitting failure.

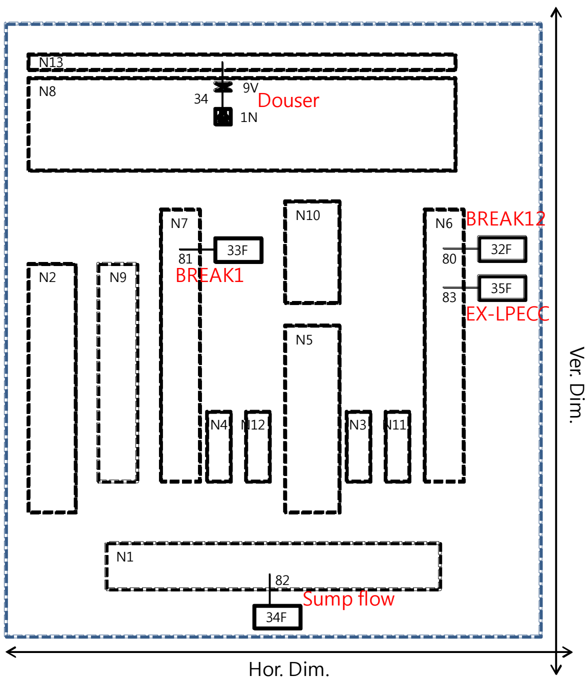


Fig. 1. Outline of GOTHIC nodding diagram

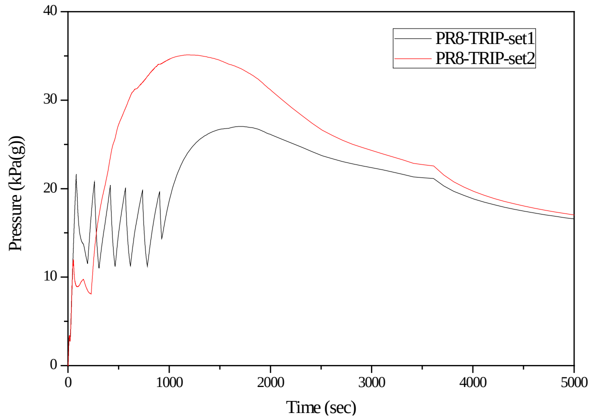
2.5 Results

Table 1 and Figures 2&3 are the result of sensitivity analysis on radioactive release of dousing spray trip condition in PTR with EFF.

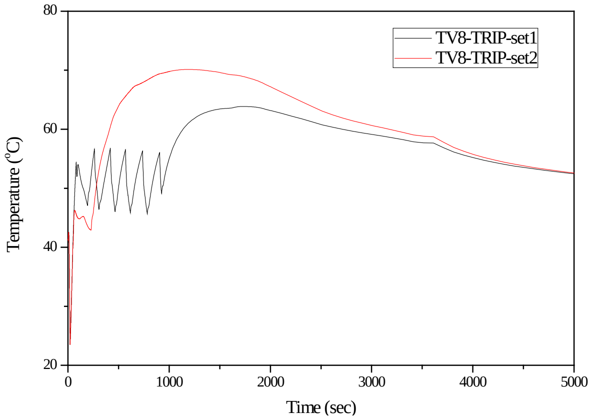
Table 1 and Figure 2 show that the initial dousing spray rate is higher and faster and the depletion time of dousing inventory is shorter in the set 2 trip condition than those of the set 1 trip condition. Before the depletion of dousing water, the dousing spray system operates once in the set 2 trip condition and 6 times in the set 1 trip condition.

Table 2. Dousing spray time duration

System Description	Using Set 1	Using Set 2
Start time of dousing spray	81 sec	48 sec
Stop time of dousing spray	194 sec	228 sec
Time duration of 1st cycle	83 sec	180 sec
Number of dousing spray operation	6	1
Depletion of dousing spray water	925 sec	228 sec



(a) Pressure



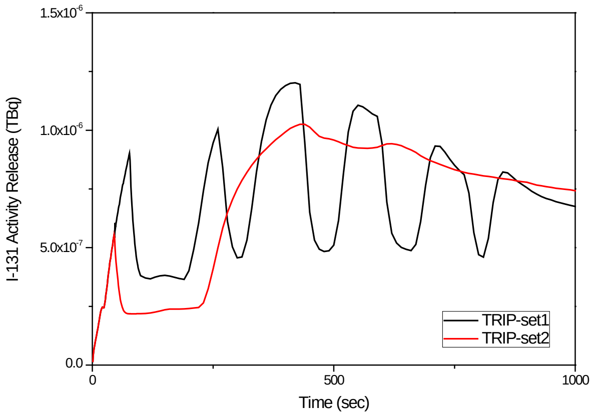
(b) Temperature

Fig. 2. Themalhydraulic behavior in steam generator node

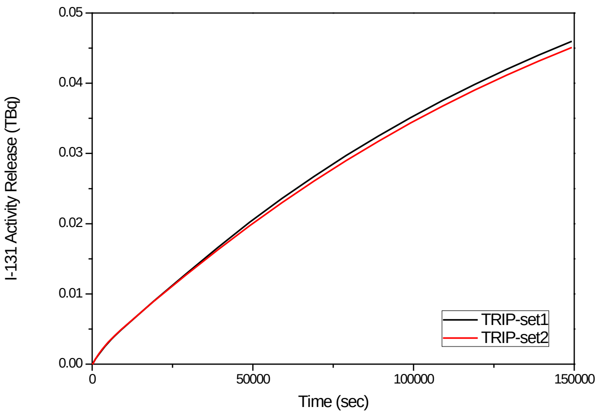
The initial pressure and temperature of containment building are lower in the set 2 trip condition than those of the set 1 trip condition. However, after 280 seconds, the pressure and temperature of containment building are higher because of the depletion of dousing spray water and they have similar behavior after 5,000 seconds.

Figure 3 shows the activity release of I-131. As shown figure 2 (a), the I-131 release is lower in set 2 trip condition than those of set 2 trip condition. It would be due to the increased time of initial dousing spray cycle and the washing of the radionulides discharged early to containment r building.

Therefore, in the pressure tube rupture accident with both end fitting failures, the set 1 trip condition may show more emission of I-131 and more conservative result than the set 1 trip condition in terms of activity release.



(a) Instantaneous release



(b) Cumulative release

Fig. 3. I-131 activity release from reactor building

3. Conclusions

We analyzed the sensitivity analysis of dousing spray trip conditions on radioactive release. In terms of conservativeness, the set 1 trip would be more appropriate in RR analysis than set 2 trip, which is the general condition of RR analysis.

In case of the pressure tube rupture accident with both end fitting failures, the set 1 trip condition may show more emission of I-131 release than those of the other condition.

REFERENCES

[1] EPRI, GOTHIC-containment analysis package user manual, NAI8907-02 Rev7, 2006.
[2] AECL, SMART-IST Ver-0.300/Rev.0 : User's Manual, RC-2779, 2002.
[3] KHNP, Final Safety Analysis of Wolsong 1 nuclear power plant, chapter 15.2.1.5.C.
[4] KHNP, Final Safety Analysis of Wolsong 1 nuclear power plant, chapter 15.2.1.1.F.