

Failure Trend Analysis for Safety Related Components of Korean Standard NPPs

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1. Introduction

The component reliability data of Korean NPP that reflects the plant specific characteristics is required necessarily for PSA of Korean nuclear power plants. We have performed a project to develop the component reliability database (KIND, Korea Integrated Nuclear Reliability Database) and S/W for database management and component reliability analysis. Based on the system, we have collected the component operation data and failure/repair data during from plant operation date to 2002 for YGN 3, 4 and UCN 3, 4 plants. Recently, we provided the component failure rate data for UCN 3, 4 standard PSA model from the KIND. [1]- [5]

We evaluated the components that have high-ranking failure rates with the component reliability data from plant operation date to 1998 and 2000 for YGN 3,4 and UCN 3, 4 respectively. We also identified their failure mode that occurred frequently. [6]

In this study, we analyze the component failure trend and perform site comparison based on the generic data by using the component reliability data which is extended to 2002 for UCN 3, 4 and YGN 3, 4 respectively. We focus on the major safety related rotating components such as pump, EDG etc.

2. Methods and Results

2.1 Components having High-ranking Failure Rates

We identified the components which have high-ranking failure rates among the major safety related rotating components and compare their failure rates with the generic data.

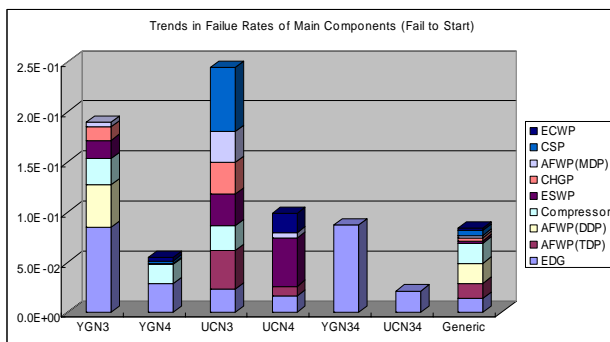


Figure 1. Components with high-ranking failure rates (Fail to Start)

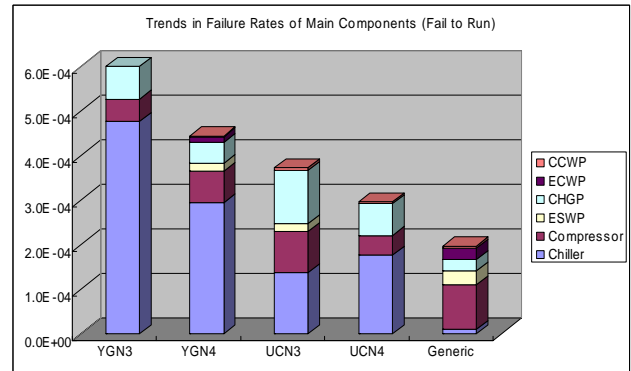


Figure 2. Components with high-ranking failure rates (Fail to Run)

In the case of fail to start mode, the failure rates of all EDGs, some diesel driven AFWs pumps, and some ESWS pumps are higher than the generic data by Figure 1. Figure 2 give information that all chillers and charging pumps have higher failure rates than generic data for fail to run mode.

Therefore, we perform detail failure trend analysis for EDG (fail to start mode) and chiller and charging pumps (fail to run mode).

2.2 Decision of Interval for Failure Trend Analysis

Because YGN 3, 4 and UCN 3, 4 plant started their plant commercial operation sequentially, each base dates for trend analysis are different. Therefore we use the operation year instead of calendar year for the interval of the failure trend analysis.

Table 1 shows the trend analysis interval. The operation year means the interval between two successive overhauls. The first operation year is the interval between the first plant commercial operation date and the first overhaul.

