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Preliminary Tests for an Identification of the System Characteristics of the ATLAS Facility

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1. Introduction

A thermal-hydraulic integral effect test facility, ATLAS (Advanced Thermal-hydraulic Test Loop for Accident Simulation), has been constructed at the Korea Atomic Energy Research Institute (KAERI). It is a 1/2 reduced height and 1/288 volume scaled test facility based on the design features of the APR1400, an evolutionary pressurized water reactor developed by the Korean industry [1]. Preliminary tests are being carried out in order to characterize the basic thermal hydraulic characteristics such as a pressure drop distribution, a temperature distribution along the primary loop and natural circulation characteristics.

Recently, natural circulation characterization tests were carried as the first commencement of the operation of the ATLAS facility. Subsequently, a preliminary small break LOCA test was done. This paper briefly introduces the major results for the natural circulation and the SB-LOCA tests. Though both tests were not carried out at well-defined initial and boundary conditions, the major thermal hydraulic characteristics of the ATLAS facility were identified and the preliminary tests will contribute to gaining an insight into the operation of the ATLAS facility and to help in preparing for several target test scenarios such as LB-LOCA, SB-LOCA, DVI line break accidents, etc.

2. Natural Circulation Test

Natural circulation tests were carried out for two core power level; 500kW, 1000kW. Figure 1(a) shows the core power control outputs. The real power is expected to be lower than the control power outputs by about 10%, because the linearity between the control signal and the real power was not yet adjusted. During the early 400 seconds, the total core power is 1000kW and then it is reduced to 500kW. As seen the Figure 1(b), the primary pressure slightly drops to lower level when the core power is reduced. Figure 2(a) and 2(b) show the primary temperature and natural circulation flow rate. The absolute temperature of the RCS coolant is about 20^{o}C lower than the design data of the APR1400. In this test, we found that the power capacity of the pressurizer is not enough to heat up the whole system to the design condition. However, the temperature difference between the hot and cold leg is about 30^{o}C which is similar to the design value. The pressure drop distribution data along the primary loop was not successfully obtained in this case. Figure 3 shows the steam generator level and the secondary pressure. In this case, the main steam line was isolated to minimize the heat removal from the primary system.

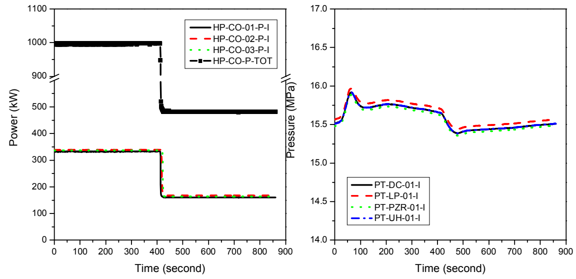

Fig.1 (a) Core power (b) Primary pressure

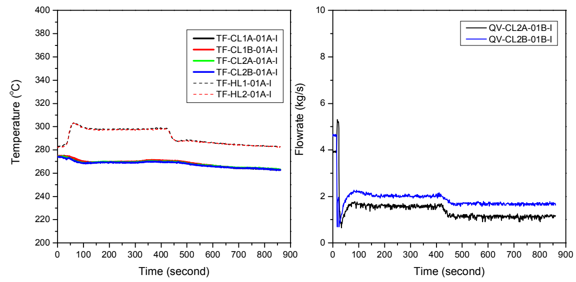

Fig.2 (a) Primary temperature (b) Primary flow

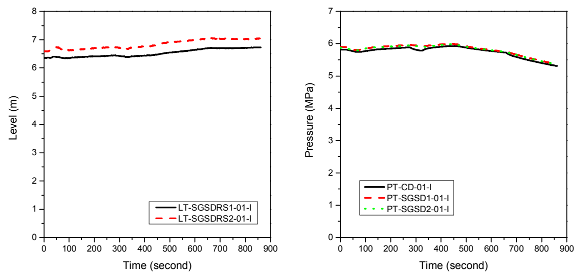

Fig.3 (a) SG level (b) SG pressure

3. SB-LOCA Test

A small break LOCA of which the size is 3" equivalent to the cold leg break of the APR1400 was simulated as a preliminary integral effect test. A pre-calculation with the best estimate code MARS3.0 was done to define the sequence of events during the SB-LOCA event [2].

