Evaluation of Large Load Rejection Capability for Kori 3/4 and Yonggwang 1/2 Units after Power Uprate

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1. Introduction

As a part of Power Uprate(PU) Program for Kori 3/4 and Yonggwang 1/2 Units, large load rejection(LLR) capability was evaluated. The current LLR capability is 100% rated load with 70% of steam dump(SD) capacity. However, the plants got experiences of reactor trips at the grid disconnect events as in table 1. Moreover, steam dump capacity will be decreased to 64% after power uprate. In this paper, large load rejection capability is reviewed and more reasonable load rejection capability is proposed for a design criterion.

Table 1 No. of plant trips vs No. of grid disconnects

year / unit	85	86	87	88	89	92	93	97	00	02	03/04	sum
Kori #3	1/1										1/1	2/2
Kori #4		1/1					1/1				1/1	3/3
YGN #1		4/4										4/4
YGN #2			0/1							1/1		1/2
Uljin #1				0/1		0/1		0/1	1/1		0/1	1/5
Uljin #2					0/1			1/1	1/1		0/1	2/4
sum	1/1	5/5	0/1	0/1	0/1	0/1	1/1	1/2	2/2	1/1	2/4	13/20

2. Status of Steam Dump Capacity and Load Rejection Capability

Because of that reduced steam dump capacity, reactor trip is inevitable when a grid disconnect event occurs. In this regards, all the nuclear power plants in U.S.A. which performed power uprate abandon their 100% load rejection capability and adapt 50% load rejection capability as in table 2. In U.S.A. the grid disconnect event is very rare and they didn't modify steam dump system in order to maintain 100% load rejection capability. However, because grid disconnect event is not so rare in Korea, we may have different solution.

In order to get 100% load rejection capability, more than 80% of steam dump capacity is needed and 4 more steam dump valves are installed to get that capacity. Moreover, those steam dump valves open quickly within 3 seconds and modulated close not less than 20 seconds when they are required to.[1] All the pressurizer PORVs and turbine speed control system also function properly when they are required to.

Table 2 Steam Dump Capacity and Load Rejection Capability[1]

Plants	Steam Dump Capacity		Load Rejection Capability	
	Before PU	After PU	Before PU	After PU
North Anna 1/2	40	30~35	50	50
Shearon Harris	85	~60	100	50
Farley 1/2	40	30~35	50	50
Callaway	40	30~35	50	50
Vogtle	40	30~35	50	50
Surry 1/2	40	30~35	50	50
V.C. Summer	85	~60	100	50
Turkey Point 3/4	40	30~35	50	50
Byron/Braidwood	40	30~35	50	50
Diablo Canyon	85	~60	100	50
Kewaunee	85	~60	100	50
Beaver Valley	85	~60	100	50
Maanshan*	85	85	100	100

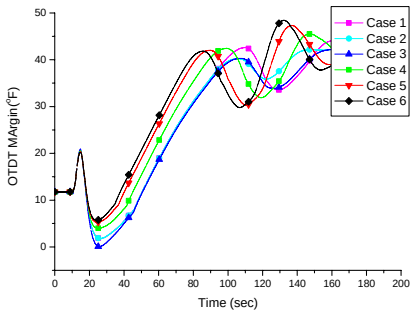
* Maanshan doesn't perform PU.

3. Simulation Results

In order to confirm load rejection capability, some computer simulations were performed. LOFTRAN[2] code which was developed by Westinghouse for non-LOCA safety analysis was used for primary side margin calculation and ACSL/KSR010[3] code was used for secondary side margin calculation. The input deck was prepared using best estimate assumptions and conditions to simulate plant transient more realistically.

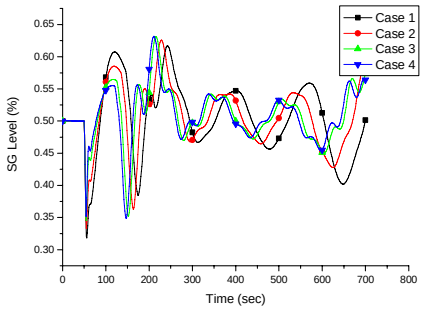
Figure 1 shows there is no OTDT margin with the expected SD capacity of 64% after power uprate at 100% load rejection transient. If we increase SD capacity up to 80%, then we have margin to maintain the reactor without a trip. However, figure 2 shows a

lot of SG level oscillation even though a minor margin improvement is obtained per SD capacity increases. During those SG level oscillations, a plant trip is expected due to the possible dull control system operations. Figure 3 shows a lot of OTDT operating margins at 50% load rejection transient. Figure 4 shows a little bit oscillation at the beginning of the transient. However, those oscillations are gone in a minute. Per those results, we can even reduce SD capacity in this case.



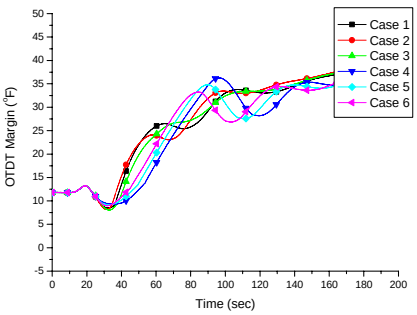
Case1: Proportional Band(PB)=15, SD=0.64
Case2: SD Control Lead Time =10 sec
Case3: PB = 17 deg F
Case4: SD Capacity = 72%
Case5: SD Capacity = 80%
Case6: SD Capacity = 84%

Figure 1 OTDT Margin(deg F) at 100% Load Rejection Transient



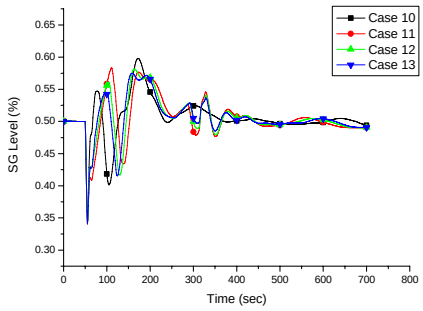
Case1: SD Capacity = 64.1%
Case2: SD Capacity = 72.1%
Case3: SD Capacity = 80.1
Case4: SD Capacity = 84.1%

Figure 2 SG Level(%) at 100% Load Rejection Transient



Case1: Proportional Band(PB)=15, SD=0.64
Case2: SD Control Lead Time =10 sec
Case3: PB = 17 deg F
Case4: SD Capacity = 36%
Case5: SD Capacity = 40%
Case6: SD Capacity = 44%

Figure 3 OTDT Margin(deg F) at 50% Load Rejection Transient



Case10: SD Capacity = 64.1%
Case11: SD Capacity = 36.1%
Case12: SD Capacity = 40.1%
Case13: SD Capacity = 44.1%

Figure 4 SG Level(%) at 50% Load Rejection Transient

4. Conclusion

Simulation results show there is no operating margin enough after power uprate at 100% load rejection transient. Even though before power uprate, there is little operating margin and therefore, at almost all the cases we experiences plant trip at the grid disconnect transients. Instead of 100% load rejection capability, 50% load rejection capability was proposed as a design criterion after power uprate. This will save plant modification cost and can maintain the plant more reasonable conditions.

REFERENCES

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[2] T.W.T. Burnett, "LOFTRAN Code Description", WCAP-7907-P-A, April, 1984.
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[5] KED/RD-040021M, “Transmittal of KEPRI Interface Data (SD System Capacity)" April 30, 2004