Sensitivity studies on a 100% break of the DVI nozzle of ATLAS using MARS code

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1. Introduction

A Domestic Standard Problem (DSP) exercise using ATLAS facility was organized by KAERI. As the first DSP, the DVI line 100% break was determined. In the event of a DVI line break, the behavior of the two-phase flow in the upper annulus downcomer should be investigated minutely with relevant models of safety analysis codes in order to predict these thermal hydraulic phenomena correctly. To investigate the modeling uncertainties, sensitivity studies on the bypass model and the break flow model are carried out.

2. Analysis Models and Results

2.1 Analysis conditions and methods

For the calculation, the thermo-hydraulic safety analysis code, MARS-KS 3.1 is used [1]. The nodalization diagram of the provided steady-state input deck for ATLAS is depicted in Figure 1.

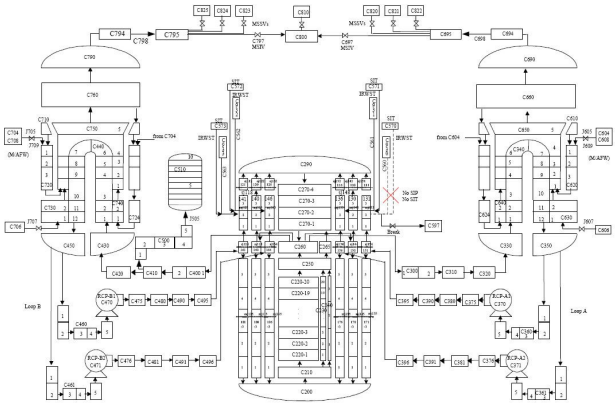

Fig. 1 Nodalization diagram of the ATLAS

To analyze DVI line break accident, a break pipe line, SITs, SIP and IRWST were modeled. The provided steady-state model for the 8% power condition of ATLAS facility was adopted and additional safety-related components are modeled according to the given description of test facility tabulated in Table 1.

Table 1 Major parameters of the break simulation system

No.	Type	Area	Length	Inclined angle	Elevation change	K_f	K_r
575	Sngljun	0.0	-	-	-	0.5	1.0
576	pipe	1.14E-03	0.47	0.0	0.0		
		1.14E-03	0.4	0.0	0.0	0.63	0.63
		1.14E-03	0.29	-90.0	-0.29		
577	Sngljun	0.0	-	-	-		
578	pipe	1.80E-04	0.07	-90.0	-0.07		
		1.80E-04	0.07	-90.0	-0.07		
579	Sngljun	0.0	-	-	-		
580	pipe	1.14E-03	0.15	-90.0	-0.15	0.63	0.63
		1.14E-03	0.380	0.0	0.0	0.63	0.63
		1.14E-03	1.69	-90.0	-1.69	0.63	0.63
		1.14E-03	0.4965	0.0	0.0		

For bypass model, the downcomer to upper head bypass and the downcomer to upper head bypasses were modeled with several pipe components as shown in Figure 2. Sensitivity studies of loss coefficient on upper head temperature in steady state are carried out.

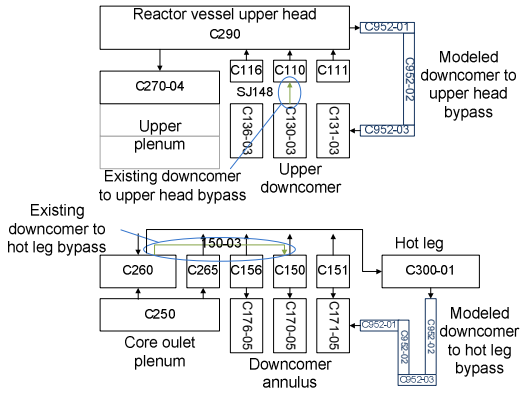

Fig. 2 Schematics of bypass flow model

The transient behaviors of break mass flowrate for several break flow condition was simulated with MARS. The initial peak of the break mass flowrate are underestimated in most of the break flow models when compared to the measured data. The integrated mass of break flow of reference case (Henry-Fauske model) agree well with measured data as shown in Figure 3.

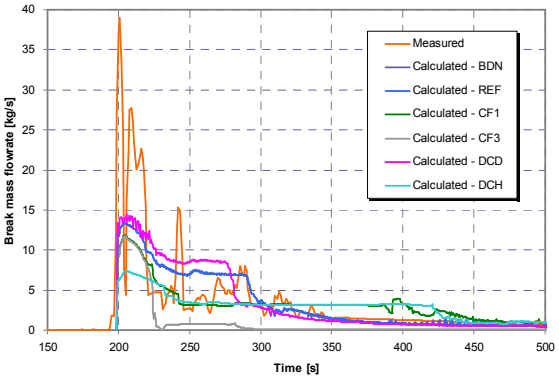

Fig. 3 Comparison of break mass flowrate

At the view point of the mass balance at the upper downcomer which the broken DVI line is connected, the major inflow sources of the break flow are the crossflows from horizontally connected neighbor volumes as depicted in Figure 4. The pressure difference between the upper downcomer and the DVI line is the most dominant force when compared to the gravity. In Figure 5, the calculation results for the maximum cladding temperature are presented. The peak

cladding temperature is observed only in the case using Ransom-Trapp critical flow model.

