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Safety Assessment for transient event occurred during the ASTS test of Hanbit Unit 2

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1. Introduction

Safety Injection has been actuated during the ASTS (Automatic Seismic Trip System) test of Hanbit Unit 2 on Feb. 28, 2014. It could be bad effect on system integrity. KHNP has been performed safety assessment of system for effect of Safety Injection (SI) actuation occurred during the ASTS test of hanbit Unit 2. Stable state of nuclear power plant system has been confirmed according to Safety Injection and reactor trip event occurred during the ASTS test of hanbit Unit 2. In the result of system safety assessment, major variables of nuclear power plant are located in optimal range and not exceed safety limit. It remains nuclear fuel and the integrity of the power plant is in a safe condition were conformed. After ASTS action, thermal elimination has been processed throughout the turbine until turbine signal occurrence because ASTS is connected to M-G set in the present hanbit Unit 2. Therefore, Safety Injection signal has been actuated by rapid reduction of Steam Generator pressure.

In this paper, it is concluded that consideration of equipment and setpoint is needed for that Safety Injection has been not occurred under the unnecessary situation.

2. Plant operational data analysis

Major variables of nuclear power plant are analyzed from SCRAM signal action by ASTS and Safety Injection to plant has been reached stable condition by operator action. Plant operational data are obtained from PIS (Plant Information System).

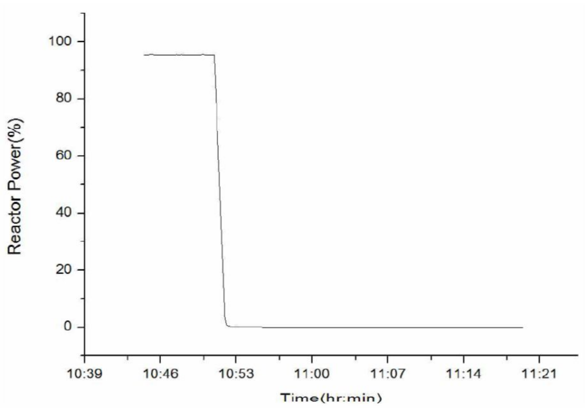

Fig. 1. Nuclear power (plant operational data)

Figure 1 shows a reactor power of plant operational data. Reactor power rapidly reduced from 10hr 51min. by control rod insertion according to ASTS signal actuation.

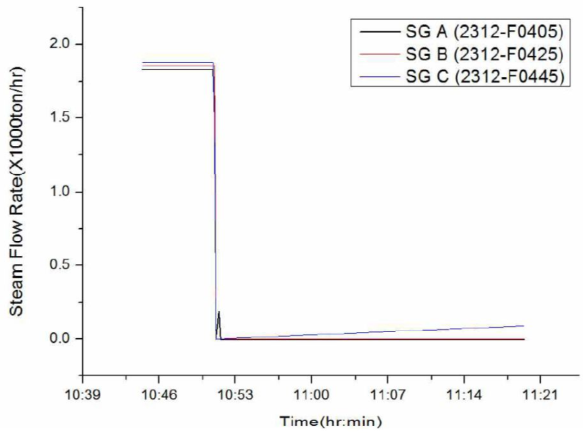

Fig. 2. Steam flow rate (plant operational data)

Figure 2 shows a steam flow rate of plant operational data. Steam flow remains to 1860 ton/hr in the normal condition. It is rapidly reduced at 10hr 51min.. Reactor power rapidly reduced from 10hr 51min.. But steam flow has been remained normal flow quantity during the 27 seconds until turbine had been stopped.

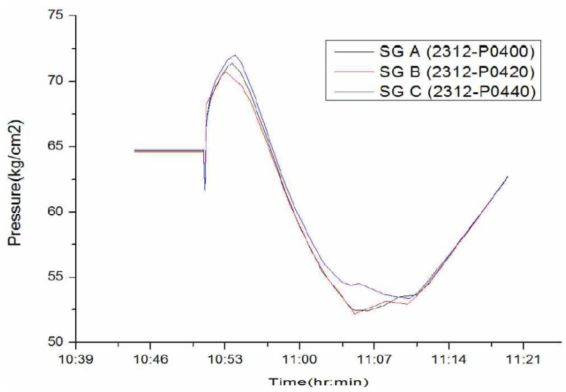

Fig. 3. Steam generator pressure (plant operational data)

Figure 3 shows a steam generator pressure of plant operational data. Steam generator pressure remains to 64.7 kg/cm^2. It has been rapidly reduced at 51hr 27 seconds and finally reduced to the 61.6 kg/cm^2 at 51hr 35 seconds. Pressure signal of steam line has reached setpoint (41 kg/cm^2) through lead/lag circuit at that time. It is estimated that Safety Injection signal has occurred at that time.

