Analysis of SG Level Control System Stability after Power Uprating at Kori 3&4 and Ygn 1&2

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1. Introduction

Poor control of the steam generator water level in the secondary system of a nuclear power plant after power uprating at Kori Unit 3&4 and Younggwang Unit 1&2 can lead to frequent reactor shutdowns. Such shutdowns are caused by violation of safety limits on the water level. The performance of steam generator level control system has been evaluated. The purposes of simulation analysis are to provide the expected plant responses as follows; 1) To support training plant operators and engineering personnel in preparation for performing the actual site test. 2) For evaluation to determine appropriate SG level control system setpoints in advance of performing the site startup test.

2. Methods and Results

In this section some of the methods used to evaluate are described and results of evaluation are shown.

2.1 Analysis methods

The test simulation transients were simulated using a computer code written in the Advanced Continuous Simulation Language (ACSL). This code includes detailed steam generator and feedwater system models that provide more accurate prediction of steam generator level response than any other codes.

The transient cases are large load rejection, 10% load change, level setpoint change and ramp load change.

The following acceptance criteria for the load change transients are as follows; A stable steam generator feedwater control system shall not induce sustained or diverging oscillations and shall automatically control the plant without challenging the protection system setpoints and shall not require operator actions following the test simulation transients.

In response to step changes in level setpoint, the SG narrow range level shall not overshoot or undershoot the new level setpoint value by more than 2% of level span and shall remain within the new setpoint value ±1 percent of level span within a time period of three times the reset time constant of the level proportional integral controller.

2.2 Step Load Change(SLC)

These transient cases were simulated as a runs of a 10-percent step decrease from 100-percent power and as a run of a 10-percent increase from 90-percent power. For the 10-percent step load decrease, steam dump valve are not enabled because the rate-lagged turbine

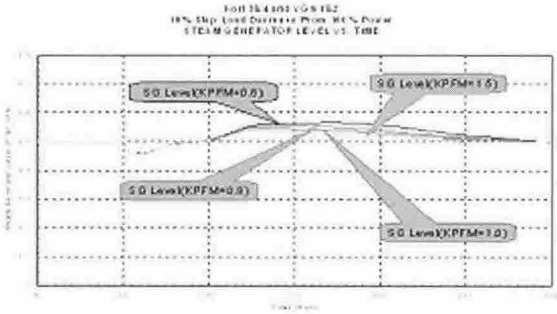

Figure. 1 Steam Generator Level in the Case of 10% SLC

pressure signal dose not exceed the setpoint. These transients represent relatively small disturbances on the secondary side parameters and the response on the SGLCS is not affected by steam dump control action.

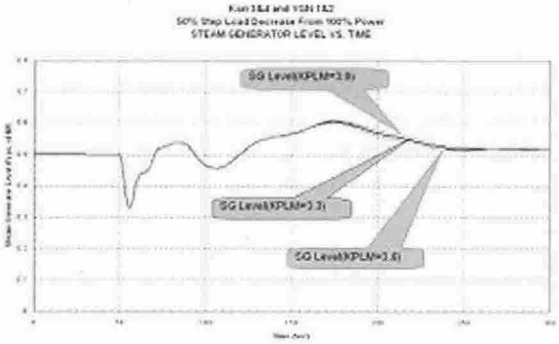

Figure. 2 Steam Generator Level in the Case of 50% LLR

2.3 Large Load Rejection Transient

The LLR transients (95% and 50%) are the most limiting plant transients that are formally evaluated in this paper. In the LLR transients, minimum NRL reached early in the transient and is affected by the difference in steam dump response. In the cases that PB is changed from 22□ to 15□, LLR Simulation Analysis Results showed acceptable control performance for 50% LLR and resulted in insufficient margin to the NRL trip setpoint for 95% LLR.

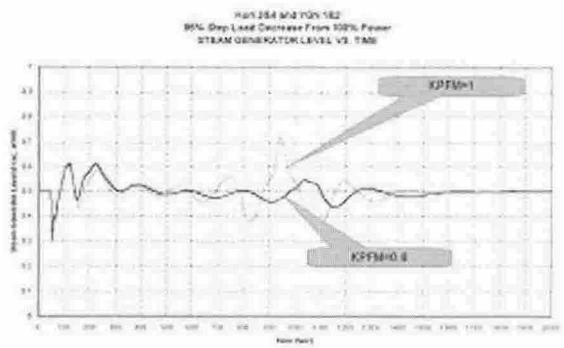

Figure. 3 Steam Generator Level in the Case of 95% LLR

2.4 SG Level Step Change (SGLSC)

Simulation runs made to predict the response of the plant and SGLCS to ±5% step changes in the NRL setpoint. From various analyses results, the NRL response was well-controlled and without excessive overshoot or under shoot. The settling times for the low-power cases are longer than those for the high power cases, but within the criterion of three times the reset time constant value that is typically applied.

