Steam Generator Level Optimization by Adjusting the Differential Pressure of Main Feedwater System for Kori 3&4 and Yonggwang 1&2 Uprated NPP

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1. Introduction

The steam generator water level evaluation was established by modeling and simulating steam generator water level response and by comparing with the steam generator water level operation data for 4.5% power uprated nuclear plants. The evaluation has been performed to assess thermodynamic and flow balance of feedwater system designs after power uprating. The operation date of the steam generator level behavior and control system for Kori 4 after power uprating were taken from Kori site. The results of operation data such as pump speed, feedwater control valva open position and steam generator water level were compared with the calculation of the previous simulation study for the unit.

2. System Modeling and Operation Data

The model includes NSSS components and control systems to evaluate steam generator level behavior.

A schematic of the primary model is shown on Figure 1. Simple point-kinetics is used for modeling the reactor. And a transport delay time model is used for determining the temperature of the hot and cold legs. A first order lag on the actual RCS average temperature represents the hot and cold leg temperatures, and the RCS pumps are not modeled. Then in the primary system the pressure change and heat transfer due to the pumps is not calculated[1].

The steam generator model can effectively be separated several sections. The sections are consist of the primary side tubes, secondary side tube bundle area, riser, upper downcomer, lower downcomer and steam dome. The heat transfer from primary to secondary system is determined with heat transfer coefficients, which is expressed as a function of the logarithmic mean temperature difference. The control system was modeled based on the Westinghouse plants equipped with Model F steam generators. The control systems include the reactor control, steam generator level control, feedwater pump speed control and steam dump control. The detailed value and setpoint of each of the control systems logic, input, and variables were achieved from Kori 3&4 and Yonggwang 1&2 control systems for updating[2] .

3. Operation Data

We acquired and analyzed opeartion parameters such as main feedwater control valve open position, main feedwater pump speed in normal operation and main feedwater pump speed in case of loss of one pump from Kori Unit 4 plant compuer system.

4. Results

The loss of one feedwater pump transient was evaluated to determine SG narrow range level behavior and was compared with the operation logging data for the power uprated Kori unit 4. Design condions were referred to the uprating project of Kori 3&4 and Yonggwang 1&2 [2]. As shown in Fig. 1 & 2, when differential pressure of feedwater system is 14.5 ㎏/㎠, the open positions of main feedwater control valves are 67-70% in both cases of operation data and simulation results.

As shown in Fig. 3, when operation quantity of main feedwater pump (MFWP) was changed from one pump to two pump, the speed of the MFWP went down from 4050 to 3550 rpm (the change of 500 rpm). As shown in Fig. 4 & 5, when one MFWP was stopped, the speed of the MFWP increased about 500 rpm both cases of operation and simulation results. Therefore, it is concluded that the change of one pump cause the change of 500 rpm. This fact is important that when one pump is stopped abruptly, speed is increased and over speed limit will be violated, and then, the safety of the pump will be challenged and get into danger. Speed limit of Kori unit's MFWP is 4280 rpm. Therefore if we operate in some speed under the 4780 rpm, MFWP will be safe in case of abrupt loss of one pump.

Main feedwater pump speed and flow increase linlearly in case of power ramp change for 4.5% power uprated Kori Unit 4, as shown in Fig 6 & 7.

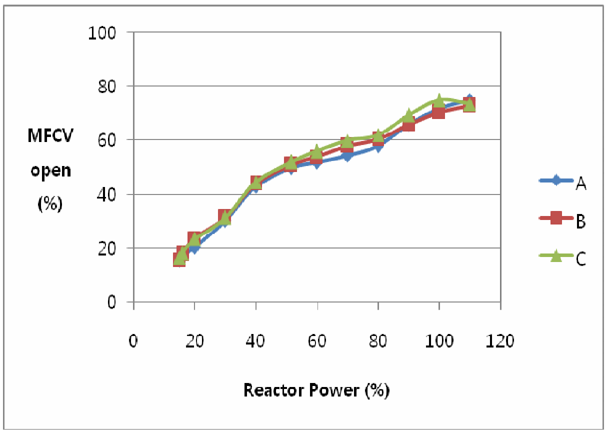

Fig. 1 Main feedwater control valve open position after 4.5% power uprating in Kori Unit 4.

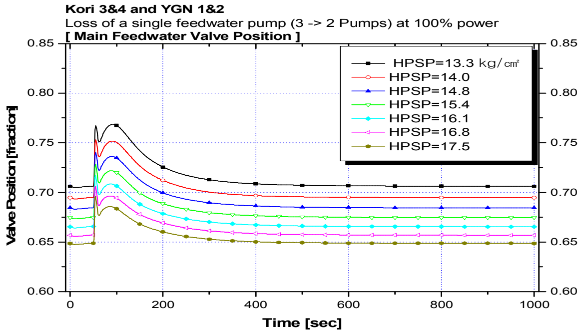

Fig. 2 Simulation results of main feedwater control valve position for 4.5% power uprated Kori 4[3].