3. Safety analysis using the code

RETRAN-3D code developed in EPRI has been used for the thermal hydraulic behavior of major system analysis during the transient of Hanbit Unit 2.

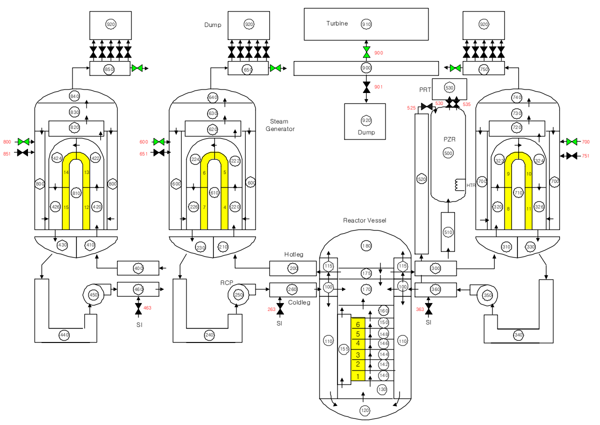

Fig. 4. RETRAN system nodal diagram for Hanbit Unit 2

The RETRAN model for Hanbit Unit 2 is composed of 67 control volumes, 108 junctions, 6 reactor core heat conductors, 112 trip cards, and 227 control block description cards. Entire loops are modeled separately to assure the capability to analyze the loop asymmetry events. The nodal diagram is shown in Figure 4.

SCRAM signal actuation was modeled using the trip card of RETRAN code for ASTS action simulation. Safety Injection flow measured in the plant has been used to boundary condition in the RETRAN code

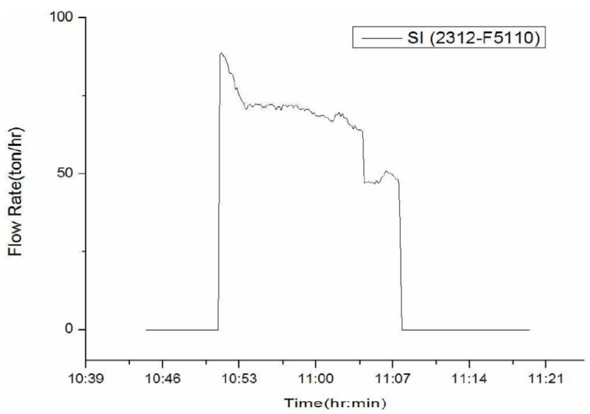

Fig. 5. Safety Injection flow (plant operational data)

Because confirmation of nuclear fuel integrity using the plant operational data is difficult. Minimum DNBR (Departure from Nuclear Boiling Ratio) and system safety analysis are estimated for confirmation of nuclear fuel integrity at the same time.

Safety analysis of Hanbit Unit 2 has been divided into two. One is to confirm that reactor trip and turbine trip signal has been followed Safety Injection signal by low pressure signal of steam line. Two is comparison analysis has been performed for nuclear fuel and system integrity using the plant operational data and safety analysis during the transient event.

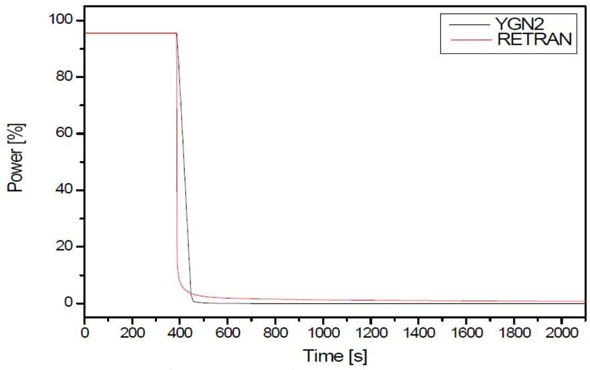

Fig. 6. Power in transient event

After SCRAM signal occurrence by ASTS signal, power decreases rapidly in figure 6. That reason is SCRAM curve used in the RETRAN code is used in the safety analysis conservatively. Overall behavior of RETRAN code result is similar with plant operational data one.

