

Proposals of Plant Level Performance Criteria for Maintenance Rule Implementation

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1. INTRODUCTION

For the purpose of maintenance rule implementation utility should determine the performance criteria. Performance criteria for evaluating SSCs are necessary to identify the standard against which performance is to be measured. Criteria are established to provide a basis for determining satisfactory performance and the need for goal setting. Non-risk significant SSCs (those normally operating) are monitored against plant level criteria. In this paper, surveyed the NUMARC guideline, US Utilities' PLPCs for maintenance rule(MR) implementation, and domestic practice related in this part and proposed the plant level performance criteria(PLPC) for maintenance rule implementation in Uljin 3,4 nuclear power plants.

2. RESULTS

2.1 Guideline

US utilities have used NUMARC 93-01[1] as a guideline for MR implementation, which is endorsed by Reg. guide 1.160[2]. NUMARC 93-01 specified Plant level performance criteria should include, the following

- Unplanned automatic reactor scrams per 7000 hours critical;
- Unplanned safety system actuations; or
- Unplanned capability loss factor

Each utility should evaluate its own situation when determining the quantitative value for its individual plant level performance criteria. The determination of the quantitative value will be influenced by different factors, including such things as design, operating history, age of the plant, and previous plant performance.

2.2 US For the case of United States

There are three categories of NPPs depending on the principles of each power plant as following;

- 1) NPPs which apply minimum items recommended in NUMARC 93-01,
- 2) NPPs which apply Initiating Event Cornerstone suggested in NEI 99-02[3], and,
- 3) NPPs which apply all three items recommended in NUMARC and risk colors in risk monitoring program as a part of MR (a)(4).

Some NPPs use criteria of 7,000 critical hours in specified in NUMARC 93-01 and NEI 99-02 as monitoring interval, and the others use self defined intervals. PLPC for some

NPPS in US in terms of NUMARC 93-01 were summarized in table 1

Table 1 Comparison between NUMARC 93-01 and US Utilities' PLPCs

NUMARC 93-01	Exelon	Energy	Prairie Island ⁴⁾	Kewaune ⁴⁾	PVNGS
◦ Unplanned automatic reactor scrams	○	○ ¹⁾	○	○	○
◦ Unplanned safety system actuations; or	○	X	○ ²⁾	○	X
◦ Unplanned capability loss factor	○	○	○	○	○
	○ ³⁾				○ ³⁾

1) Use the initiating event cornerstones as following
 ◦ < 2 Unplanned (automatic and manual) scrams per 7,000 critical hours
 ◦ < 2 Scrams with a loss of normal heat removal per rolling 36 months
 2) Use the number of LER (Licensee Event Report) as following
 ◦ Safety System Actuation (< 1 per year/unit)
 ◦ Safety System Failures (< 2 per year/unit)
 ◦ Unplanned Radioactive Releases (< 1 per year/unit)
 3) Unplanned entries into red or orange outage risk monitoring levels
 4) Same Company(NMC)

2.3 Operated Program by Regulatory Body in Korea

In Korea, there is no official program such as Reactor Oversight Process (ROP), Korea Institute of Nuclear Safety (KINS) has specified Safety Performance Indicators (SPI) and the status of SPI is disclosed in real-time through Operational Performance Information System for Nuclear Power Plant (OPIS).

Also, the notice of minister of science and technology 2005-7, "Rule for reporting and disclosure of the accidents and failures in nuclear facilities" in which the items and process for the reporting of accidents and events during the operation of nuclear facilities by licensee to government was noticed in 2005. In this rule, reporting criteria for ESF actuation described in Table 3 is related to one of the PLPCs for MR implementation.

Table 2 Operational Safety Index which is one of the SPI Operated by KINS [4]

Operational Safety	Index	Threshold
Unplanned Reactor Scram	Excellent	< 1.5
	Good	1.5 ≤ ~ < 3
	Normal	3 ≤ ~ < 5
	Warning	5 ≤
Unplanned Power Reduction*	Excellent	< 0.75
	Good	0.75 ≤ ~ < 1.5
	Normal	1.5 ≤ ~ < 5
	Warning	5 ≤

* The number of unplanned changes in reactor power of greater than 30% of full-power,

Table 3 Reporting criteria for ESF actuation [5]

