Analysis of Loss of Offsite Power events based on Domestic Operation Experience

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Abstract

This study is an update of previous analysis for LOOP (loss of offsite power) frequency and restoration time. In this paper, the actual LOOP events that have occurred from 2005 to 2012 at commercial nuclear power plants in Korea are collected. The LOOP frequency and restoration time analysis are re-performed to apply Korean NPPs's (Nuclear Power Plant) specific and realistic risk model. Additionally, an engineering analysis is also performed to obtain the insights from the domestic LOOP events.

1. Introduction

It is recognized that the availability of AC power to nuclear power plants is essential for safe operation and shutdown. Unavailability of AC power can be an important adverse impact on a plant's ability to recover accident and maintain safe shutdown. The probabilistic safety assessment (PSA or PRA) performed for Korea NPPs also have indicated that a loss of offsite power event and a station blackout (SBO) event would be important contributors to total risk at nuclear power plant in Korea. Therefore, in this paper, to update the previous LOOP frequency and restoration time analysis[1], the actual LOOP events occurred from 2005-2012 in Korean NPPS are collected. And, the statistical analysis for LOOP frequency and restoration time is re-performed for new data. Additionally, an engineering analysis is also performed to obtain the insights about the specific LOOP events.

2. Data Collection

For this study, the operating experience data are reviewed from the plant trip analysis Data base program[2]. The unplanned plant transient data has been gathered from all the commercial nuclear power plants in Korea from 1978 to 2012. During this duration, about 520 plant transient events were gathered from 20 commercial operating nuclear power plants(4 units in Kori, 4 unit in Wolsong, 6 units in Ulchin and 6 units in Youngkwang) and the cumulative operating experience has been about 339.4 reactor operating years and 46.4 shutdown operation years. Through the reviewing the plant trip caused by electrical failure, a total 17 events are identified as a potential LOOP event and summarized in Table 1.

Table 1. Domestic LOOP Events

	Date	Unit Status	Cause	Duration
1	1986,08,28	at power	Typhoon	7hrs 45min
2	1986,08,28	O/H		7hrs 45 min.
3	1987.07.16	at power	Typhoon	8hrs
4	1987.07.16	at power		8hrs
5	1987.07.17	at power		9hrs 36min
6	1987.07.17	at power		9hrs 36min
7	1997.01.01	at power	Heavy snow	28min
8	1997.01.01	at power		28min
9	2004.6.19	O/H	Human error	3hrs 38min
10	2009.09.03	O/H	Human error	1hrs 23 min
11	2010.12.29	O/H	Human error	21min
12	2006.11.29	O/H	Component failure	26min
14	2011.4.19	O/H	Human error	50min
14	2012. 2.9	O/H	Human error	12min
15	2011.4.19	at power	Human error	50min
16	1987.07.15	at power	Severe wind	less than 2 min.
17	1987.07.15	at power		

The Korean NPPs's LOOP events were grouped into several categories to analyze effectively as described in foreign LOOP analysis report [3, 4, 5]. The first LOOP categorization is based on occurring period. Total 10 out of 17 events have occurred at power operation and the other 7 events have occurred during shutdown operation. The LOOP events were grouped into several categories based on root cause also. A LOOP events could be classified several cause as the foreign precedent results[3,4,5]. But in this study two classification scheme was applied as plant centered and severe weather related. Total 10 out of 17 events are severe weather related LOOP events and the other event are plant centered LOOP events. Only one plant centered LOOP event is caused by component failure and the others are caused by human error. The human error induced LOOP events have occurred every year during last 5 years. The severe weather (typhoon induced) related LOOP events were occurred multi units simultaneously are in the same site because they share

the offsite power supply system. Especially the units at Kori site located on the southeastern coast of Korea have experienced multi units LOOP events more frequently than other site because the typhoon often strike the southeastern coast of Korea. The other LOOP categorization scheme is based on a restoration time. The LOOP Events restored to at least one safety bus within less than two minutes are defined momentary LOOP events. And the events did not restored to at least one safety bus within less than two minutes are defined sustained LOOP events. In this study, the 14 sustained LOOP is considered because the momentary events were caused by switching error or delayed transfer result from failing to transfer from a faulted power source to a live back-up power source and actual restoration time is less than 2 minutes.

3. LOOP Frequency and Restoration Time Analysis

Two frequency estimation for 14 sustained LOOP events is performed during at power operation and shutdown operation to apply the Korean NPP PSA. The results are summarized Table 2. LOOP recovery time are also analyzed. Only one probability of exceedance versus duration is estimated for all LOOP events due to lack of domestic LOOP experiences using by lognormal distribution and Weibull distribution and presented in Figure 1.

Table 2. LOOP Frequency

	Number of occurrences	Mean frequency (per year)
at power	7	2.21E-02
shutdown	7	1.60E-01

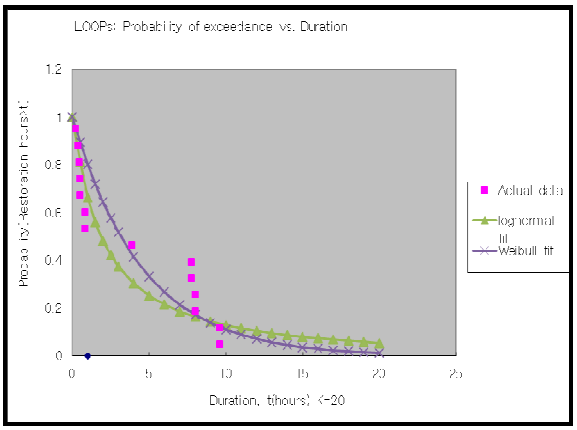

Figure 1. Probability of exceedance versus duration curve

4. Conclusion

The LOOP frequency and restoration time analysis are re-performed to apply specific and realistic PSA risk model for Korean NPP. The total of 17 LOOP events are collected and analyzed. Two frequencies estimation for 14 sustained LOOP events are performed during at power operation and shutdown operation. The probability of exceedance versus duration is also estimated.

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