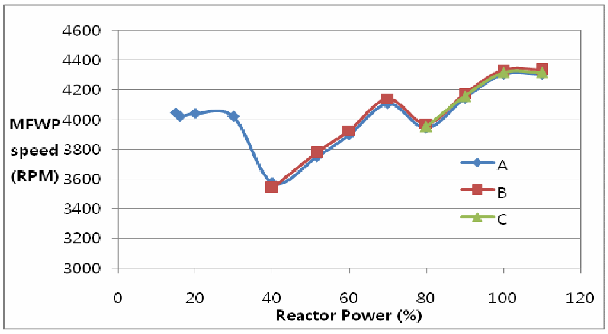

Fig. 3 The operation data of main feedwater pump speed for 4.5% power uprated Kori Unit 4.

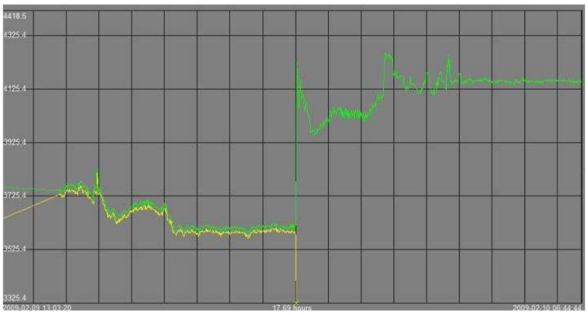

Fig. 4 Main feedwater pump speed in case of loss of one pump for 4.5% power uprated Kori Unit 4.

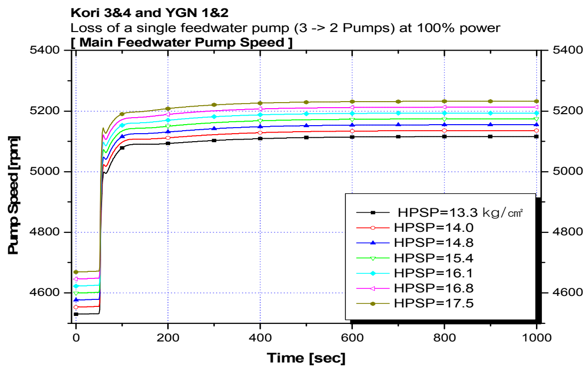

Fig. 5 Simulation results of the pump speed in case of loss of one pump for 4.5% power uprated Kori 4[3].

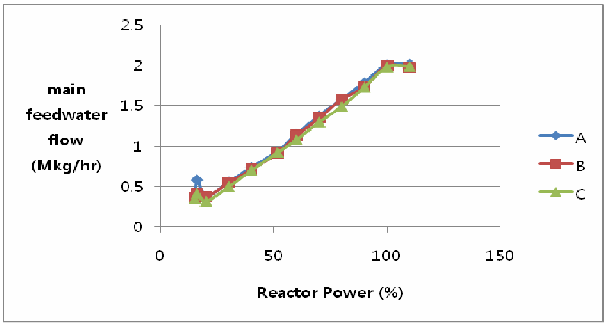

Fig. 6 Main feedwater flow in case of power ramp change for 4.5% power uprated Kori Unit 4.

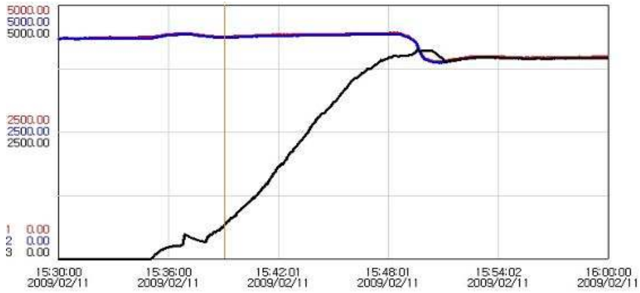

Fig.7 Main feedwater pump speed in case of power ramp change for 4.5% power uprated Kori Unit 4.

5. Conclusion

The operation data and simulation results were compared to evaluate steam generator level behavior for 4,5% power uprated Kori Unit 4 with feedring style steam generator. To estimate the performance of Kori Unit 4 unit were selected after power uprating and one pump loss transient was simulated. Comparing with the operation date for uprated plant, the steam generator level and feed flow, speed of feedwater pump, and various behaviors of steam generator were consistent well as expected. The simulation will be useful for evaluation of the transient and the setpoints of the power uprated plants were changed appropriatly. Therefore it is conclude that the feedwater pump is operated safely when control system setpoint has been changed after power uprating.

REFERENCES

[1] Duk Joo Yoon, Jae Yong Lee, TM Reprot of Main Feedwater Pump Speed Program for Kori Units 3 & 4 and Ygn Units

[2] Duk Joo Yoon and Yong Soo Kim at al, Optimization for Setpoints of SG Water Level Control Systems in Power-uprated YGN 1&2 and Kori 3&4, Journal of Nuclear Science and Technology, Vol. 42, No. 12, pp. 1067-1076, December 2005.

[3] Duk Joo Yoon, Jae Yong Lee, Hwang Yong Jun, Optimization of Main Feedwater Pump Speed Program for Kori Units 3 & 4 and Ygn Units 1 & 2 Power Uprate, KNS fall meeting, 2006.10