

Investigation of Maintenance Rule Program's Suitability as a Performance Monitoring Tool for Surveillance Test Interval Extension of RPS/ESFAS

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1. Introduction

Technical Specification of Nuclear power plants (NPPs) requires Limiting Conditions for Operation (LCO) and Surveillance Requirements (SR) in order to secure the safety of NPPs during Design Basis Accident (DBA) and satisfy the regulatory requirements of the Final Safety Analysis Report (FSAR)

The regulatory organization has required a specific plan and implementation strategy for monitoring the reliability of the system by using a continuous monitoring tool in order to assure the reliability of the system at the approval process of the Surveillance Test Interval (STI) extension on, the Reactor Protection System & Engineered Safety Features Actuation System (RPS/ESFAS) for Korea standard nuclear power plants.

In response to the regulatory body's demands, the Korea Hydro & Nuclear Power Co. (KHNP) decided to use a Maintenance Rule (MR) program to monitor and manage the system's reliability due to the STI extension after introducing MR into KHNP (which is The National Committee of Nuclear Safety's recommendation) [1].

In this paper, the Surveillance Test requirements and MR program performance criteria for the RPS/ESFAS of Ulchin unit 3&4 are compared to each other in order to examine whether the MR program would be an adequate tool for performance monitoring, which satisfies the regulatory requirements for the STI deregulation.

2. Comparison between STI requirement and MR program

In the case of Ulchin unit 3&4, regulatory body allowed the STI extension of RPS/ESFAS from 31 to 92 days on condition of specifying the acceptable number of test failures and interval changes as the result of test failures on the Surveillance Test (ST) procedures and LCO.

This paper investigates the details and conditions of the regulatory approval of STI for the RPS/ESFAS and reviews the MR program thoroughly in order to see if it could meet the regulatory requirements on the STI extension.

2.1 The investigation of STI requirements

The role of ST is to confirm the operability of safety-related components and to take action in advance before the failure or degradation of the components.

The total number of deregulation items (Table 1) of ST for the RPS/ESFAS of the Ulchin unit 3&4 is 4. These items were tested in 3 month intervals with the exception of some parts of the RPS logic matrix functional tests (e.g. logic matrix functional test, manual trip functional test and RTSG channel functional test of initiation logic).

Table 1: Items of STI deregulation

	past	current
RPS Bistable Function Test	31days	92days
RPS Combinational Logic Circuit Test	31days	92days
ESFAS Bistable Function Test	31days	92days
ESFAS Combinational Logic Circuit Test	31days	92days

KHNP had to submit the risk increases caused by the STI extension, such as Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) in order to get the approval for the STI extension from regulatory body.

After that, the risk changes would be managed by a Risk Information Management System (RIMS). In addition, a performance monitoring tool is required in order to guarantee the good performance.

However, there is no appropriate performance monitoring tool now. Therefore, Regulatory body gives the limitations, such as those described in Table-2.

Table 2: The Changed LCO Conditions

Failure numbers for each test	Test Intervals
In case of ≥ 2 failure per 2 cycle	1 Month
If there is no failure during 1 year after above condition	3 Months

Failure numbers are applied based on 2 units and test intervals are switched according to the above condition.

2.2 The investigation of MR program

The MR program aims to enhance the Structure, System, and Components (SSCs) reliability in NPPs in order to get the maintenance activity and program better, as well as securing the safety of NPPs through monitoring the performance and condition of SSCs

Every function of the plant SSCs are categorized, such as safety-related, non-safety-related and outside SSCs. After that, the performance criteria are established on those SSCs. With the performance criteria established, SSCs are monitored.

The performance criteria of the RPS/ESFAS are established on a component level (e.g. Analog channel, Logic card, Relay, etc.). The evaluation interval of the MR program is 2 refueling cycles (RF). That period is the same as the period for LCO application.

Table 3 shows the performance criteria for the RPS/ESFAS.