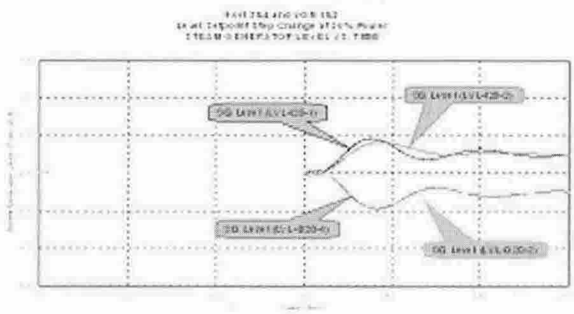

Figure. 4 SG Level in the Case of 50% SGLSC

2.5 One Pump Loss during 2 feedwater pump operating

Two cases were run. Case one is one pump loss during 3 feedwater pump operating. In this case, steam generator level has not almost variation.

Case two is one pump loss during 2 feedwater pump operating and initiates turbine runback to 50% load. In this case, a maximum turbine runback is 200%/minute and the time delay between an initiating event and the start of the runback is 5 seconds. The pu mp loss is initiated at 50 seconds and steam generator level exceeds the lo-lo SG level trip setpoints at 107 seconds.

3. Conclusion

The large load rejection(LLR) simulation analyses are performed when PB is changed from 22□ to 15□. The results showed acceptable control performance 50% LLR and results in insufficient margin to the NRL trip setpoint for 95% LLR depending on steam dump control action. Analysis results of one pump loss during two feedwater pump

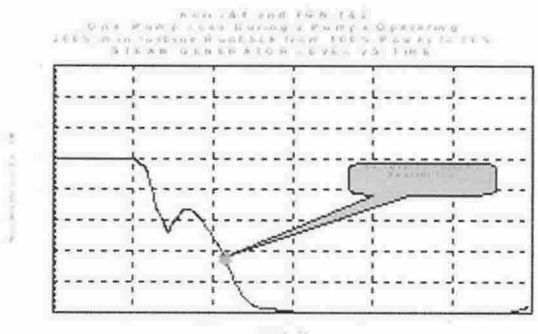

Figure. 5 SG Level in the Case of One Pump Loss during 2 feedwater pump operating

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operating with maximum turbine runback reached the lo-lo SG level trip setpoints.

The steady state prediction of main FCV position is reasonable. This result will be compared with the results of pressure drop between feedwater header and steam header from the independent BOP/NSSS.

REFERENCES

[1] PCWG-03-58, Rev. 1, "Kori Units 3&4(KGA /KHB) and Yonggwang Units 1&2(KSR/KTR): Approval of Category 1 (for Feasibility Study) PCWG Parameters to Support a 4.5 Uprate Feasibility Study", October 15, 2003

[2] Calc. No. CN-TA-92-147, J.Y. Lee, "KGA/KHB/KTR LOFTRAN Base Deck for Vantage 5 Hybrid Fuel", 11/9/92

[3] KFD/RD-030020M, PM Memo, "Reactivity Data to Evaluate Control System Setpoints", 10/16/2003

[4] WTP-ENG-81-016, "Model F Steam Generator Thermal-Hydraulic Data Report", Kori Units 3(KGA) and 4(KHB), Apr. 8, 1981

[5] WNEP-8316, "Model F Steam Generator Thermal-Hydraulic Data Report", Yonggwang Units 1(KSR) and 2(KTR) , Jan. 26, 1983

[6] CN-OPES(98)-011, "Loss of One Main Feedwater Pump Transient Analysis for Farley Replacement Steam Generator Project", 6/9/98

[7] Feedwater Control Valve Manual, Drawing No. 568161-1, J. Zamora, 04/03/91

[8] Main Feedwater Pump Manual, Performance Curve

[9] WCAP-10378, Rev. 0, "Process Control Systems Scaling Manual for Kori Nuclear Power Plants 3 & 4", Section 23 SG Water Level Transmitter Calibration, January 1984

[10] SE-ICAT(95)-227, R. Calvo, "User's Manual for plant simulation Computer Program", KSR010, 5/22/95

[11] Kori 3&4, KHNP, "Precautions, Limitations, and Setpoints for Nuclear Steam Supply System", Rev.1, 1984

[12] Yonggwang 1&2, KHNP, "Precautions, Limitations, and Setpoints for Nuclear Steam Supply System", Rev.3, 1993.12

[13] KNA/ED-040012L, " Korea Uprate Technology Development Project Best Estimate Plant Parameter at Plant Power Condition, March 22, 2004.