

Strategy for establishing Integrated I&C Reliability Of operating nuclear power plants in Korea

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1. Introduction

Nuclear power plants are required safety operation and higher availabilities based on the integrated set of activities for enhancing reliability of structure, systems, and components (SSC). Related to this activity, INPO(Institute of Nuclear Power Operations) issued the "equipment reliability process description, AP-913" in November 2001. This document describes an equipment reliability process offered to assist member utilities to maintain high levels of safe and reliable plant operation in an efficient manner. KHNP (Korean Hydro & Nuclear Power Co. LTD) has planned a strategy for enhancing reliability of SSC with the basement of AP-913 document since 2005. The development of preventive maintenance template (PMT) is the typical activity for implementing AP-913 under the consideration of Korean environment.

In this paper, we will discuss how to establish the long term reliability strategy of I&C system and accordingly the guidance of I&C upgrade of nuclear power plants in Korea.

2. Equipment Reliability(ER) Process

2.1 Top Level of ER Process

Top level diagram of ER process of AP-913 consists of 6 sections. Each section describes the main activities to be performed. The activities of each section are as follows:

- Section of scoping and identification of critical component.
- Section of performance monitoring.
- Section of continuing equipment reliability improvement covering development and use of PM templates and continuing adjustments, documentation of the PM technical bases, and continuous improvement from plant staff recommendations.
- Section of corrective action.
- Section of PM implementation.
- Section of life cycle.

Especially for each system, at section of scoping and identification of critical component, functional equipment grouping (FEG) is necessary which establishes the functional boundary that does not affect the adjacent system function such as shown in figure 1 and subsequent classification which is called structural classification(SC) can made for more detailed analysis as shown in figure 2.

So there may be many SCs to perform the function of

FEG of the system. SC also may consist of several

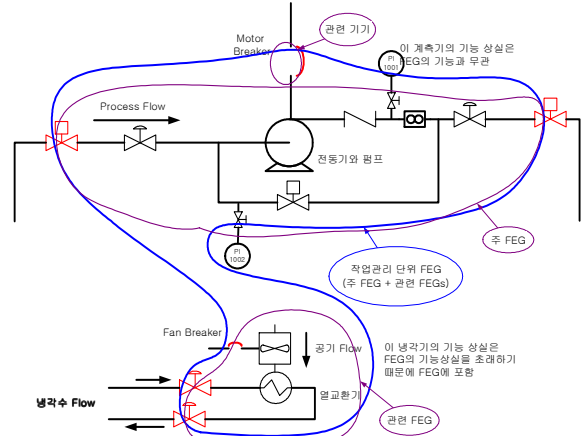
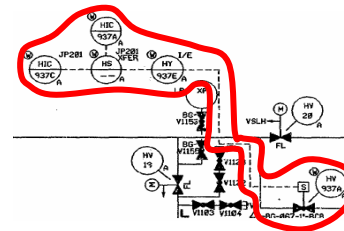


Fig. 1 Typical example of FEG



2312-BH-HV-937A	SIS HP ISOLATION VV BYPASS HV-937A
10595601	HV-937A, SIS HP ISOLATION VV BYPASS I&C
10595704	HV-937A, SIS HP ISOLATION VV BYPASS
2312-BH-HCY-937A	SAFETY INJECTION THROTTLING
2312-BH-HIC-937A	SIS HP ISOLATION VALVE CONTROLLER
2312-BH-HIC-937C	SAFETY INJECTION THROTTLING CONTROLLER
2312-BH-HY-937A	SAFETY INJECTION THROTTLING
2312-BH-HY-937E	SIS HP ISOLATION VALVE I/E CONVERTER
2312-BH-ZS-937A	SAFETY INJECTION THROTTLING

Fig. 2 Typical example of structural classification

components of key component and sub-components. The determination of each component of the SC which is called function importance determination (FID) depends on its function & its characteristics and can be one of "critical", "minor", and "no impact", one of the "severe", and "mild" according to the service condition, and , one of "high", and "low" according to duty cycle.

2.2 Preventive Maintenance

There are two ways for plant maintenance work such as preventive maintenance and corrective maintenance [1]. Preventive maintenance includes actions that detect, preclude, or mitigate degradation of functional structures, systems, and components (SSC) to sustain or extend its useful life by controlling degradation and failures to an acceptable level. There are three types of preventive maintenance: period, predictive, and planned. Corrective maintenance includes actions that restore – by repair, overhaul, or replacement- the capability of a

failed SSC to function within acceptance criteria. Especially for proper preventive maintenance (PM) template is very important. PM template is a documentation for the maintenance strategy of particular component and covers major failure mode, symptom of performance degradation, condition-based or time-based PM, monitoring, and failure finding & correction. Etc.

