

## PSA Lessons Learned from Maintenance Rule

Young Joo Lee, Han Sang Kim, Tae Wan Kim

Korea Hydro & Nuclear Power Co., Inc. ULJIN 2nd Plant, Organization & Administration / PSA, Bugu-ri 84-4 Bukmyon Uljin-gun Kyoungbuk-do, hahayo@khnp.co.kr

Mi Ro, Seo

KEPRI, Nuclear Power Laboratory, 103-16 Munji-Dong Yuseong-Gu, Daejeon, 305-380, Korea, mrseo@kepri.re.kr

### 1. Introduction

According to the recommendation for introducing the Maintenance Rule (MR) to nuclear power plants from Nuclear Safety Committee in December 2002, KHNP and KEPRI are developing maintenance rule implementation program for pilot plant, Ulchin 3&4, planned to complete at September 2006.

In the process for establishment of Maintenance Rule program, the risk information from Probabilistic Safety Assessment (PSA) is an important roles in determination of risk significance and performance criteria. On the other hand, MR program gives the chance to review the PSA model more realistically. That is to say, MR program and PSA are cooperative program each other. PSA information makes MR to be risk-informed and MR program makes the PSA more realistic. In this study, the roles of PSA in MR implementation were investigated and PSA issues found during establishment of MR program were discussed.

### 2. Role of PSA in MR

The MR implementation program was developed based on NUMARC 93-01[1]. According to this guideline, final decision-making organization is Expert Panel, and all information including risk information and defense in depth are utilized. From the view point of PSA, the following information for each step of MR implementation should be provided to expert panel.

#### 2.1 Scoping

- Provide the list of SSCs (Structures, Systems, and Components) or function which is modeled in PSA.
- It is helpful to understanding what functions and SSCs are important to safety

#### 2.2 Significance Determination

- SSC whose Risk Reduction Worth is >0.5 percent of the overall Core Damage Frequency, or
- SSC whose Risk Achievement Worth shows at least a doubling of the overall Core Damage Frequency, or
- Identify the cut sets that account for about 90 percent of the overall Core Damage Frequency.
- According to these 3 criteria, risk significance is determined for SSCs modeled in PSA

#### 2.3 Performance Criteria

If the function is modeled in PSA, the function's reliability and availability criteria are based on failure rate used PSA. [2] The methodologies for calculating the performance criteria, Reliability Performance Criteria (RPC) and Availability Performance Criteria (APC), are as follows.

- Reliability Performance Criteria

The following is simplified equation to calculate expected numbers of failures. Expected number of failures is mean value to calculate RPC.

$$F = P * D$$

F : Expected number of Failures

P : Failure Data used in PSA

D : Demands in monitoring period

According to the failure characteristics, we choose the distribution type, Poisson or Binomial, whose mean value is F. The RPC is the value which has 95 percent reliability in that distribution.

- Availability Performance Criteria

The following is equation to calculate APC.

$$A = P * H$$

A : Unavailable times

P : Unavailable probability in PSA

H : Required in service times during monitoring period

### 3. PSA Issues on MR

#### 3.1 PSA Modeling

While scoping and determining risk significance, we learned more about plant. Because MR required to review all plant SSCs, we could find vulnerability in PSA model. The vulnerability should be compiled and considered for living PSA.

Following are some examples.

- Current PSA model consider only DWST (Demineralized Water Storage Tank) for alternate feed water source after CST(Condensate Storage Tank). But EOP and Plant design basis consider not only DWST but also raw water tank. If raw water tank were modeled in PSA, the risk significance may be changed.

- EDG load sequencer was not modeled but this function is important at LOOP case. So, PSA model revision was needed.

- In MR EP, system engineer mentioned about EDG Design basis. According to the comment, EDG room cooling function was not important since the external air used for EDG cooling. If we had more basis, we can exclude the function from PSA model.

### 3.2 Failure data

To determine the RPC, failure rate of PSA basic event were reviewed by MR expert panel. Such a process revealed some incompatibility between PSA failure rate and experience.

- PSA assumed the failure rate of SBCS (Steam Bypass Cutback System) as 0.1[/demand], but expert panel did not agree the rate. So, we used the generic data (3.0E-5[/hr]; failure rate of I&C card) for calculating the RPC.

- In similar case, some basic events were modularized events such as “MSSVZRESEAT”(FAILURE OF ALL 8 MSSV'S ON RUPTURED SG (SG1) TO RESEAT).

- Some failure rates are too low or high compare with operation experience. That should be reviewed and confirmed.

## 4. Conclusions

In U.S, nuclear industry has already applied the PSA technologies to plant operation and utilized risk information in several ways. They have tried to strengthen the PSA model via feedback from MR program, and make MR program more effective one.

In Korea, MR program is being introduced to the nuclear plant, as in the case of Risk-Informed Technology. So, it is expected that so many issues and problems will be found hereafter. The issues about PSA quality is a representative one and major problem in PSA field at this time in Korea. It was judged that the key for PSA Quality is in the realism. So, we hope that MR implementation program and their feedback will be a good solution for PSA Quality.

PSA and Risk-Informed Technology will give us the motive for safer and more flexible operation of nuclear power plant. And MR will give us more confidence about PSA and Risk information.

## REFERENCES

- [1] NUMARC93-01 Rev.3, Industry guideline for monitoring the effectiveness of maintenance at nuclear power plants. NEI. July 2000.
- [2] TR-1007079, 'Reliability and Risk Significance for Maintenance and Reliability Professionals at Nuclear Power Plants', August 2002.