Table 1 Major sequence of event for SB-LOCA

Event	APR1400	ATLAS	Control devices
Break begins			OV-BS-06
LPP	P<10.7214MPa	P<10.7214MPa	PT-PZR-01
Rx. trip	LPP + 1.15sec	LPP + 0.81sec	HP-CO-01,02,03, table control
Turbine trip	LPP + 0.14sec	LPP + 0.10sec	FCV-MSCV-01 close
RCP trip	LPP + 0.5sec	LPP + 0.36sec	PP-RCP1,2A,B-01 trip
MSIAS	Rx.trip + 10sec	Rx.trip + 7.07sec	FCV-MF1,2-01,02 close OV-MSIV1,2-01 close
Safety injection begins	LPP + 40sec	LPP + 28.28sec	PP-HPSI1,3-01 table control FCV-HPSI1,3-01 open OV-SIS1,3-01 open
SIT begins	PT-DC-01<4.03MPa	PT-DC-01<4.03MPa	FCV-SIT1,2,3,4-01 open OV-SIS2,4-01 open

The obtained SOE is shown in Table 1. Among the control devices, the core heaters and the SI pump are controlled by the predefined table. Other devices are controlled according to the SOE signals defined in Table 1. Figures 4 and 5 show the measured trends of the major parameters. The secondary pressure and the water level of SITs are shown in Figure 6. It can be found from the figures that the SB-LOCA is simulated well in the ATLAS facility and the overall trends of the major parameters qualitatively agree with pre-calculation results. In this case, we had difficulty in measuring some important parameters such as break flow rates and SI flow rates due to a problem of the instruments and malfunction of a certain device. However, we were able to obtain a valuable experience to carry out integral effect tests with the ATLAS facility.

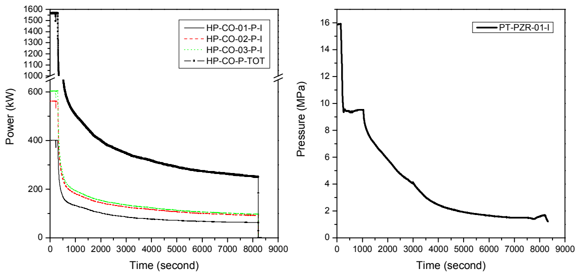

Fig.4 (a) Core power (b) Primary pressure

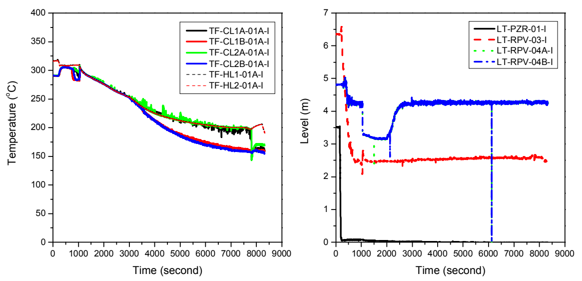

Fig.5 (a) Primary temperature (b) Primary levels

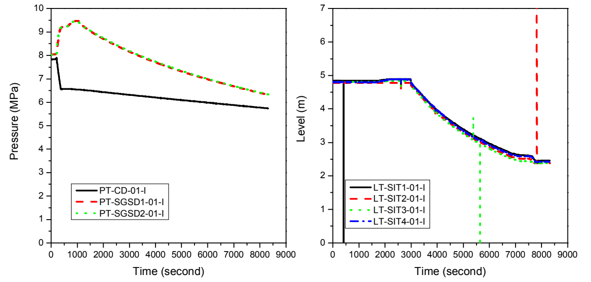

Fig.6 (a) Secondary pressure (b) SIT levels

4. Conclusion

The first integral effect tests with the ATLAS facility commenced with basic natural circulation tests. Through the NC tests, important fundamental characteristics of the ATLAS facility were obtained. A preliminary small break LOCA at the cold leg was also carried out. It was shown that the major devices were controlled well to follow the pre-calculated sequence of events. It was also found that the trends of the major thermal hydraulic parameters agreed reasonably with the pre-calculation results. It implies that the ATLAS facility has a similarity with the prototype plant, APR1400/OPR1000.

Several weak points of the ATLAS facility have been found from the present tests. Extensive efforts are being made to compensate for the weak points. As a next step, a LB-LOCA test is scheduled to be carried out in the course of time.

REFERENCES

[1] W. P. Baek et al. "KAERI Integral Effect Test Program and the ATLAS Design," *Nucl. Technol.*, **152**, 183 (2005).
[2] K. Y. Choi et al., "Simulation Capability of the ATLAS Facility for Major Design-Basis Accidents," *Nucl. Technol.*, **156**, 256 (2006).