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Sensitivity analysis of the heat loss on the pressurizer for ATLAS integral effect test facility

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1. Introduction

Heat loss phenomena can affect the heat transfer experiment and plays an important role in the performance of the system. For this reason, the evaluation of the heat loss effect is essential to predict the performance of experiment using thermal hydraulic system code.

This paper describes the methods and the results of sensitivity analysis of the heat loss on the pressurizer of ATLAS facility using SPACE code. Especially, the pressurizer behavior and the event sequence time is confirmed in case of the different heat loss on the pressurizer. The pressurizer behavior is most important factor during the transient. Because this variable is related to the total pressure on primary side, pressurizer pressure signal, and safety injection initiation. For this reason, it is performed how much heat loss on pressurizer affects the entire transient behavior.

2. Methods and Results

In this paper, the experiment which is performed on ATLAS facility is selected for heat loss effect. The selected experiment scenario, the modeling information of heat structures for heat loss simulation are briefly described in reference [1].

2.1 Initial conditions for sensitivity case

The information of total heat loss on primary side is applied in accordance with the experiment information [2] and the heat loss portion of each heat structure groups was designed using the information of reference [3]. For sensitivity analysis, the different heat loss proportion on pressurizer distributed for each cases as described in table I. The other components such as reactor pressure vessel, hot leg, and cold leg are distributed the same heat loss proportion for each cases. Inputs for surrounding atmosphere temperature and convective heat transfer coefficient on heat structure groups are applied using the 'TABL' function of SPACE code. And, the heat flux which transfers to surrounding atmosphere on each components was calculated. In order to meet the each sensitivity conditions, heat transfer coefficient was adjusted using the trial and error method and fix the heat loss on each components as described in table I. It is assumed that atmosphere temperature is 300 K.

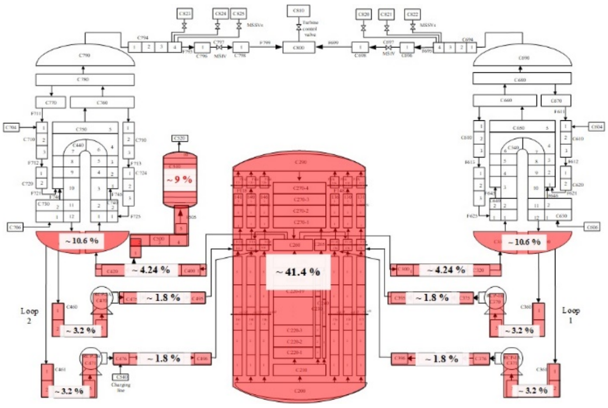

Fig. 1. Example illustration of heat loss proportion modeled in 1-C case for sensitivity analysis.

Table I: Cases for primary side heat loss

Case	PZR	RPV	HL	CL	IL	SG side
1-A	~0 %	37 ~ 43 %	7 ~ 11%	7 ~ 9 %	10 ~ 14 %	19 ~ 23 %
1-B	~5 %					
1-C	~9 %					
1-D	~ 15 %					
1-E	~ 20 %					

2.2 Analysis results

The initiation time of initiate the safety injection and PAFS operation are described in table II and III, respectively. These tables show time difference between experiment result and code calculation results. As described in table II, if the heat loss is much lower, the time to initiate the safety injection is faster. As shown in figure 2, the increase rate on pressurizer level increased as the heat loss on pressurizer increased. This is because the mass flow rate of safety injection increases with increase in pressurizer heat loss. As mentioned in reference 1, the MSGTR with PAFS operation experiment was selected for this study. The break flow is dominant factor in the primary system depressurization period. The smaller the heat loss of the pressurizer, the higher the pressure of the pressurizer, so the break flow is larger due to the pressure difference between the primary and secondary sides at the beginning of accident. On the other hand, the larger heat loss causes the PZR pressure to be lowered by the cooling effect so that the break flow is much lower.

However, as shown in Figure 3, after 200 seconds, the break flow becomes the dominant factor in the overall pressure, resulting in a reversal of the break flow rate (red circle in figure 3). And, the depressurization rate of PZR is also changed as illustrated in figure 4. These phenomena affects the major component actuation such as SIP and PAFS.

Table II: Time difference to initiate the SIP injection

	Time difference(s)		
SIP initiation time	Exp.	PZR 0%	PZR 5%
	0.0	-9.0	-1.0
	PZR 9%	PZR 15%	PZR 20%
	3.0	9.0	12.0

Table III: Time difference to initiate the PAFS operation

	Time difference (s)		
PAFS actuation time	Exp.	PZR 0%	PZR 5%
	0.0	-2930.0	-3092.0
	PZR 9%	PZR 15%	PZR 20%
	-3164.0	-3034.0	-1113.0

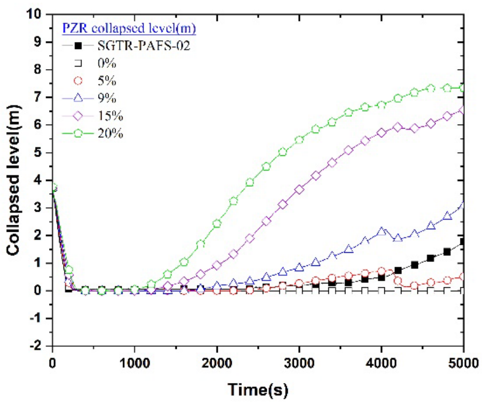

Fig. 2. Pressurizer level behavior in case of different heat loss on pressurizer

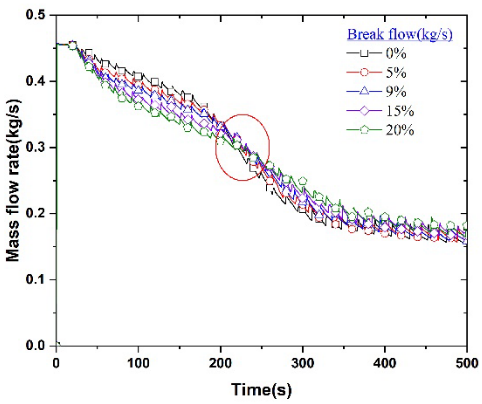

Fig. 3. Break flow behavior by calculation results.

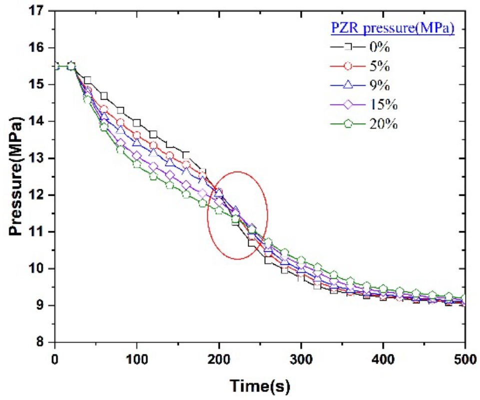

Fig. 4. Pressure in pressurizer by calculation results.

3. Conclusions

In this paper, the sensitivity analysis is performed to confirm the heat loss effect on pressurizer. It is shown that the heat loss on pressurizer can significantly affect the primary system behavior and time to initiation of safety system. Especially, the safety injection system is related to the pressure on primary side. So, the initiation time of initiate safety injection is different for each cases. Additionally, the behavior of pressurizer level is also different for each cases. As a results, it is concluded that the heat loss on pressurizer is one of important factor to predict the large scale heat transfer experiment using thermal hydraulic codes.

ACKNOWLEDGMENT

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