Pilot Study for Maintenance Rule at KSNP

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1. Introduction

Maintenance Rule (MR), which was developed to monitor the effectiveness of maintenance in a nuclear power plant (NPP), has been received as highly successful program by and large since its implementation in 1996 in the United States. Korea has initiated two pilot programs to implement the Maintenance Rule program in 2003. Selected plants for the pilot implementation are Kori 3&4 units and Ulchin 3&4 units, where Kori 3&4 units are Westinghouse units and Ulchin 3&4 units are Korean Standardized Nuclear Power (KSNP) Plant units. This paper describes the results of each key tasks completed to date and insights gained from pilot study on the KSNP units.

Currently, Scoping of the functions of maintenance rule and determination of safety significance level have been completed during first year. As first task, total 607 functions were identified and defined by detailed function analysis on 135 systems that cover all plant systems. About 55% of total functions are selected as within the scope of maintenance rule. Among these in-scoped functions, 56% of scoped functions are safety related and 44% are non-safety related functions. Evaluation of safety significance for each function was determined by expert panel consist of eight experts in field of plant maintenance, operation, PSA, work schedule and system engineers. As a result, about 46% of functions were determined to be high safety significant functions and rest of the functions were classified as low safety significant. The remaining tasks that are included determination of performance criteria and preparation of implementing guideline will be performed in following years.

2. Function Scoping

It is necessary to identify and document the functions for both safety related and non-safety related SSCs that causes the plant safety function's failure. The scoping screening criteria is seven criteria based on NUMARC 93-01, Rev 3. These criteria is classified as three criteria for safety related function and four criteria for non-safety related function.

2.1 Consideration of Function Scoping

Decision Basis for whether the function is safety related or non-safety related does not depend on SSC design classification but inherent character of function included these SSC. Even though some component in the function is safety related, that function may not be safety related.

In application of NSR 4 (Non safety related SSCs whose failure cause a reactor scram or actuators safety systems) on KSNP, Turbine trip does not lead to reactor scram due to plant's reactor protection design concept.

Among the functions which is not classified as In-scope function, especially NSR 4, major functions as trip initiator to the turbine are selected as "In scope" of maintenance rule. These are Main turbine and auxiliary system, Turbine generator lube oil system, Generator stator cooling water system and Generator hydrogen seal system

2.2 Results of Function Scoping

Through discussion on first Expert panel meeting, 55% of total functions are screened as within the scope of maintenance rule as following table 1. The other 45% functions are out of scope of maintenance rule.

Table.1 Function Scoping Result of Ulchin 3&4

\	Mech.	Electr.	I&C	SUM
System	91	19	25	135
Function	459	62	86	607
In-Scope	241	41	54	336
Out-Scope	213	21	29	263
Deleted	5	0	3	8

Among these in-scoped functions, 56% of scoped functions are safety related and 44% are non-safety related functions.

3. Determination of Safety Significant Level

In evaluation of safety significance on each scoped function, quantitative method and qualitative method are used. Importance values in case which is modeled by PSA (Probabilistic Safety Assessment) are used in quantitative method. But in case of non PSA model, delphi process is used as qualitative method. And also delphi method is used as final evaluation process for determination of safety significant level in 2nd Expert panel meeting.

All functions within the scope of Maintenance Rule are evaluated. These results are summarized in Table 2.

Table. 2 Summery of Safety significant result (2nd E.P)

	Safety significant function		Sum	Remarks
	High	Low		
In scope function	164	174	338	48.5%
Structure	5	22	27	
Total	169	196	365	46.3%

4. Insights gained from Expert panels

Key element in decision making of major process of Maintenance Rule is the role of expert panel. In this section, insights gained from expert panel meeting are described. Up to now, we have two expert panel meeting. Member of expert panel consist of four expert in field of operation, maintenance, work control and system engineer and three researcher joined on MR project who have a knowledge of MR concepts included PSA analyst. Role of coordinator of expert panel was given to project leader.

First expert panel meeting was reviewed on applicable operating mode and inclusion of PSA model before evaluation of scoping the function. Applicable operating mode is used in review of important function. And expert panel make a final decision which function is safety related, which function is in-scope as it's non-safety related function.

Second expert panel meeting review and determined the safety significant level on those functions within the scope of the Maintenance Rule. In this meeting, containment Isolations, fire protection and seismic event etc. are evaluated.

4.1 Main Steam (MS) Pressure Boundary

Safety and non-safety classes separate pressure boundary before and after MSIVs. Care should be exercised when determining the performance criteria in that the condition monitoring should be applied across the boundary via the same condition-monitoring program available in the station. It is required to investigate what the condition monitoring tasks entail for MSIVs

4.2 Isolation of Containment building

In evaluation of delphi process, Penetration isolations of containment building are evaluated as Low significant level. But, by the results of level II PSA, several penetrations are evaluated as important function in view of LERF(Large Early Release Frequency). These functions are determined as high significant level. These functions are listed as below.

CV-05 : Reactor coolant Drain Tank line
DE-02 : Containment sump drain line
PS-02 : S/G sampling line
GW-02 : Gaseous radiowaste line for reactor coolant
VQ-04 : Connection line for ILRT

4.3 Fire Protection

Most functions of fire protection system are simply classified in scope of MR. But safety significance on this functions are determined as just low in expert panel. Detail consideration on fire protection system will not be reviewed in this time, because the detail guidance on fire protection system is assumed to be developed as fire protection implementation guide by regulatory body. After the guide is executed, monitoring program for the fire protection discipline in MR will be followed to the fire protection guidance later.

4.4 Other PSA Consideration

External events PSA such as flooding, seismic event are considered as qualitatively in expert panel meeting for safety significant determination process.

3. Conclusion

For improvement of reactor safety and prevention of unscheduled plant trip, function scoping and determination of safety significance for performance monitoring in Maintenance Rule have been successfully completed. About 55% of total functions are classified as In-scope of MR. And 46% of In-scope functions are determined as high safety significant function. These processes could done by Expert panel members have a willing to support this work. Determination of performance criteria (APC, RPC) and a(1) evaluation will be performed by the end of this year

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