Reporting Elements	Due date	
	Oral	Detail
During the applicable modes on technical specification, In case of NSSS ESF Actuated as following (include actuated by malfunction). Except Test, Surveillance etc, planed actuation.. a. ECCS, containment isolation, containment spray, aux feed-water system b. In case of emergency diesel generator auto started and by class 1E electrical bus low voltage and power supplied to the related bus.	4hr	30day

2.4 Operated Program by Utility in Korea

Korea Hydro and Nuclear Power Co., Ltd (KHNP) developed site evaluation indices and these indices were used as internal purposed in KHNP. There indices are as following;

- 1) Index of power generation availability
- 2) Unplanned electric loss
- 3) Scram number per unit
- 4) Compliance of maintenance schedules

Unplanned electric loss and scram number per unit were directly related indices to plant level performance monitoring criteria specified in NUMARC 93-01 . The target for '2005 for unplanned electric loss is 2.35%, and target for scram number per unit is 0.56 times per unit. The management of target and actual values for unplanned electric loss and scram number for unit are as following;

- Unplanned Electric Loss (UEL) : Actual/Target
 - Target: KNNP NPPs average UEL rate per past 3years
 - Actual: UEL which is unit responsibility
- Scram number per unit: Actual/Target
 - Target: KNNP NPPs average scram number per past 3years UEL rate
 - Actual: Total number of scram/Total number of generator

2.5 Proposed PLPC for Uljin units 3&4

The PLPCs for UCN 3&4 were determined by considering the KHNP internal evaluation indices and KINS SPI which is in pilot application status. For the unplanned scram number, '2005 target value of KHNP 0.56 time per unit can be translated into "1.68 time/unit/2 cycles" by applying 2 cycles (36 months) which is the maintenance program effectiveness evaluation interval. When applying the excellent class criteria of KINS SPI, unplanned scram number criteria can be translated into "2.25 times/unit/2 cycles." For the case of unplanned electric loss, KHNP target 2.25% cannot be translated into the "times," but KINS SPI can be translated into "4.5 times/unit/2 cycles."

By NUMARC 93-01, it is not necessary to specify the unplanned actuation of ESF as PLPC when unplanned electric loss were specified as a PLPC. However, the legislation for detailed reporting procedure about events summarized in table 5, were already enforced by the notice of ministry of science and technology 2005-7, "Rule for reporting and disclosure of the accidents and failures in nuclear facilities," and the implementation process was developed and in operation. Regarding these, unplanned actuation of ESF as a PLPC was

included in PLPC's and the criteria were determined considering the past experiences.

The draft PLPC's for UCN 3&4 are as following. For unplanned scrams and unplanned capability loss factor, definitions in table 2 were applied. For unplanned NSSS ESFAS actuations, it was limited to the events for reporting in event category for power generation facility of table 3. This PLPC's will be modified during the item determination process focused monitoring in next research phase by reflecting plant operational experiences..

- ≤ 2 Unplanned scrams per 2 Refueling Cycles
- ≤ 1 Unplanned NSSS ESFAS actuations
- ≤ 4 Unplanned capability loss factor

Risk colors which are used as PLPC in some of NPPs in US cannot be applied to UCN 3&4 now, and this index will lose its meaning unless on-line maintenance. Therefore, this index was not included as PLPC for UCN 3&4.

3. CONCLUSION

It is recommended that the periodic modification of PLPC's during the implementation of maintenance effectiveness monitoring program based on the operation principle of KHNP. Also, it is needed to consider the expanded application of PLPC to all NPPs in Korea for the improvement of plant performance. For this, the equipment reliability index should be used as PLPC. And this means that the degree of achievement for the targets in terms of unplanned scram number per unit and unplanned electric loss should be managed by KHNP. For example, 1 time of target achievement failure within 3 years could be permitted but the inclusion of plant, which do not achieve the target more than 2 times within 3 years, to (a)(1) item should be reviewed through the KHNP level committee.

REFERENCES

- [1] Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, NUMARC 93-01 REVISION 3, NEI, July 2000
- [2] Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Reg. guide 1.160, USNRC
- [3] Regulatory Assessment Performance Indicator Guideline, NEI 99-02, 19 November 2001
- [4] Operational Performance Information System for Nuclear Power Plant (OPIS), KINS
- [5] Rule for reporting and disclosure of the accidents and failures in nuclear facilities, MOST 2005-7