

## Insights from Maintenance Rule(MR) application at Ulchin units 3&4

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### 1. Introduction

Korea had developed two pilot programs to implement the Maintenance Rule(MR) program similar to the United States in 2006. One for the pilot implementation is Kori 3&4 units and another is Ulchin 3&4 units, where Kori 3&4 units are Westinghouse reactor type units and Ulchin 3&4 units are Korean Standardized Nuclear Power(KSNP) Plant units.

### 2. Insights from MR application

Maintenance Rule application process in this pilot program is shown as Figure 1.

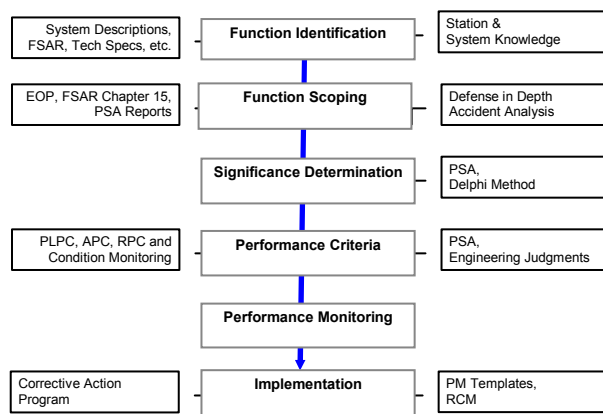


Figure 1. MR application process in pilot program

The technical meetings at initial stage of MR application program were used as a primary means of technology transfer and forum for the open discussion with participants in this project. Each technical meeting was held to discuss the key issues related to the process relevant to each stage of the MR process. Each meeting where the any progresses made since last meeting was also reviewed and discussed. Of these technical meetings, there were four MR expert panel sessions and one special expert panel session on determining the Delphi weighting factors.

First expert panel session involved the MR function determination and scoping; second expert panel session involved determination of the safety significance using PSA insights and Delphi method; third expert panel session involved determination of Performance criteria (PC) for MR including the monitoring level; and fourth expert panel session involved a(1) selection based on the past three years plant performance which was

separately analyzed by the project team on a parallel path. With completion of the third expert panel, during which the performance criteria and the monitoring level were determined, it can be said that the main structure and framework of the MR program was established. This last expert panel session tested the robustness and integrity of the developed functions, risk significance determination, and performance criteria.

#### 2.1 Function Scoping

- Turbine trip for plants with RPCS

C-E design contains RPCS, which prevents Rx trip resulting from a turbine trip. Whether to include the turbine trip as a part of in-scope of MR via NSR-4 was much discussed. Per design, a turbine trip will not necessarily result in Rx trip or any safety SSC actuation. This leads to a conclusion that much of the BOP systems to be excluded from the out-of-scope within MR per NSR-4 criteria.

- Local/MCR Alarm and Indications

Auto control function sent directly to SSCs(Systems, Structures and Components) should not be included in the local/MCR alarm and indication functions. The reason is an important control function can be hidden among the alarms and indications, which are in general, associated the operator actions in PSA via EOPs. If any exceptions are made in the function definition, then this should be specifically documented in the function scoping form.

- Containment Hydrogen Igniter

Hydrogen Igniter was not included in the base Level 2 PSA study, but is included in the Severe Accident Management Program (SAMG). Strictly speaking, the SAMG is not a part of the scope as specified in NUMARC 93-01, and the igniter function may be a potential out-of-scope candidate. However, this function would have an impact in maintaining the containment integrity during the postulated severe accident, which is evaluated during the safety significance determination using the Delphi method. Considering its impact on the containment integrity, a consideration was given to include this function in the MR scope..

#### 2.2 Determination of the safety significance

For quantitative risk significance evaluation, a mapping between the MR functions and PSA basic

events is required. In order to establish a meaningful and practical relationship between Maintenance Rule (MR) functions to the PSA (Probabilistic Safety Assessment), each risk significant basic events found in the PSA must be linked to the MR functions.

○ Other PSA Consideration

Level II PSA such as LERF, internal flooding, seismic event and other external events are considered as qualitatively in expert panel meeting for function scoping and safety significant determination process.

○ 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 handled 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.

*2.4 Performance Criteria(PC)*

○ Monitoring level of PC

PCs at train level are established for all safety significant functions and for non-risk significant functions in a standby mode. Functional failure definition can be different depending on the determination of monitoring level. It is necessary to consider that which monitoring level is proper to improve the maintenance effectiveness of the system.

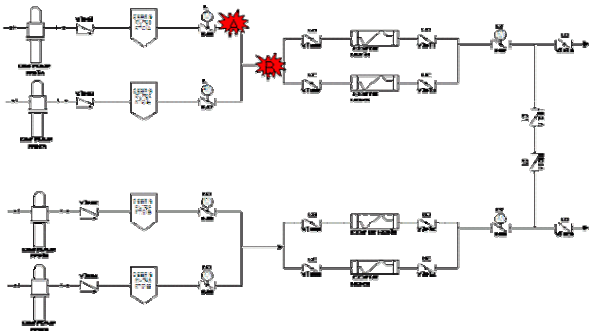


Figure 2 Monitoring level of Essential Service Water system

○ Surrogation of mapping phase

During technical meetings and afterward discussions, there seemed to be some confusion between a surrogation for the MR function significance determination and a surrogation for the performance criteria (PC) development. A key difference is that for the PC development purpose, much of the surrogation is directly related to the key SSCs of the function under evaluation, not necessary at a functional level.

*2.3 Performance monitoring process*

○ Functional failures vs SSC failures

Functional failures are not same as SSC failures. A SSC failure may or may not be a functional failure, depending on the function under the examination. On the other hand, there may be functional failures that are not related to SSC failures (e.g., procedure errors, process deficiencies, etc.).

○ Review of MRFF

System Engineer initially screens Maintenance Rule Functional failure (MRFF), which is then reviewed by the MRC(Maintenance Rule Coordinator). The expert panel makes the final determination of whether it should be a maintenance preventable functional failure (MPFF). PSA analyst (or Risk Management engineer) should further review each MRFF to determine whether it is applicable failure in PSA space. The review should be done at least on a monthly basis, before expert panel reviews them for MPFF determination so that PSA analyst is aware about the events.

○ Functional failure definition (FFD)

It is important to clearly define what the functional failure definition (FFD) is. Importance of clearly defining the FFD cannot be over emphasized, since System Engineers will need clear guidance as to how to determine the functional failure. Much of these definitions will be refined during initial phase of the data analysis.

**3. Conclusions**

In pilot study for implementation at Ulchin unit 3&4, insights and lessons learned on each step are gained.

These insights gained from each process will be useful for following implementation of other plant.

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