A Study regarding Evaluation of Impact on Nuclear Power Plants according to Occurrence of Low Voltage in 4.16 KV Bus of Non-Class 1E Electric Power Supply System

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1. Introduction

Recently, during the power set-back to perform the 12th preventive maintenance in Yeonggwang #3, there was an abnormal occurrence in its electric power supply system. While performing non-essential power transfer to the start-up transformer from the auxiliary transformer at 32% output, non-class 1E 13.8 kV non-essential power was lost due to a failure in the interlock logic system card. Low voltage in the bus caused the shut down of the reactor coolant pump, and the reactor could be maintained in a safe manner according to the related emergency procedure. However, as non-class 1E 4.16 kV power failed to fast transfer to the start-up transformer from the auxiliary transformer and the resulted low voltage brought about difficulty to recover the secondary system of the nuclear power plant.

The need for preparing the applicable procedure for abnormal occurrences has been raised in order to systematically analyze the inoperability condition of non-class 1E loads and to provide for abnormal occurrences in the electric power supply system. Actual power loss simulation was carried out using a simulator, and based on this result, the procedure for abnormal occurrence(N-1E 4.16 kV bus low voltage) was developed.

2. Methods and Results

2.1 Impact to the nuclear power plant of heavy duty Inoperability

Critical heavy duty equipments in the nuclear power plant are designed in a concept of redundancy to provide against abnormality of one path loss. As one set of equipment for following heavy duty is provided for each path as well, stand-by equipment starts up automatically in case of any one bus loss. Even with only one path operation, the nuclear power plant can be operated in normal.

2.2 Experienced cases of Non-class 1E 4.16KV bus low voltage

While beginning the power set-back to perform the 12th preventive maintenance in Yeonggwang nuclear power plant #3 and performing the non-essential power transfer to the start-up transformer from the auxiliary transformer at 32% output, RCP 01B and 02B, which were receiving the electricity from 06SN bus, tripped due to power transfer failure of non-class 1E class 13.8 kV bus 06 SN, and the reactor/turbine generator stopped. After the reactor/turbine being stopped, there were abnormal occurrences including failure of N-1E 4.16kV bus 01SN automatic power transfer, automatic change over failure of N-1E 480V L/C 13SN Tie circuit breaker, and delay in turning gear operation at condenser vacuum sudden drop and turbine speed reduction. However, swift actions could stabilize the power plant.

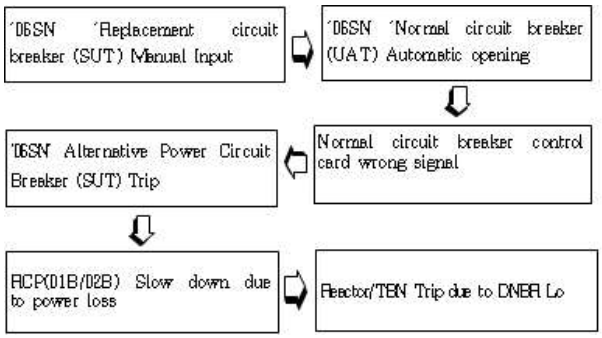

Fig 1 Reactor Trip Flow Chart

Table I: Main Operation Parameters

		Before Rx Trip	Transient value	Stable value
RCS Pr (kg/㎠)		158	150 ~ 158	158
RCS Cold Leg Temp(℃)	LOOP #1	294.6	275 ~ 292	292
	LOOP #2	293.8	275 ~ 292	292
S/G Pr (kg/㎠)	#1	77	59 ~ 76	77
	#2	77	59 ~ 76	77
S/G Level (WR, %)	#1	74	51 ~ 76	77
	#2	74	59 ~ 78	77
Condenser Vacuum (mmHgA)		14	32 ~ 220	32
Aux Steam Supply Header Flow (kg/s)		31	0 ~ 17	-

2.3 Simulation Outline

A simulation test on non-class 1E 4.16 kV bus low voltage was carried out at # 3 & 4 simulators in the Younggwang Training Center. A circuit breaker was manually opened by operators in the main control room in order to arbitrarily generate low voltage of each bus of 01SN and 02SN at 100% of turbine output. It was observed that at the same time of bus low voltage generation, equipment under operation stopped and stand-by equipment started up automatically.

2.4 Simulation Analysis

As shown in the simulation result, items to be automatically operated operate perfectly in the non-defect power plants, interruption of power generation or abnormal occurrence does not occur without operators' action. However, facilities in the actual power plant must not be relied upon in 100%, because there may occur diversified circumstances such as malfunction of equipment and device and disassembled condition for repair and maintenance work. Therefore, if the bus low pressure abnormality occurs, lists of equipment and device which may require emergency measures and confirmation must be arranged so that operators can take measures quickly.

3. Conclusion

As the power plants that are designed, constructed and operated by human cannot be perfect, they must be improved through try and error. Even the high cost facility becomes useless if the power supply system is lost. Against this case, diesel generators were provided for critical equipment and system to supply power, however, which might be a status of inoperability, if a natural disaster such as earthquake and tsunami. However, if the power plants were designed even against the natural disaster with extremely low possibility, it would cause economic profitability and utilization ratio to be significantly lowered. For this reason, it will be necessary to improve the operation technology of existing facility for optimization. As a result of power supply constitution examination while carrying out this research, we found some items to be improved for optimization of facilities in the nuclear power plant.

REFERENCES

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