Influence of Non-safety Important Component on Maintenance Rule

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1. Introduction

The Maintenance Rule (MR) programs in KHNP have been implemented since Jan 2009. KHNP is currently developing MR program for new built plant which has been constructed from December 2011. MR program for new built plant is developed before plant's commercial operation.

It is required to utilize plant-specific probabilistic safety analysis (PSA) result as risk significant criteria to determine which components are significantly important to safety. [1] The criteria consist of three PSA risk values which are risk reduction worth (RRW), risk achievement worth (RAW) and core damage frequency (CDF) contribution. Most safety related components are classified as high risk significant, and non-safety related components as low safety significant in MR program.

This paper presents the influence of the non-safety related component which has high PSA risk value on MR program of new built plant.

2. Change in PSA Risk Evaluation Results

This section describes the difference in PSA risk evaluation result between operating plants and new built plant.

2.1 Importance change of Initiating Events in CDF

The new plant's PSA program adopted Loss of Coolant Accident (LOCA) initiating event (IE) frequencies from NUREG/CR-6928 database and other IE frequencies from domestic database. Compare to previous database, importance of SG Tube Rupture, Loss of safety related (or 1E) AC and Station Black Out in CDF are relatively increased as shown at table 1. [3]

Table 1. Importance change of Initiating Events in CDF

Initiating Event	Operating	New built	% Diff
SG Tube Rupture	2.9%	6.1%	3.2% ↑
Loss of 1E AC	0%	0.1%	0.1% ↑
Station Black Out	60.8%	64.2%	3.4% ↑

These changes are influenced on relative importance of electrical components which are major success factor to prevent core damage when such IEs happen in accident scenarios. Such components are including Emergency Diesel Generators (EDGs) and Alternate AC Diesel Generator (ACC DG).

Table 2. Importance change of Diesel Generators in CDF

Basic Event	Operating	New-built	Change
AAC DG	RAW 3.20	RAW 9.02	5.82 ↑
Fail to Start	RRW 1.06	RRW 1.09	0.03 ↑
EDG A	RAW 3.17	RAW 8.15	4.98 ↑
Fail to Start	RRW 1.06	RRW 1.08	0.02 ↑
EDG B	RAW 3.21	RAW 8.90	5.69 ↑
Fail to Start	RRW 1.06	RRW 1.08	0.02 ↑

Relative importance of Diesel Generators is sharply increased in RAW value as shown at table 2. This means that these generators are more important to prevent core damage than previous analysis.

2.2 MR Importance change of Diesel Generator's supporting systems

Risk Significance is determined by plant expert panel. This panel utilizes two methods which are quantitative and qualitative method. In case of PSA modeled component, the risk importance is determined by quantitative method based on PSA risk values. If the risk values are higher than criteria (RAW exceeds 2.0 or RRW exceeds 1.005), the component is classified as high safety significant (HSS) and the other is determined as low safety significant (LSS). If the component is not included in PSA model, its importance is determined by qualitative method in plant MR expert panel. [2] Emergency DGs and AAC DG were determined as HSS by PSA risk value.

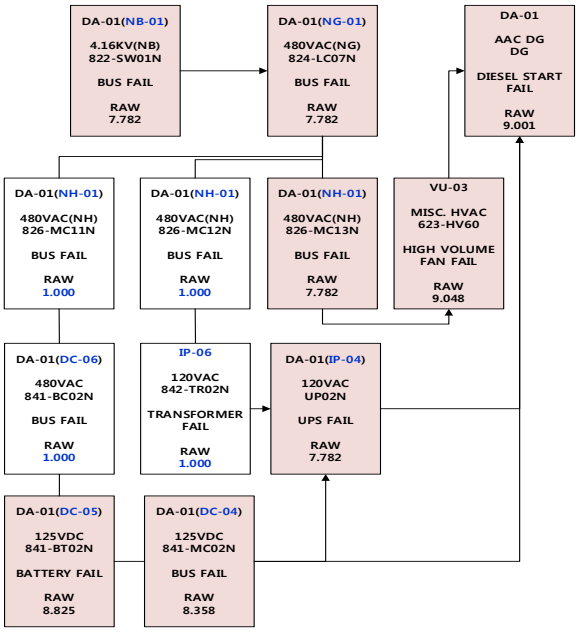
The supporting systems of safety related component are designed as safety related systems and non-safety related component has non-safety supporting systems. Thus, AAC DG receives AC/DC power from non-1E sources such as non-1E AC & DC systems.

