Performance Evaluation for YGN 3 and 4 Using RETRAN-3D

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1. Introduction

The purpose of performance evaluation is to confirm the Yonggwang unit 3 and 4(YGN 3 and 4) plant transient response to Performance Related Design Bases Events(PRDBEs) and to provide setpoint requirement for the Plant Protection System(PPS) and the Diverse Protection System(DPS). This evaluation is used to confirm the suitability of plant operating and thermal-hydraulic behavior with control systems in case of anticipated transient conditions using RETRAN-3D[1,2,3 and 4].

2. Description and Results

2.1 Performance Evaluation

We have evaluated plant responses by the actuation of control systems during the anticipated transient conditions satisfying following conditions.

(1) Plant Protection Systems(PPS) and Diverse Protection Systems(DPS) should not initiate reactor trip.
(2) Engineered Safety Features(ESF) shouldn't be actuated.
(3) Primary and secondary system safety valves shouldn't be actuated.

Performance related design bases events includes some categories of plant transient condition that consist of small turbine load step changes, large turbine load step changes, turbine load ramp changes and upset events. And these categories have detailed transients. Evaluation cases are summarized in Table 1. And these evaluation cases are related to evaluate plant responses to control systems including Pressurizer Pressure Control System(PPCS), Pressure Level Control System (PLCS), Control Element Driving Mechanism Control System(CEDMCS), FeedWater Control System(FWCS), Steam Bypass Control System(SBCS) and Reactor Power Cutback System(RPCS). Table 2 shows what control system can be operated with performance evaluation cases.

Table 1. Summary of performance evaluation

Performance Evaluation Category	Events	Evaluation Number
Small Turbine Load Step Changes	Turbine power step changes of -10% power	P1
	Turbine power step changes of +10% power	P2
Large Turbine Load Step Changes	Turbine trip	P3
	Turbine power runback to house load	P4
Turbine Load Ramp Changes	Turbine power ramp changes of -5%/min	P5
	Daily load cycle of 100-50% power over 2 hours	P6
Upset Events	Reactor trip	P7
	Spurious actuation of the pressurizer spray	P8
	Spurious actuation of the pressurizer heaters	P9

Table 2. Evaluation of each control system modeling

	Evaluation Number								
	P1	P2	P3	P4	P5	P6	P7	P8	P9
PPCS	O	O	O	O	O	O	O	O	O
PLCS	O	O	O	O	O	O	O	O	O
CEDMCS	O	O	O	O	O	O	O	O	O
FWCS	O	O	O	O	O	O	O	O	O
SBCS			O	O			O		
RPCS			O	O					

2.2 Evaluation Results

We have performed performance evaluation number from P1 to P9 in Table 1. However, we show the evaluation results of P1 and P5 due to the limit of page.

The transient initiator of evaluation number P1 is sudden change of turbine load within 1 seconds. The evaluation results are shown in Figure 1. This change causes power mismatch between primary and secondary system. The power mismatch causes the primary temperature increase and provide negative reactivity that alters reactor power from 100% to 90% by the actuation of the CEDMCS. The power mismatch also causes the expansion of primary coolant which results in primary pressure increase and level increase. The primary pressure increase causes the actuation of sprays and is controlled near 2250psia by the PPCS. The PLCS decreases letdown flow for the control of

pressurizer level and the pressurizer level is controlled near 50.6% which is level control setpoint with reactor coolant system(RCS) average temperature. The decrease of turbine load causes the increase of secondary pressure and the secondary pressure slowly decreases due to decrease of reactor power. And the steam generator level is controlled by the FWCS at a constant value which is 44% narrow range level over the entire power range.

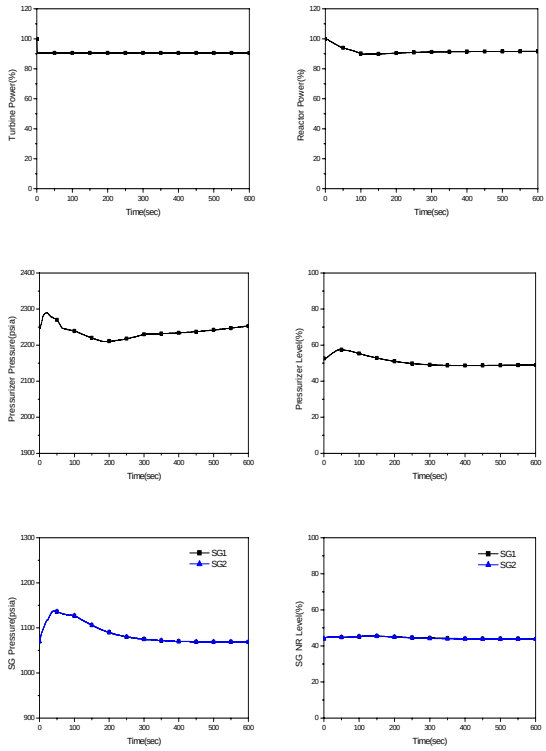

Figure 1. Evaluation results of P1

The transient initiator of evaluation number P5 is ramp decrease of turbine load from 100% to 21% with 5%/minute. The evaluation results are shown in Figure 2. With the same manners as P1, turbine load decrease causes power mismatch and increase primary temperature. The primary temperature increase causes negative reactivity insertion by the CEDMCS. And primary coolant expansion increases primary pressure and pressurizer level. The PPCS decreases primary pressure by the actuation of spray and controls primary pressure near 2250psia. PLCS decreases letdown flow and controls pressurizer level near 37% level control setpoint. Turbine load decrease increases secondary pressure due to the power mismatch. And the secondary pressure increase causes increase of secondary temperature. Thus secondary temperature increase causes decrease of heat transfer rate between primary and secondary system and also causes decrease of steam flow rate. Thus steam generator level increases. However the FWCS controls steam generator level at a constant value which is 44% narrow range level.

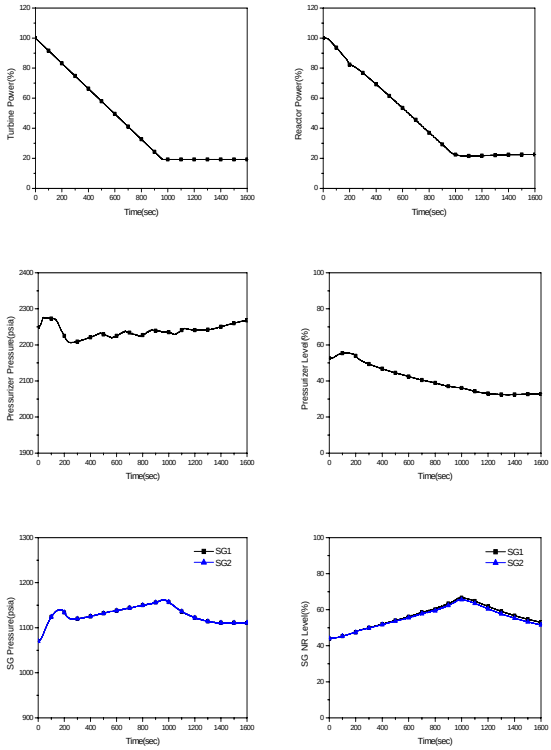

Figure 2. Evaluation results of P5

3. Conclusion

Performance evaluation using RETRAN-3D shows reasonable plant thermal-hydraulic responses to control systems without actuation of PPS, ESF and primary/secondary safety valves. Thus we can confirm the suitability of control system models of RETRAN-3D for the YGN 3 and 4.

REFERENCES

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