Test Specification of A1-1 Test for OECD-ATLAS Project

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1. Introduction

KAERI (Korea Atomic Energy Research Institute) is operating an OECD/NEA project (hereafter, OECD-ATLAS project) by utilizing a thermal-hydraulic integral effect test facility, ATLAS (Advanced Thermal-hydraulic Test Loop for Accident Simulation) [1]. In the OECD-ATLAS project, design extension conditions (DECs) such as a station blackout (SBO) and a total loss of feed water (TLOFW) will be experimentally investigated to meet the international interests in the multiple high-risk DECs raised after the Fukushima accident. The proposed test matrix for the OECD-ATLAS project is summarized in Table 1.

In this study, detailed specification of the first test named as A1-1 in the OECD-ATLAS project was described. The target scenario of the A1-1 test is a prolonged SBO with delayed supply of turbine-driven auxiliary feedwater to only SG number 2 (SG-2). A SBO is one of the most important DECs in that without any proper operator actions, a total loss of heat sink leads to core uncover, to core damage, and ultimately a core melt-down scenario under high pressure. Due to this safety importance, a SBO is considered to be a base test item of the OECD-ATLAS project.

Table I: Test Matrix for the OECD-ATLAS Project

Topics	Tests	Remarks
A1-Prolonged SBO - Asymmetric 2nd cooling - Asymmetric passive 2nd cooling	1 1	Asymmetric FW supply and additional failure Asymmetric passive FW supply (ex. PAFS)
A2-SBLOCA during SBO - SBO+RCP seal failure - SBO+SGTR	1 1	Effects of leakage flow rate TISGTR
A3-TLOFW - 1ry & 2nd bleed + 1ry feed	1	With additional failure such as stuck open POSRV, ATWS, and a SGTR
A4-MBLOCA - PZR surge line break (10-inch)	1	Safety injection through cold leg (or DVI)
A5-Open items	2	Counterpart test for addressing scaling issues
Total	**8**	

2. Test Specification of A1-1 Test

2.1 Overview of A1-1 Test

The target scenario for A1-1 test was determined to be a prolonged SBO with delayed asymmetric secondary cooling via supply of turbine-driven auxiliary feedwater only to SG-2. In the A1-1 test, any active component such as a safety injection pump (SIP) is unavailable. However, passive components such as a pilot-operated safety relief valve (POSRV) and a main steam safety valve (MSSV) are assumed to be available. Turbine-driven auxiliary feedwater will be supplied in a periodic manner depending on the secondary level of SG-2. In general, turbine-driven auxiliary feedwater will be started to supply at the level of 25% of wide-range and be terminated at the level of 40% of wide-range. In order to simulate the supply of auxiliary feedwater as an accident management measure, turbine-driven auxiliary feedwater will be supplied with an intentionally delayed actuation in the present A1-1 test.

The objective of A1-1 test is to investigate the primary cool-down performance by the asymmetric turbine-driven auxiliary feedwater supply as an accident mitigation measure. The following items will be highlighted in the A1-1 test:

- High-pressure asymmetric single- and two-phase natural circulation
- SG heat transfer degradation during dry-out of SG
- Effects of turbine-driven auxiliary feedwater supply on primary cool-down performance
- Establishment of data base for safety analysis code validation especially focused on multi-dimensional thermal-hydraulic behaviors

2.2 Pre-test Analysis for A1-1 Test

With an aim of setting up the detailed test procedures for A1-1 test and also gaining the physical insights for a prolonged SBO transient, a pre-test analysis was performed. In the present pre-test analysis, a best-estimate safety analysis code, MARS (Multi-dimensional Analysis of Reactor Safety) [2] was used. Major components of ATLAS were modeled as realistically as possible as shown in Fig. 1.

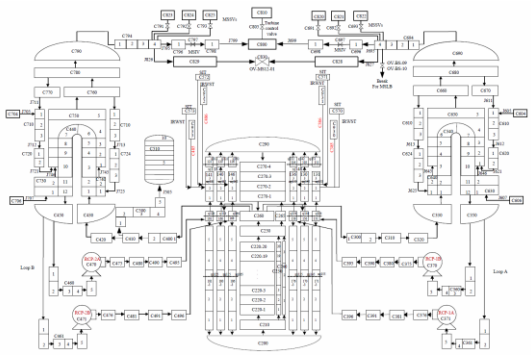

Fig. 1. Nodalization scheme for pre-test analysis for A1-1 test

In the A1-1 test, a prolonged SBO transient will be simulated with two temporal phases: Phase (I) for conservative SBO transient without supply of turbine-

driven auxiliary feedwater and Phase (II) for asymmetric cooling via single trained supply of turbine-driven auxiliary feedwater. Delayed supply of turbine-driven auxiliary feedwater was simulated by adjusting a set point at 1.9 m of core level in the pre-test analysis.

