On-Line Maintenance Methodology Development

Hyowon Kim[a], Jaeho Kim[a], Moosung Jae[a*]
[a]*Department of Nuclear Engineering, Hanyang University, Seoul, 133-791, Korea*
[*]*Corresponding author: jae@hanyang.ac.kr*

1. Introduction

Most of domestic maintenance activities for nuclear power plants are performed while overhaul. Therefore, On-Line Maintenance (OLM) is one of the proper risks informed application techniques for diffusing maintenance burden during overhaul with safety of the plant is secured.

The NUMARC 93-01 (Rev.3) presents the OLM state of the art and it provides methodology. This study adopts NUMARC 93-01 (Rev.3) and present OLM. The reference component is Emergency Diesel Generator (EDG) of Ulchin 3, 4.

2. Method and Result

According to a technology report EPRI TR-1009708 in the United States Electric Power Research Institute (EPRI)', the OLM of nuclear power plant is as shown in figure 1 is planned and implemented.

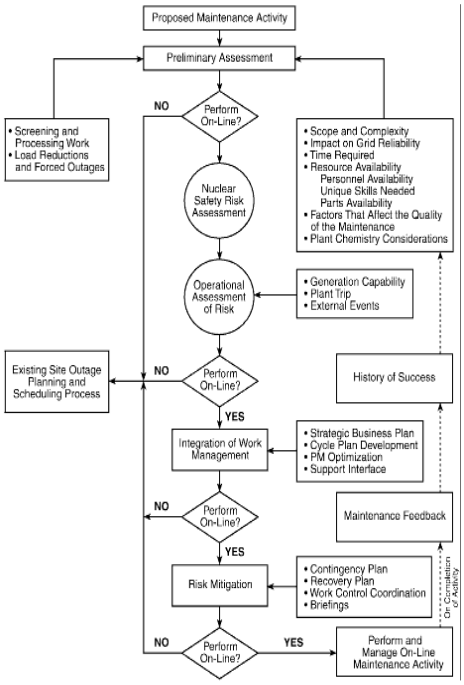

Fig.1. The OLM Planning and Implementation

2-1. Target Selection

By the NUMARC 93-01 sec.11, the list of the target SSCs is down below.

-HPSI, LPSI, SIT, SDC, CSS, CVCS, AFWS, MFWS, SGBDS, CCWS, ECWS, ESF, RPS

These SSCs have high safety significant and conduct critical function. So, these SSCs are included in Internal event evaluation in level 1 PSA. Applying of the OLM increases risk, therefore the acceptance guidelines required. The guidelines in NUMARC 93-01 are in the table down below.

Table 1: Proposed risk acceptance guidelines

RISK ACCEPTANCE GUIDELINE	BASIS
ICCDP < 1E-6	• ICCDP is an appropriate metric for assessing risk impacts of out of service equipment per RG 1.177 & NUMARC 93-01 • 1E-6 is consistent with NUMARC 93-01 guidance, as endorsed in RG 1.182, for routine maintenance and with RG 1.174 increases assess as "very small" • Greater than RG 1.177 guideline (5E-7) for permanent TS changes, but that criterion is applied to changes which are allowed to be entered repeatedly over the life of the plant, whereas the proposed SX CT is a one time change.
ICLERP < 1E-7	• ICLERP is an appropriate metric for assessing risk impacts of out of service equipment per RG 1.177 & NUMARC 93-01 • 1E-7 is consistent with NUMARC 93-01 guidance, as endorsed in RG 1.182, for routine maintenance and with RG 1.174 requirement that risk increases are "very small" • Greater than RG 1.177 guideline (5E-8) for permanent TS changes, but that criterion is applied to changes which are allowed to be entered repeatedly over the life of the plant, whereas the proposed SX CT is a one time change.
Configuration-specific CDF < 1E-3/yr	• NUMARC 93-01 recommends configurations exceeding this guideline be avoided.

2-2. Applying OLM to EDG

EDG is Component that supplies electricity to the 4.16kV AC line when off-site power is out.

(1) Risk changes in Full power operation

The full-power operation when the emergency diesel generators to the dissatisfaction of the actions of two EDGs, if unavailability the AOT is 72 hours. To quantifying plant's risk, using the Ulchin 3,4 PRIME 1.0 model for full-power operation, a train of EDG out of service(OOS) by assuming perform the OLM to illustrate the unavailability due to maintenance.

The result of Configuration changes are in table down below.

Table 2. CDF results due to EDG configuration changes

	CDF_{Base}	CDF_{OOS}	△CDF
EDG01A	5.491e-6	1.177e-5	6.279e-6
EDG01B	5.491e-6	1.186e-5	6.369e-6

(2) Risk assessment during low-power/shutdown operation

During the low-power/shutdown operation, the process changes continuously variable type operations, so all PSA forms to be analyzed to consider the operation mode is practically impossible. Therefore, the target plant stopped operation performed during the various processes in accordance with plant configuration after examining the change, the PSA analysis is performed based on this mode of operation was classified. The PSA for low-power/shutdown operation, a little more granularity operation mode is called plant operational states (POS).
The EDG A, B trains of the low-power/shutdown operation status while operation, summarized in the table 3.

Table 3. Result of △CDF and CDP due to EDG's configuration changes

POS	CDF_{Base}	△CDF	CDP
POS1	1.369E-9	n/a	n/a
POS2	5.120E-9	n/a	n/a
POS3	4.196E-7	-2.05E-7	-1E-9
POS4A	6.282E-8	-4.335E-8	-4.949E-11
POS4B	5.920E-7	-1.175E-7	-3.487E-10
POS5	9.603E-7	-1.49E-7	-4.763E-10
POS6	2.220E-6	-5.51E-7	-8E-9
POS10	1.739E-7	-1.15E-7	-4.2E-10
POS11	7.917E-7	-1.1E-8	-6.781E-11
POS12A	3.947E-9	n/a	n/a
POS12B	2.229E-7	n/a	n/a
POS13	7.174E-7	n/a	n/a
POS14	4.327E-8	n/a	n/a
POS15	3.501E-8	n/a	n/a

POS1, POS2, POS12A, POS12B, POS13, POS14, POS15, there is no change in risk because two trains of the EDGs are all standby during operation. But the POS3, POS4A, POS4B, POS5, POS6 had a negative value △ CDF (after configuration changes - before configuration changes) due to the EDG B train standby during operation, so both the CDF and the CDP decreased. And the POS10, POS11 decreased the CDF and the CDP, because the EDG A train standby during operation.

3. Conclusions

To perform the OLM, reduce maintenance volumes during O/H, so improve the plant utilizations, and maintenance safety related equipments during operation period can contribute to safety improvement by implementing the OLM. Also due to perform the OLM, a decrease in maintenance volume in O/H so that the major tasks of this period is able to deploy many people and resources to improve the quality of maintenance. These aspects are advantage of the OLM. On the other hand, due to maintenance during operation can be a factor of increase in risk.
Through this study, nuclear power plant for safety evaluation of the OLM risk assessment method was developed, Korea Standard Nuclear Power Plant(Ulchin 3,4 nuclear power plant)'s emergency diesel generator for risk assessment was carried out according to configuration changes.
The results in the development of the OLM regulatory guidelines in the future decisions based on the information provided is expected to be utilized as intruder.

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