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Transient Initiating Event Analysis for Nuclear Power Plants in Korea

Park, Jin-Hee, Han, Sang-Hoon
P.O. Box 105, Yusong, Taejon, 305-600, Korea
Tel : +82(42)868-8297, Fax: +82(42)868-8256
Email:jhpark6@kaeri.re.kr

I. INTRODUCTION

It is recognized that operating experience data is essential for an accident analysis (including Probabilistic Safety Assessment) and other quantitative activities such as a Risk or Performance informed application for a nuclear power plant. The data for a PSA or other quantitative activities have to use specific data to consider domestic operation experiences, because they are considered important contributors to the total risk at a nuclear power plant. The frequencies of transient initiating events for Korean nuclear power plants were updated reflecting the recent operating experiences. For the analysis of transient initiating events, the recent domestic operation experience data were gathered, new transient category and a trend analysis function were added in transient analysis database program also.

II. Data gathering and Database program updating

For this study, unplanned plant transient data has been gathered from all the commercial nuclear power plants in Korea during April 1978 in which the first nuclear power plant(Kori 1 Unit) started its commercial operation through the end of 2004. During this duration, about 488 plant transient events were gathered from 19 commercial operating nuclear power plants and the cumulative operating experience has been about 195.5 critical years and 34.3 stutdown operation years. In table 1, the accumulated operating years and the number of unplanned transient events collected from each plant are summarized.

In order to analyze the data, the new transient initiating events category scheme based on NUREG/CR-5750's methodology was added in the database program.

After the data were collected each transient was reviewed and categorized to apply it to a PSA or other quantitative activities.

A review of the operation experience data showed that almost all nuclear power plants experience a high frequency of initiating events in a early stage(called learning period) of commercial operation, which drops sharply after the plant has been operating for a short time. To analysis the effect of learning period, a trend analysis function was added in transient analysis database program also.

Table 1. Summary on the operating year & number of events for each unit

Unit	Cal. Year	Rx. Year	# of events
1	26.69	21.18	115
2	21.45	17.37	55
3	19.27	16.4	39
4	18.69	16.18	35
5	18.36	15.95	33
6	17.57	15.00	32
7	9.76	8.65	12
8	9.01	7.97	113
9	2.62	1.02	7
10	2.02	1.64	1
11	16.32	13.83	30
12	15.26	13.41	23
13	6.39	5.8	3
14	5.01	4.52	9
15	0.42	0.41	1
16*	21.71	18.63	56
17*	7.51	6.71	15
18*	6.51	5.91	8
19*	5.25	4.93	3
total	229.82	195.51	488

* CANDU type plant

III. Analysis.

Transient initiating event frequencies are an essential input to the analysis process of a nuclear power plant PSA or quantitative activities. To evaluate the initiating event frequencies, all the events are inserted into the computer program according to the transient category based on the NUREG/CR-5750.

To assess the effect of the learning period, a trend analysis for 9 plants that their critical operating years over 10 years. The cumulative number of all initiating events for sample plant is shown in figure 1. Operation times measured in days from the commercial operation start date. The cumulative number of events is plotted against operation experience, and the slope of the cumulative plot represents the frequency, events per time. This plot shows the learning period at sample plant, when many initiating

events occur in quick succession in the Figure 1. The vertical dashed line in Figure-1 marks the learning period. This plot suggest that the data occurred in the learning period could be excluded on the transient initiating event frequencies analysis to describe the current status of plant. Eight of nine plants examined showed a clear learning period.