Table 3: Performance Criteria [2].

Items		Monitoring level	RPC number
Analog Channel	RPS	Channel	2
	ESFAS		1
Logic Cabinet	RPS	Channel	2
	ESFAS		2
Sub Relay	ESFAS	Component	0
Trip breaker	RPS	System	0

System Engineers (SE) monitor the performance criteria acceptance continuously according to the performance monitoring procedure. If the actual performance doesn't meet the Reliability Performance Criteria (RPC), then the SSCs should be evaluated for entering into stringent monitoring requirements (i.e., a(1)). Once the cause determination and corrective actions have been completed, the performance should continue to be monitored and periodically evaluated until the performance criteria or goal is achieved.

If the performance is acceptable for specific surveillance tests (e.g. 3 times surveillance test), the SSCs may be returned to a normal monitoring process (i.e., a(2)).

2.3 The investigation for the possibility of using MR instead of STI requirement.

To verify the possibility of using the MR performance criteria instead of the regulatory requirements about extending ST intervals for the RPS/ESFAS, the following items are compared with each other

2.3.1 Monitoring SSCs in scope

- ST : Bistable Card, Matrix logic, Initiation relay card and Trip Breaker
- MR : Bistable Card, Matrix logic, Initiation relay card and Trip Breaker

The monitoring of SSCs required for ST corresponds with that of MR mentioned above.

2.3.2 Definition of functional failure

- ST : limited to failure in test (including alarm functional test before trip)
- MR : including random failure in operation as well as failure in test (excluding alarm functional test before trip)

ST confines failure only to the failure that happened during the test. However, MR includes failure as being what happened during the entire time the function required (which is regulatory body's requirement at

present). MR doesn't establish alarm functional failure criteria. If the ST requirements could be replaced by MR, the alarm functional failure criteria could be added to MR

2.3.3 Acceptance Criteria

- ST : Bistable Card(2 failures/2RF/2Unit), Matrix Logic and Initiation Relay Card (2 failures/2RF/2Unit) and Reactor Trip Breaker(2 failures/2RF/2Unit)
- MR : Bistable card(2 failures/2RF/1Unit), Matrix Logic and Initiation Relay Card(1 failures/2RF/1Unit) and Reactor Trip Breaker(failure is not allowed)

The above comparison shows that the allowed failure number of MR is more conservative and stricter than that of ST.

2.3.4 A countermeasure in the case of exceeding Acceptance Criteria

- ST : Restore to original test interval(3 months) if there was no test failure during one year after shortening the test interval from 3months to 1 month.
- MR : Restore to normal monitoring condition[a(2)] if there was no more functional failure during the specific monitoring period(e.g. 1 year or 1 RF) after finishing corrective actions under a(1) condition.

ST changes only the test interval in the case of dissatisfying acceptance criteria. However, MR does not only change the test interval but also implements corrective actions on the base of Root Cause Analysis (RCA). Besides, MR is able to extend its monitoring period beyond 1 year.

3. Conclusions

The STI requirements and MR performance criteria for the RPS/ESFAS of the Ulchin unit 3&4 were compared on an item by item basis. The result of comparison shows that MR, as a tool for monitoring system reliability, could cover the STI requirements.

The current MR performance criteria need some changes to meet the ST requirements perfectly, but overall, the MR performance criteria are stricter than the requirements of ST. Furthermore, the MR program can give additional countermeasure, such as corrective action, RCA and intensive monitoring period. Therefore, with these findings, it is possible to use the MR program instead of the STI requirements.

REFERENCES

- [1] Development of the Maintenance Rule Implementation Programs for Yonggwang Unit 1&2/ Unit 3&4/ Unit 5&6 and Ulchin Unit 5&6, July 2009, KHNP NETEC
- [2] H. S. Jang, The Establishment of MR Standard Performance Criteria in KHNP NPPs, July 2009, KHNP NETEC