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The Improved Methods of Critical Component Classification for the SSCs of New NPP

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1. Introduction

Functional Importance Determination (FID) process classifies the components of a plant into four groups: Critical A, Critical B, Minor and No Impact. The output of FID can be used as the decision-making tool for maintenance work priority and the input data for preventive maintenance implementation.

FID applied to new Nuclear Power Plant (NPP) can be accomplished by utilizing the function analysis results and safety significance determination results of Maintenance Rule (MR) program. Using Shin-Kori NPP as an example, this paper proposes the advanced critical component classification methods for FID utilizing MR scoping results.

2. The improved FID methods and their results

In this section, some of the methods used to classify the critical components are described. These methods include a matching table between MR and FID criteria, a subdivision for critical component criteria, FID function boundary diagram, and exempt component concept.

2.1 Analysis of the relation between MR scoping and FID critical criteria

The matching table as shown in Table 1 is made to analyze the relation between MR scoping and FID critical criteria. This table helps determine important functions from MR scoping results. The critical criteria include some of the important function of MR. Critical criteria match safety-related (SR) functions like SR2 or SR3 in aspect of nuclear safety or nonsafety-related (NSR) functions like NSR2 or NSR4 in the aspect of plant operation. With this table, safety or nonsafety-related functions of MR can be easily converted to the critical criteria of FID.

Table 1: Relation between MR and FID criteria

MR Scoping code		FID Critical Criteria
SR2		Reactor shutdown within 72hr or less according to Tech. Spec
SR2		Reactor shutdown between 72hr and 7days according to Tech. Spec
	NSR4	Reactor Shutdown
SR2		Safety System Actuation
SR2		Degraded capacity to shutdown the reactor and maintain it in a shutdown condition
	NSR2	Inability to perform an emergency operating procedure
SR3		Potential offsite exposure in excess of 10CFR100 Limits

SR2 indicates safety-related structures, systems, or components (SSCs) that are relied upon to remain functional during and following design basis events to ensure the capability to shutdown the reactor and maintain it in a safe shutdown condition. SR3 is the capability to prevent or mitigate the consequence of the accident that could result in potential offsite exposure comparable to the 10 CFR part 100 guidelines. NSR2 is nonsafety-related SSCs that are used in plant emergency operating procedures (EOPs). NSR4 is the function whose failure could cause a reactor scram [1].

2.2 The subdivision of critical criteria

Two critical criteria are additionally developed to select critical components that play an important role in function. It is written in INPO AP-913 that if a failure of the component defeats or degrades an important function or a function that is redundant to important function, then it is a critical component [2]. Two additional criteria are added in accordance with AP-913 concept as shown in Table 2.

Table 2: Subdivision of critical criteria

FID criteria	Critical Criteria	remark
C-5a	Failure to control critical safety function	
C-5b	Loss of Main Control Room(MCR) indication, control, interlock, alarm	added
C-6a	Failure to shutdown/maintain the reactor in a shutdown condition	
C-6b	Loss of a safety function redundancy including train redundancy	added

There is some difficulty in using C-5a in component classification because of the ambiguity and broadness of the definition. Therefore, C-5b criterion is added as sub-criteria to avoid this difficulty. C-5b is applied to only the instruments for MCR. The instruments that are used only for local indication and alarm are out of this criterion because there is no operation burden by instrument failure at that location.

C-6b criterion is added to classify the redundant components within a safety-related redundant function as critical components. Even though the loss of a safety-related redundant component doesn't cause a functional failure, it would be more reasonable in the safety aspect of NPP to classify safety-related redundant components as critical components by making additional criterion such as C-6b.

2.3 Function boundary Diagram Drawing

To start FID work, we need to see the component identification number and name list. However, it is very difficult to identify relations among each component with that list. Function boundary diagram drawing identifies each MR function and marks it on the Pipe and Instrumentation Drawing (P&ID). This drawing is helpful in classifying the components within a function as the same importance such as critical component. This drawing is made by comprehending the function boundary and drawing the boundary on P&ID as referring to operation procedures and MR function. A sample of FID function boundary diagram about CS-01-04 of MR [3] is shown in Fig. 1.

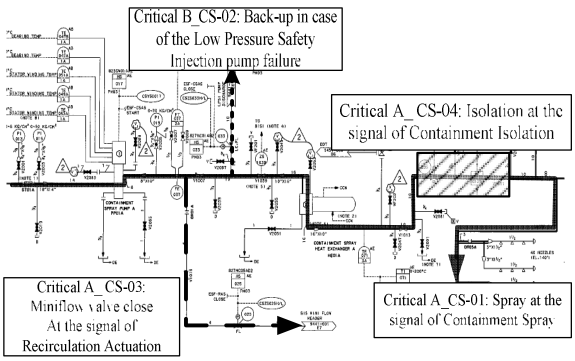

Fig.1. FID function diagram

2.4 Exempt component

No-impact component is a component whose failure does not impact nuclear safety, power generation, reliability, and cost effectiveness. No-impact components can be divided into some component types. We named these types of components as Exempt Component. Exempt component includes operationally insignificant, highly reliable, and largely passive component for which no preventive/predictive maintenance activity is applicable. The examples of the exempt components are vent/drain/root valve, orifice, hand switch, thermal well, fuse, panel, software, and local instruments such as flow, pressure and temperature indicator. With this concept, no-impact components can be more effectively classified than before.

2.5 Result of Critical Component Classification Methods

The matching results for the system of Fig. 1 using the above methods are shown in Table 3. Safety-related functions of CS-01-04 are matched to critical criteria of FID and each component within the function is classified as a critical component.

Table Ⅲ: The matching result according to critical component classification methods

MR Function ID	SR 1	SR 2	SR 3	FID criteria	FID classification
CS-01	N	Y	Y	C-2a	- Critical A
CS-02	N	Y	N	C-6b	- Critical B
CS-03	N	Y	N	C-6a	- Critical A
CS-04	N	N	Y	C-8	- Critical A

3. Conclusions

MR and FID matching table, additional criteria for component classification, FID function boundary diagram and exempt component list can be useful methods in classifying components of new NPP.

The graded approach using these methods would ensure that plant personnel understand the functional importance of SSCs and enhance the quality of FID. In addition, The FID data resulted from these methods could allow resources to focus on maintaining critical components reliable.

REFERENCES

[1] Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, NUMARC 93-01, Revision 3, NEI, p7-10, 2000

[2] Equipment Reliability Process Description, AP-913, Revision 3, INPO, p9-11, 2001.

[3] S. D. Lee, J. W. Kim, J. W. Hyun, "Process of Function-based Importance determination for Containment Spray System ", Transactions of KPVP meeting, 2010.