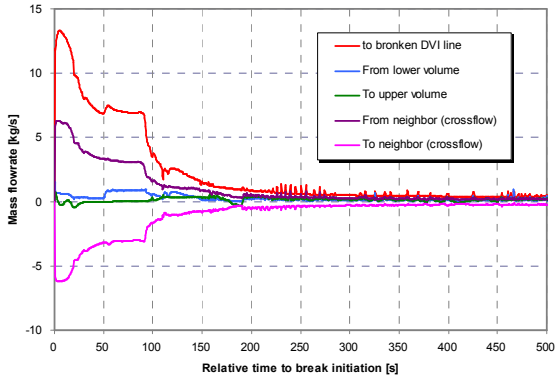

Fig. 4 Transient mass flowrate at upper downcomer volume

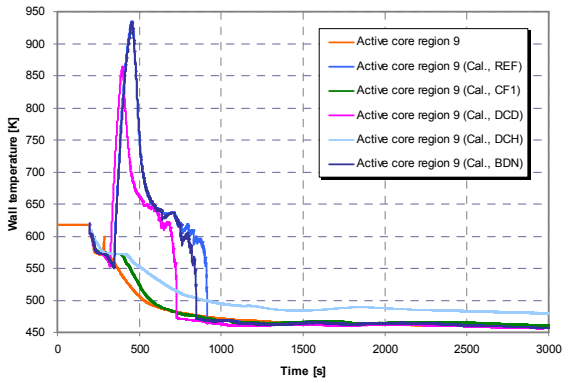

Fig. 5 Comparison of cladding temperature

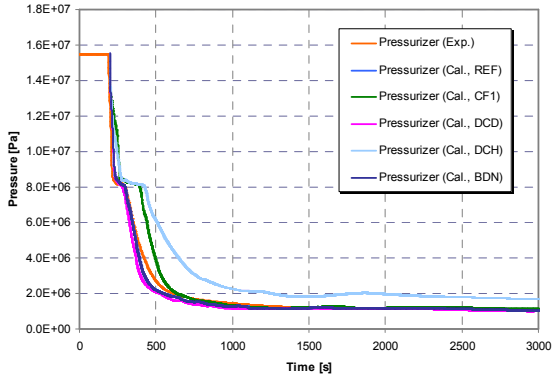

Fig. 6 Comparison of depressurization behavior of pressurizer

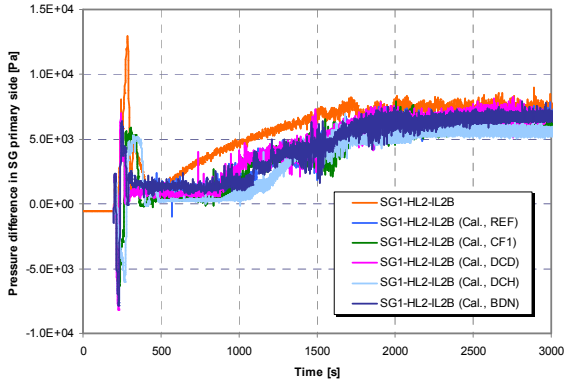

Fig. 7 Comparison of pressure difference between hot leg and intermediate leg

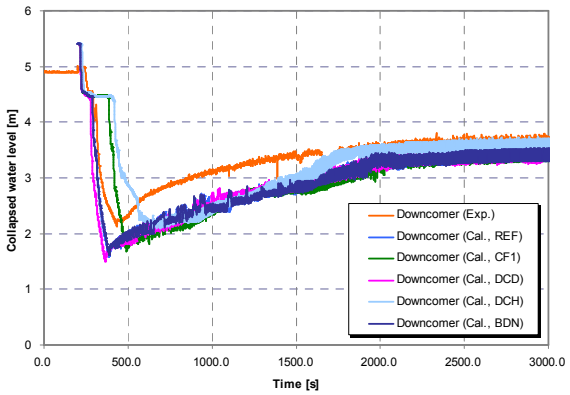

Fig. 8 Comparison of collapsed water level in downcomer

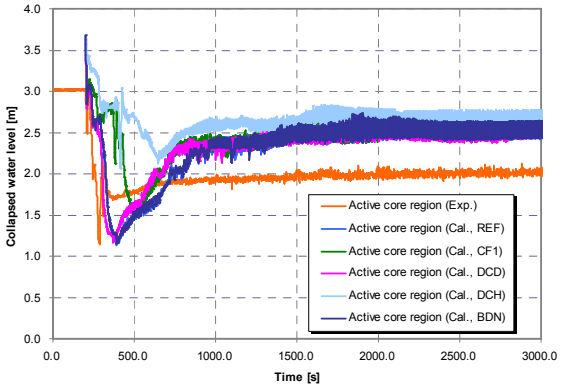

Fig. 9 Comparison of of collapsed water level in core

The loop seal clearing delayed in the simulations when compared to the experiment. In spite of similar lowest water level in core, core uncovery periods of calculations are longer than experiment.

3. Conclusions

The transient analyses for 100% break of DVI line were carried out with MARS-KS code. The break line, safety injections and boundary conditions was modeled according to the description of the ATALS facility. For the steady state condition, the sensitivity of bypass models on the upper head temperature was investigated. For the several break flow model, transient analyses were performed. The break massflow rate of early phase of accident should be reconsidered. An investigation on the reflood phenomena in core is needed for a future work.

ACKNOWLEDGEMENT

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REFERENCES

[1] Korea Institute of Nuclear Safety, Expert training course for the regulatory auditing safety analysis, KINS/TR-143, 2007