Table 1. Operation Year Classified by Plants

Plant	Operation Year	Operation Start date	Operation End Date	Days
YGN3	1st	95-04-01 0:00	96-02-01 0:00	307
	2nd	96-05-02 6:05	97-02-06 0:05	280.75
	3rd	97-03-31 20:20	98-03-31 0:03	365.15
	4th	98-05-19 18:25	99-06-03 0:48	380.27
	5th	99-07-16 12:39	00-09-30 0:00	442.53
	6th	00-11-19 8:00	02-03-08 0:00	474.67
YGN4	1st	96-01-01 0:00	96-11-14 0:10	319

	2nd	97-01-17 16:43	97-10-21 0:05	277.31
	3rd	97-12-03 20:13	98-12-24 23:02	387.12
	4th	99-02-03 19:40	00-02-08 6:00	368.43
	5th	00-03-31 5:10	01-05-03 17:30	399.51
	6th	01-06-28 15:00	02-10-14 0:01	473.38
UCN3	1st	98-08-11 0:00	99-06-23 0:00	317
	2nd	99-09-02 7:30	00-5-27 0:00	268.69
	3rd	00-07-08 12:00	01-06-30 0:10	357.51
	4th	01-07-30 20:00	02-11-23 0:10	481.17
UCN4	1st	00-01-01 0:00	01-02-10 4:00	338.47
	2nd	01-03-23 1:30	02-04-05 0:10	378.94

2.3 Detail Failure Trend Analysis and Site Comparison

In this section, we perform the trend analysis classified by each plant and compare each failure rates with the generic data for fail to start mode of EDG and fail to run mode of chiller and charging pump which have high-ranking failure rates in the previous section.

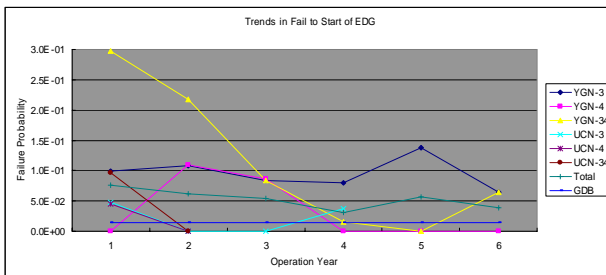


Figure 3. Failure Trend of EDG (Fail to Start)

Figure 3 shows that the total failure rates of EDG (Total) look like a little bit constant even though those are higher than the generic data (GDB). The failure rate of the AAC DG of YGN 3, 4 plants, however, shows a trend that it is very high at early operation year then goes down gradually.

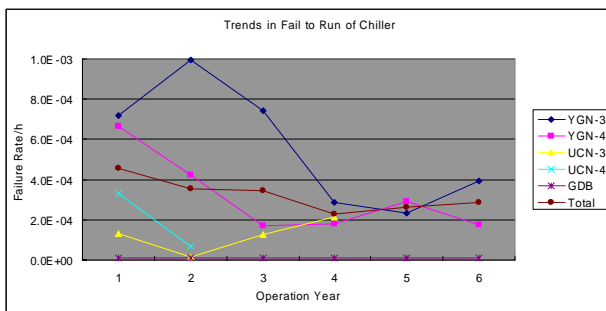


Figure 4. Failure Trend of Chiller (Fail to Run)

We can see that the failure rates for fail to run of chiller of four plants are higher than generic data respectively by Figure 4. Moreover, Figure 4 shows that failure rate of UCN-3 is increasing from the second interval.

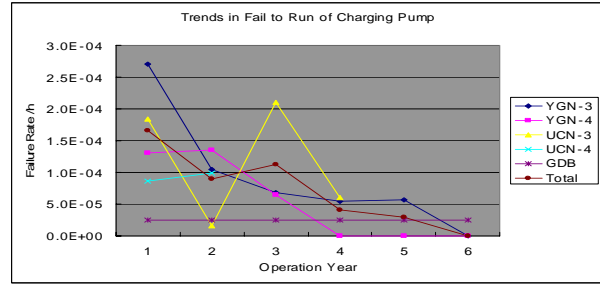


Figure 5. Failure Trend of Charging Pump (Fail to Run)

The failure rate for fail to run of charging pump of UCN3 shows a trend of oscillation, while others goes down by Figure 5.

3. Conclusion

In this study, we analyze the component failure trend and perform site comparison based on the generic data with the component reliability data during from plant commercial operation date to 2002 for UCN 3, 4 and YGN 3, 4. We focus on the some safety related rotating components such as pump, EDG etc.

We first identify the components having high-ranking failure rates for fail to start and fail to run modes. From the results, we perform detail failure trend analysis for EDG, chiller and charging pumps.

From the failure trend results, we can estimate that all the failure rates are stabilized gradually as time goes by even though they show various shapes at early operation time. However, some components of specific site which have increasing or swing failure rates require attention.

We are going to fit the proper probability distribution for each case and estimate their parameters future.

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