Based on the present pre-test analysis result, the detailed procedure for A1-1 test was determined as shown in Fig. 2. After the core level decreased to 1.9 m, turbine-driven auxiliary feedwater was supplied to only SG-2. With a supply of auxiliary feedwater, the water level in SG-2 and high-pressure natural circulation flow in the primary loop were recovered.

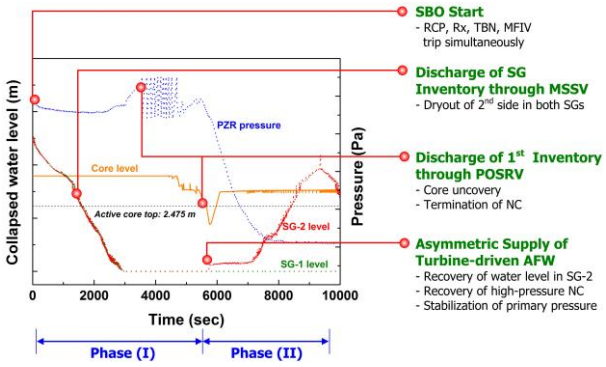

Fig. 2. Test procedure for A1-1 test

2.3 Improved Measurement of ATLAS for A1-1 test

ATLAS has own design features for simulating the multi-dimensional behavior as realistically as possible which includes an integrated down-comer of the RPV, a pertinently scale-downed primary loop and so on. In order to precisely investigate the multi-dimensional thermal-hydraulic phenomena during a prolonged SBO transient, the measurement capability of ATLAS was improved. Fig. 3 shows representative improved measuring features of ATLAS for simulating a prolonged SBO transient especially from a multi-dimensional and asymmetric thermal-hydraulic phenomena point of view.

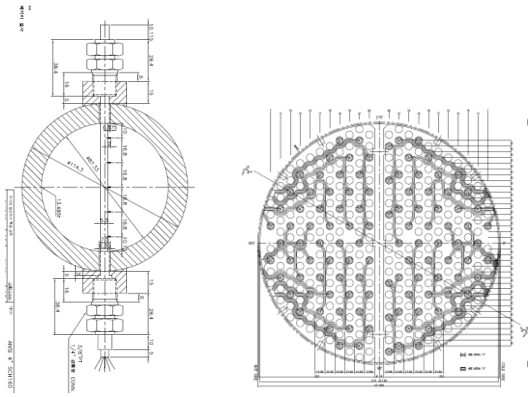

Fig. 3. Measurement systems of ATLAS for investigating the multi-dimensional thermal-hydraulic phenomena (Left: profile thermocouples in the primary loops, Right: thermocouples installed in the plena of SGs)

In the A1-1 test, with the improved measurement systems of ATLAS, the major thermal-hydraulic phenomena during a prolonged SBO transient will be precisely investigated.

3. Conclusions

A detailed specification of the first test named as A1-1 in the OECD-ATLAS project was described. The target scenario of the A1-1 test is a prolonged SBO with delayed supply of turbine-driven auxiliary feedwater to only SG-2 in order to consider an accident mitigation measure. The pre-test analysis using MARS code was performed with an aim of setting up the detailed test procedures for A1-1 test and also gaining the physical insights for a prolonged SBO transient. In the A1-1 test, a prolonged SBO transient will be simulated with two temporal phases: Phase (I) for conservative SBO transient without supply of turbine-driven auxiliary feedwater and Phase (II) for asymmetric cooling via single trained supply of turbine-driven auxiliary feedwater. Delayed supply of turbine-driven auxiliary feedwater was simulated by adjusting a set point at 1.9 m of core level in the pre-test analysis.

In order to precisely investigate the multi-dimensional thermal-hydraulic phenomena during a prolonged SBO transient, the measurement capability of ATLAS was improved.

Acknowledgements

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