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A study on Identification of Standby Functions and Establishment of Performance Criteria for Maintenance Effectiveness Monitoring of WH900 NPPs

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1. Introduction

Korea Hydro & Nuclear Power Co. (KHNP) is developing a Maintenance Rule (MR) implementation program which monitors the maintenance effectiveness of NPPs. As a part of this effort, standard MR implementation programs are being developed for Korea Standard Nuclear Power (KSNP) and Westinghouse 900Mwe(WH900) type NPPs.

The identification of standby functions is one of the key information to determine performance criteria because standby functions are required to establish specific performance criteria regardless of the level of safety significance.

The steps of the MR implementation program development are as follows: 1) to analyze and define functions for MR scoping, 2) to perform safety significance determination to identify of important functions, 3) to establish performance criteria. System functions should be checked whether it is a standby function or not. Generally Reliability Performance Criteria (RPC) and Availability Performance Criteria (APC) are established for High Safety Significant (HSS) functions whereas ULPC is for LSS functions. However, the ULPC is not an appropriate tool for monitoring LSS standby functions, because its failure of an intended function is not found until it is required to perform its function in response to a demand signal. Therefore, RPC and/or APC are needed for these standby functions.

This paper presents guidelines for the identification of standby functions and methodologies to establish performance criteria for these standby functions.

2. Definition of standby function and analyses case

This section introduces guidelines for the identification of standby functions and how they can apply to some actual cases.

2.1 Function centered performance monitoring

The MR is to monitor plant performance in the view of function rather than component. The standard MR implementation program of WH900 is composed of 135 systems and 433 functions in total [1].

System design establishes the functional requirements including roles of the system for safety and subsequently component list and their specifications are developed from these functions. Therefore, maintaining plant condition according to the initial functional design will be a basis for safe operation.

Current plant maintenance and monitoring practices focus on components rather than functions. More often than not, however, a failure of component in a system would not result in a failure of the intended function of the system. The maintenance and monitoring practice needs to be centered on the functions of systems. From this point of view, the MR could be a good tool to change management philosophy to maintain the initial design base by monitoring the system functions.

This means that plant system engineers should understand how systems are designed through functional analysis and what should be they focus during the monitoring or maintenance works.

2.2 Review of standby function definitions

In NUMARC 93-01 and RG 1.160[2~3], the plant functions are generally divided into normal operating and standby functions by operation modes

Normal operating functions are basically for power production. Failures of those functions are in most cases detected very apparently. (e.g., generator failure causes a plant trip). On the other hand, standby functions are not operating continuously during the normal operation and designed to be actuated with automatic signal (e.g., ESFAS signal) or manual demand (e.g., surveillance test). The failures of standby functions, therefore, would not become apparent until the next demand, actuation signal, or surveillance test. In nuclear power plants most failures of standby functions are identified during surveillance tests.

Table 1 shows the number of standby functions in the standard MR implementation program of WH900 NPPs. About 30% of the scoped functions are identified as standby functions.

Table 1 Results of Analysis for Standby Functions in WH900 MR Implementation Program

	Functions	Standby Functions	Standby with LSS
Total Functions	433	108	N/A[1]
Scoped Functions	242	76	38

2.3 Application of guidelines to identify standby functions

For the practical application of the NUMARC 93-01 guidelines for standby function identification, more detailed sub-guide is necessary. The following are the

[1] Uncounted as the scoped number of the functions is meaningful.

detailed guidelines to define the standby function and examples analyzed.

i. Standby components in normal operating functions carry out normal operating function, not standby function. In many cases, standby components and functions are confused with each other. For example, component cooling water supply function has two trains and each train consists of two segments of pumps and valves to supply cooling water. One segment is in operation during normal operation while the other is in standby mode. However, the function of the standby segment in a train does not create standby function because the function to supply cooling water is defined on the train base and the train is in operation mode.

ii. All functions in standby systems do not perform standby functions. It is also a common misunderstanding that all the functions in a standby system perform standby functions. For example, emergency diesel generator system is a typical standby system. But, the engine lubrication and cooling function are normal operating functions, because these functions should be always in operation mode to start the diesel generator.

iii. Functions that are put on and off automatically by a set point are standby function. For example, the cooling fan function for CCW pump rooms is a standby function because it is occasionally working by signal from temperature controller. This function was initially identified as normal operating function because on-and-off operation was thought to be a normal mode.

iv. Most of the functions required to operate only in operating modes 2~6 are not standby functions because their functions are not needed during normal operation. For example, the reactor cavity filling function for refueling is not a standby function because it is needed during refueling outage in full time.

v. Functions needed in the Emergency Operating Procedure (EOP) are standby functions even though they are designed to operate in operation mode 2~6. For example, the startup feed water function is used at a plant for startup and shutdown. It is identified as a standby function because it is used during EOP as a feed water source for steam generator.

3. Methodology to establish performance criteria for standby functions of LSS

Standby functions are generally safety functions that are in standby mode during normal operation and initiated by demands as a result of plant transients in order to mitigate the events. Most of standby functions, therefore, are determined as HSS functions and monitored by RPC and APC. Some of them, however, are determined to be LSS. LSS functions are basically related to power production and those failures could cause plant shutdown or transients, and thus, are monitored by ULPC as shown at Fig. 1.

Because plant transients occur rarely, failures of standby functions from transients cannot provide sufficient information to assess the reliability of functions. For this reason, ULPC are not a good indicator or measurement of performance for LSS standby functions. Therefore plants should develop specific performance criteria or goals to adequately monitor the effectiveness of maintenance for these functions [2]. For the LSS standby functions, therefore, RPC is basically required and APC should be established if their unavailable time is assumed in the PSA. For example, the containment spray function is a safety function with LSS. It is initiated by a containment spray actuation signal (CSAS) or manual demand so that it is a standby function. Therefore RPC and APC should be established for this function because the unavailability of this function assumed in the PSA.

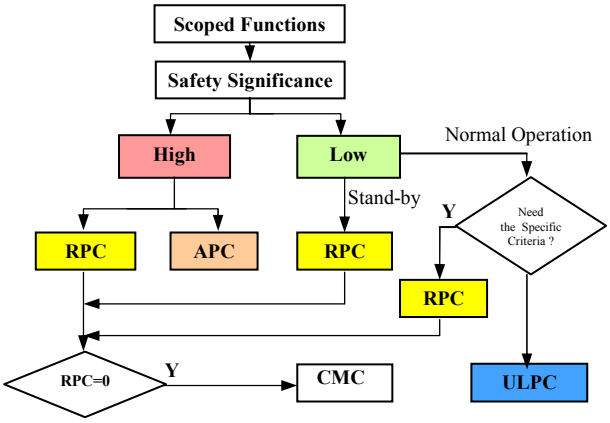

Fig 1. Flow chart of determining the required performance criteria

4. Conclusion

The detailed guidelines for the identification of standby functions are presented with examples to practically apply them to actual cases. The standby functions should be clearly defined for the MR implementation program because the required class of performance criteria is quite different depending on whether a function is standby or not. A process to set of performance criteria for standby functions is discussed as well. For the standby functions, RPC is required regardless of the safety significance of functions. APC is necessary for functions of HSS and for those of LSS, it is needed only if the unavailability is taken in the PSA.

The result of this study is used to develop performance criteria of standby function and will be useful for the plant system engineers to monitor the functions of their systems effectively by understanding the design concepts focused on functions and operation features of systems

REFERENCES

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