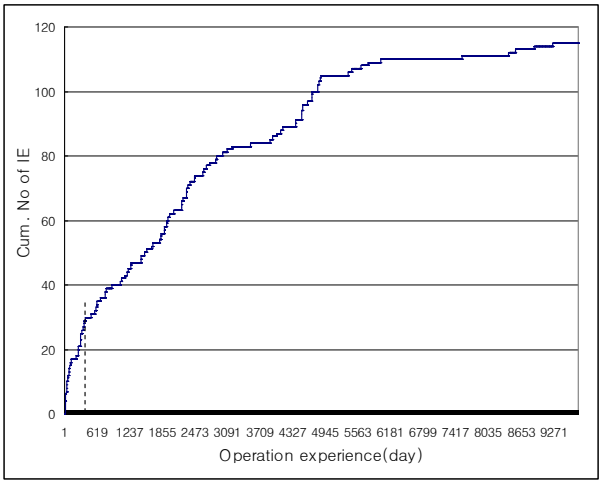

Figure 1. Cumulative # of I.E, by operation experience from commercial start date for sample plant

Two types of 12 transient initiating events frequencies dealt in PSA or RIA were estimated and summarized in Table 2. One case is including the learning period experience and the other is excluding the learning period experience. All initiating event frequencies except the Loss of Condenser Heat Sink are comparable to the U.S recent initiating transient frequencies.

IV. Conclusion

In this study, unplanned plant transient are gathered and analyzed. The frequencies of transient initiating events for Korean nuclear power plants were updated reflecting the recent operating experiences. For the analysis of transient initiating events, the recent domestic operation experience data were gathered, new transient category and a trend analysis function were added in transient analysis database program also. Total of 12 transient initiating events frequencies were estimated. All initiating event frequencies except the Loss of Condenser Heat Sink are comparable to the U.S recent initiating transient frequencies. The Korean specific transient database would be updated yearly and the results of this study could be used as basic information for a probabilistic risk assessment and other quantitative activities in Korea.

Table 2. The results of the Transient Initiating Events Frequencies

I.E	NUREG/CR-5750		Domstic data	
	Mean Frequency	*Mean Frequency	Mean Frequency	*Mean Frequency
Loss of offsite power	2.40E-02	2.30E-02	3.84E-02	3.93E-02
Loss of Vital Medium Voltage AC Bus	1.40E-02	1.50E-02	2.65E-03	3.67E-03
Loss of Vital Low Voltage AC Bus	2.10E-03	2.10E-03	7.58E-03	1.06E-02
Loss of Vital DC Bus	6.90E-04	7.00E-04	7.58E-03	1.06E-02
Loss of Instrument or Control Air System	5.80E-03	6.50E-03	2.30E-02	1.78E-02
Total Loss of Service Water	9.70E-04	3.20E-04	2.65E-03	3.67E-03
Partial Loss of Service Water	6.90E-04	7.00E-04	2.30E-02	1.78E-02
Steam Generator Tube Rupture	7.00E-03	7.10E-03	2.65E-03	1.06E-02
Loss of Condenser Heat Sink(combined)	3.80E-02	3.60E-02	1.56E-01	2.04E-01
- Inadvertant Closure of MSIVs	1.10E-02	1.10E-02	2.81E-02	2.50E-02
- Loss of Condenser vacuum	2.60E-02	2.60E-02	1.30E-01	1.47E-01
- Turbine Bypass Unavailable	2.60E-03	2.10E-03	1.28E-02	3.67E-03
Total Loss of Feed Water	5.40E-02	6.60E-02	6.90E-02	5.36E-02
Other Initial Plant fault	1.20E+00	1.30E+00	1.91E+00	1.63E+00
Fire	2.30E-02	2.40E-02	1.28E-02	1.06E-02

*) Learning period experiences are excluded

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REFERENCES

1. Development of a database system for shutdown events of nuclear power plants in Korea", KAERI/TR-2131/2002, 2002.
2. Development of transient initiating event frequencies for use in Probabilistic Risk Assessments, NUREG/CR-3862, 1985.
3. Updating of initiating events frequencies in the UCN 3,4 PSA", KAERI/TR-2957/2005, 2005.
4. Rates of Initiating Events at U.S Nuclear Power Plants:1987 -1995, NUREG/CR-5750, 2002.