Table 3. Importance change of AAC DG supporting systems

Basic Event	Operating	New-built	Change
480VAC(NG)	RAW 1.43	RAW 7.78	6.35 ↑
LC07N fail	RRW 1.00	RRW 1.00	
120VAC(IP)	RAW 1.43	RAW 7.78	6.35 ↑
UPS fail	RRW 1.00	RRW 1.00	
125VDC(DC)	RAW 1.43	RAW 8.36	6.93 ↑
MC02N fail	RRW 1.00	RRW 1.00	

The RAW values of AAC DG's supporting systems in operating plant MR program were lower than criteria (RAW=2) and those systems are evaluated as LSS. But, in new plant MR program these are determined as HSS because these systems have higher RAW value than criteria as shown at table 3 and figure 1.

Figure 1. Importance of AAC DG supporting systems



HSS function is required to set a train level reliability and availability performance criteria. On the other hand, LSS function is to set system level reliability criteria only.

If these supporting system components are defined as one function together with other non-safety Motor Control Centers (MCCs), 120VAC buses and 125VDC buses, all of these non-safety related components are treated as HSS functions.

2.3 Separation of AAC DG's supporting components from other non-safety components

To avoid unbalance in plant MR program, plant expert panel decided to separate these supporting components of AAC DG from other non-related components of no-safety related functions.

Table 4. Separation of AAC DG's Non-safety related supporting components

Components Type	Function & Components	
	DA-01	NG/NH/DC/IP
480V Load Center	0-LC07N	Other N-1E L.C.
480V MCC	0-MC11~13N	Other N-1E MCC
120VAC UPS	0-UP02N	Other N-1E UPS
125VDC Battery	0-BT02N	Other N-1E BT
125VDC Bus	0-MC02N	Other N-1E Bus

After this separation, these non-safety functions with remaining non-safety components are evaluated as LSS function. The separated AAC DG's supporting components are included AAC DG function which is previously determined as HSS. These functions are monitored its reliability and availability by AAC DG performance criteria

3. Conclusions

It is considered that safety related system has at least one or more safety functions and some non-safety functions, but non-safety system doesn't have any safety function. The safety functions are defined as three functions which are required to maintain 1) integrity of reactor coolant pressure boundary, 2) capability to shut-down the reactor and maintain it in a safe shutdown, and 3) capability to prevent or mitigate the accident that could result in potential offsite exposure.

The Maintenance Rule program is developed based on PSA result. Safety functions have high risk value in PSA program and considered HSS function in MR program. On the contrary, non-safety functions are generally has low risk value in PSA program and they are determined as LSS function in MR program.

The AAC DG and its supporting systems are designed as non-safety systems which mean they don't have any safety function. But, AAC DG is treated as an important measure to mitigate accident in PSA program. It is determined as HSS function in MR program because it has high risk value in PSA program. AAC DG supporting systems does not have high risk value in operating plant's PSA program. But, they are evaluated having high risk value in new PSA program. As a result, more severe MR performance criteria are assigned to many non-safety supporting functions.

The importance of AAC DG in recent PSA program and its influence is stretching to supporting non-safety electrical systems supplied to AAC DG. It is expected that their importance in operating plant's MR program will be much higher than before, if new IE database is reflected in their PSA programs.

REFERENCES

[1] Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, NUMARC 93-01 *Revision 4*, NEI, p. 17~21, Jan 2011.
[2] Philip H. Johnson, A History of the Maintenance Rule 10CFR50.65, EPRI/TR-1015517, p 14, December 2007.
[3] Probabilistic Safety Analysis Report for Operating License of Shin-Hanul Nuclear Power Plant, KHNP,