Figure 3 shows the concept of condition-based maintenance [2]. So around of point P, field engineer or maintainer should detect the symptom of point P through continuing monitoring and provide the proper maintenance action.

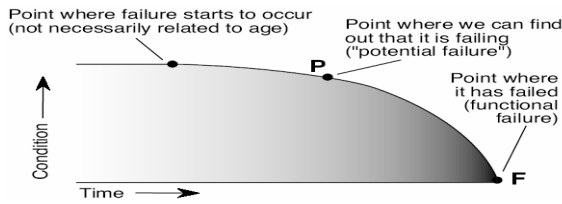


Fig. 3 The concept of condition-based maintenance

2.3 Continuing ER Improvement

For the continuing ER improvement, PM template is under development with two phases: First phase was completed at Dec. 2006 started at June 2006 and templates of 12 I&C components were made successfully. Currently second phase is under way and will be ended at June 2008 with another 53 I&C templates. Table shows a typical example of D.C. power supply template with 6 pages long tasks performance[3].

2.4 Life cycle management(LCM) of I&C System

Fig.4 shows the LCM strategy for reliability enhancement of I&C system. The cycle of ER process of AP-913 says that eventually for the reliability enhancement system upgrade should be made in a proper manner. If the component or system hit the pre-determined level of reliability which is also called long term asset management(LTAM) enabler, replacement or upgrade for restoring or enhancing reliability should be made

Table Typical Example of I&C Template

기능필요도결정(FID)									직류전원공급기 DC Power Supply	
중요도	Critical				Minor					
운전빈도	High	Low	High	Low	High	Low	High	Low		
운전환경	Severe		Mild		Severe		Mild			
예방정비 직무	CH	CLS	CH	CL	MH	MLS	MH	ML	직무 및 주기 선정기준	
	S		M	M	S		M	M		
상태감시 직무(Condition Monitoring Task)										
리플 및 직류전압 감시	18M	-	18M	-	3Y		3Y	-	EPRI, 엑셀론사, 정비경험	
주기정비 직무(Time Directed Task)										
교체	리니어	AR	-	AR	-	AR	-	AR	-	EPRI, 엑셀론사, 정비경험
	스위칭	12Y	-	15Y	-	AR	-	AR	-	
성능진단시험	AR	-	AR	-	AR	-	AR	-	절차서,	

전해 커패시터 교체	6Y	-	8Y	-	AR	-	AR	-	정비경험
Burn-in 시험	AR	-	AR	-	AR	-	AR	-	정비경험
고장발견 직무(Failure Finding Task)									
이중화전원 절제시험	18M	-	18M	-	3Y	-	3Y	-	절차서, 정비경험
비고 : 참고자료: EPRI PM Basis Database - Client/Server 1.5 etc.									

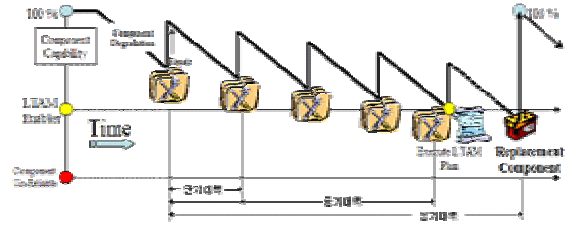


Fig. 4 I&C LCM Strategy for reliability Enhancement.

2. Strategy of Long term I&C Upgrade

KHNP has planned long term strategy of I&C upgrade. There are three types for establishing the long term upgrade strategy. Type 1 is for plants related to the life extension Such as Kori unit 1 and Wongsong unit 1~4. Secondly Type 2 is for plants which are designed with analog cards such as Kori units 2~4 and Ulchin units 1 & 2. Lastly final type is for OPR 1000 plants which are designed based on digital components. Based on the planned strategy reference designs for upgrade of Yonggwang and Ulchin units 3 & 4 have been performed since April 2007 until March 2010.

During reference design there will be three major resulting documents of technical specification, detailed upgrade process, and concept design of main control room end-point view.

3. Conclusions

In this paper, we discussed on the integrated set of activities for enhancing reliability I&C components or systems. Related to this, PM templates of completed 12 items and 53 under development are also described. According to the ER process and I&C LCM Strategy for reliability enhancement, KHNP has planned long term strategy of I&C upgrade. There are three types for accomplishing the long term upgrade strategy and implementation basis was established by initiating upgrade reference design for Yonggwang and Ulchin units 3 & 4. So it can be said that KHNP do the maintenance & operation activities based on the ER process

REFERENCES

[1] Equipment Reliability Process Description, Nov.,2001, INPO. p1.
 [2] John Moubay, Maintenance Management. 1995. A New Paradigm.
 [3] PM Template-Vol.4, 2006.12, KHNP, NETEC