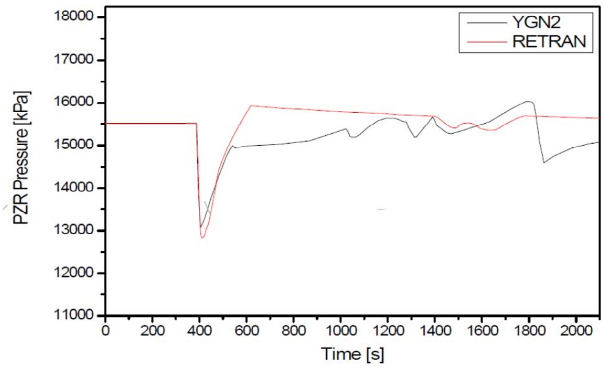

Fig. 7. Pzr pressure in transient event

In pressurizer pressure result, pressure has been dropped down rapidly by SCRAM and turbine signal occurrence according to ASTS signal actuation. There are difference in drop range and recovery in figure 7. It is estimated that the difference has been caused by operator's action for mitigation of transient situation.

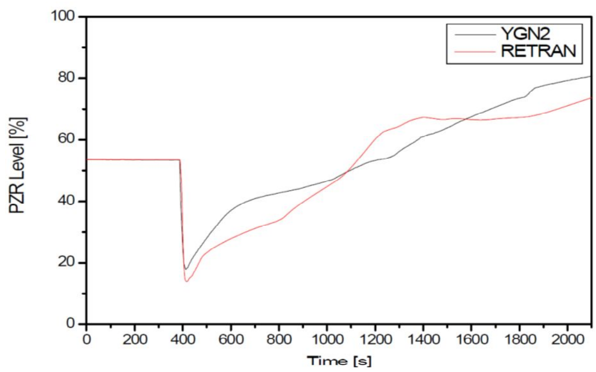

Fig. 8. Pressurizer level in transient event

Figure 8 shows a similar trend overall.

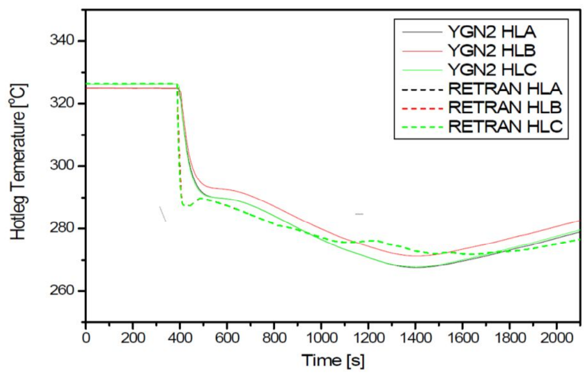

Fig. 9. Hot Leg Temperature in transient event

Hot leg initial temperature of RETRAN code result has been estimated lower than plant operational data because of relatively rapid SCRAM. But overall hot leg temperature shows similar trend.

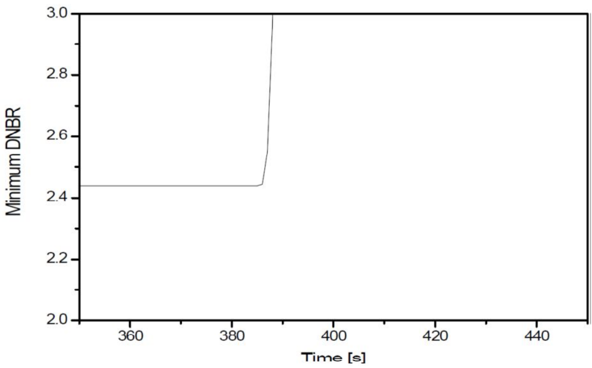

Fig. 10. Minimum DNBR in transient event(RETRAN code)

To confirm the nuclear fuel integrity, Minimum DNBR has been simulated by RETRAN code. After SCRAM signal actuation, Minimum DNBR shows constantly increase. Therefore, nuclear fuel integrity has been confirmed to safe.

3. Conclusions

Stable state of nuclear power plant system has been confirmed for Safety Injection and reactor trip event occurred during the ASTS test of hanbit Unit 2.

In the result of system safety assessment, major variables of nuclear power plant are located in optimal range and not exceed safety limit. It remains nuclear fuel and the integrity of the plant is in a safe condition were conformed.

It is concluded that consideration of equipment and setpoint is needed for that Safety Injection has been not occurred under the unnecessary situation.

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