

Evaluation of Loss of Offsite Power events at Nuclear Power Plants in Korea

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ABSTRACT

It is recognized that the availability of AC power to nuclear power plants is essential for safe operation and shutdown. A LOOP(Loss of Offsite Power) event and SBO(Station Blackout) event are involves the loss of offsite power concurrent with the failure of the onsite emergency AC power system(Emergency Diesel Generator) are considered important contributors to total risk at nuclear power plant. In this paper, the actual LOOP events that have occurred at nuclear power plants in Korea are collected and analyzed to utilize them in a PSA or Risk(or performance) informed application. An additional objective of the study is to reexamine the engineering insights concerning LOOP events

1. Introduction

It is recognized that the availability of AC power to nuclear power plants is essential for safe operation and shutdown. In the PSAs has been performed in Korea, the Risk is induced from LOOP and SBO are considered important contributors to total risk at nuclear power plant. In the KSNP PSAs, the Risk induced from those two events are over 30% of total CDF(core damage Frequency). In this study, the LOOP Events has occurred at commercial nuclear power plants in Korea has been collected during 1978 through 2002. Total 12 LOOP Events has been collected and analyzed. This paper contains a description of the LOOP data collection, analysis results to utilize PSA & Risk informed application, engineering insight and the major conclusions of this study.

2. Data

For this study, the operating experience data from KTRIP Data base program has been reviewed involving some electrical failure that occurred at commercial nuclear power plants in Korea from 1978 through 2002. To produce results for use in PSA or Risk informed application, the time to recovery was defined as time until offsite power could have been restored to at least one safety bus from an alternate electrical power source. The plants status in which the LOOP events occurred and main cause are also defined for engineering insight. A total 12 LOOP events are specified for this study (Loss of Off-site Power) and summarized in Table 1.

Table 1. LOOP Events at nuclear power plants in Korea

	Unit	Unit Status	Description	Cause	Durati on
1	Kori 4	at power	SUT 'A' & 'B' 및 MOT Trip	Typhoon	7hrs 45min.
2	Kori 3	shutdown (O/H)			7hrs 45min
3	Kori 2	at power	T/L(Transmission Line) Failure	Severe wind	less than 2 min.
4	Kori 1	at power	Kori 1 #1 & #2 345kV T/L failure & 154kV #1 failure	태풍	8hrs
5	Kori 2	at power	Kori #1 & #2 345kV T/L failure & 154kV #1T/L failure		8hrs
6	Kori 3	at power	SUT(Start-up Transformer) flashover		9hrs 36min
7	Kori 4	at power	SUT flashover		9hrs 36min
8*	UCN 1	at power	345kV #1 & #2 T/L block	Heavy snow	28 분 min
9*	UCN 2	at power	345kV #1 & #2 T/L block		28min
10	WOL 1	at power	GIS failure	Component failure	less than 2 min.
11	UCN 1	at power	forest fires	forest fires	less than 2 min.
12	UCN 2	at power	forest fires	forest fires	less than 2 min.

* house load operation

3. Analysis

The analysis results for the LOOP events are presentes as followed and the analysis results are summarized in Table 2.

- LOOP Definition -

A LOOP is generally defined as a simultaneous loss of electrical power to all unit safety buses, requiring the emergency power generators to start and supply power to safety buses. At most units, a LOOP cause the reactor trip, but some unit designs allow continued operation at power following a complete the LOOP event, with the safety buses supplied by house load operation. Two cases of Loop events(#8 & #9 events in table 1) were continuing power operation with the safety buses supplied by house load operation after LOOP event because of their specific design. These two cases could be excluded to LOOP events. But in most of PSA performed in Korea, the house load operation has not been credited because that operation has succeeded rarely in operating experience. In this study, a LOOP is defined as simultaneous loss of electrical power from off site power in switchyard if the reactor did not trip following the LOOP event. The two events are includes The LOOP category.

A second distinction of LOOP event is a restore time. The events that offsite power is restored to at least one safety bus within less than two minutes could be generally excluded from LOOP. The 4 of 12 LOOP events in table 1, offsite power recovered in less than 2 minutes. Therefore a total of 8 events were identified as meeting the criteria specified for LOOP event.

- Loop category -

The LOOP events have been generally classified into three category such as plant-centered, grid and weather-related events. All of 8 events defined LOOP events are include the weather related events such as a typhoon and heavy snow. In addition, they were grouped according to weather the plant was operating or shutdown. Only 1 of 8 events occurred during plant shutdown.

- Multi-Units site consideration-

The weather related events could have the potential to affect all units at a same site. In table 1, the three external causes(two typhoon and one heavy snow) affected to more than one unit at a same site. All of 8 LOOP events considered in this study were involving weather related the Multi-Units LOOP.

- Off-site Power Restoration Time -

For the 8 LOOP events, the restoration Time(duration) are presented in Table 1. These restoration times is much longer than that of risk assessment applied the PSA performed in Korea.

- Quantitative Analysis-

Table 2 summarize the quantitative results of this study. The results were also compared with the U.S recent data.

Table 2. The Results of analysis

		Plant-Centered	Grid-Related	Severe Weather	Frequency
Domestic Experience(1978-2002, 164Ry)	# of events	1	2	9	0.043/ry(at power)
	# of events for LOOP			7(at power), 1(shutdown)	0.04/sry(shutdown)
The U.S Experience(1980-1996, 1189Ry)	# of events	130	4	17	0.03/ry(at power)
	# of events for LOOP	46(at power), 69(shutdown)	3	10	0.18/sry(shutdown)

3. Conclusion

It is recognized that the availability of AC power to nuclear power plants is essential for safe operation and shutdown. To utilize PSA & Risk informed application, and get a engineering insight, a total of 12 LOOP events are collected and analyzed. The preliminary quantitative results between Korean specific data and U.S data did not show a big difference at power operation while there is a big difference between them during shutdown status.

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