Identification of SPV using a Blended Method

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1. Introduction

A Single Point Vulnerability (SPV) may cause plant transients like reactor trip, turbine/ generator trip, or derated power to 50% or more. In order to improve plant reliability and performance by preventing unexpected plant transients, we, KEPCO-ENC and KHNP, are developing SPV monitoring program. To have a better result of the SPV identification and monitoring, we used a blended method which was comprised of qualitative and quantitative approaches. This method is described herein, representative results of SPV identification are presented.

2. Methods

2.1 Overall Process

The blended method of SPV identification is comprised of Reliability Block Diagram (RBD), Failure Modes and Effects Analysis (FMEA) and Fault Tree Analysis (FTA). The RBD and FMEA are qualitative approach, but the FTA is quantitative approach.

The overall process is shown in Fig. 1 and each step is described in details in the following section.

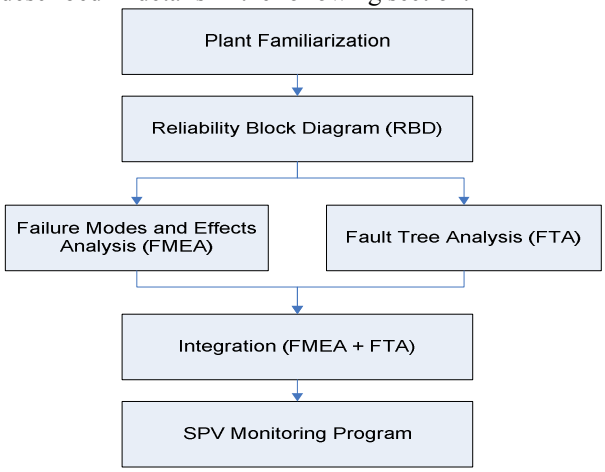

Figure 1 Overall Process of SPV Identification

2.2 Plant Familiarization

The first step of SPV identification is to familiarize themselves with plant and system. It was accomplished by a review of plant documents (system description, drawings, procedures, etc.).

2.3 Reliability Block Diagram

The second step is to develop the Reliability block diagram (RBD) to define the structure of the system, function wise. The following Fig.2 is the example of RBD.

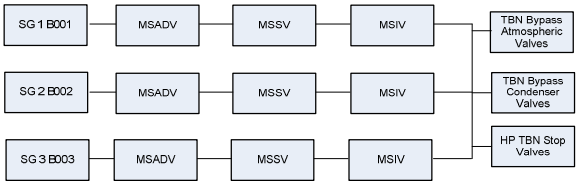

Figure 2 RBD of Main Steam System

2.4 Failure Modes and Effects Analysis

The third step is FMEA to find potential failure mode in a system and to determine the results or effects on the system and plant. The following Table.1 shows the example of result of FMEA.

Table 1 example of FMEA

계통	이름	Tag Number	기능	고장모드	고장이 계통에 주는 영향	SPV 중요도
461	RCS펌프 공통 모관 입구 격리밸브	CC-V161	o RCP로 공급되는 CCW격리 o 정상운전시 열림상태 (NO)	고장닫힘	RCP로의 CCW공급 실패로 Rx Trip	TC-1
752	Loop Controller	2632 (PA03A-06-2632)	AFS-SBC-04N : 32bit Single-Loop Controller o 461-CC-V161를 제어하기 위한 제어로직카드	오신호	RCP로의 CCW공급 실패로 Rx Trip	TC-1
752	Digital Input Card	26-3-6 (PA03A-06-2632-6)	AFS-IO-01 : 8 채 널 DI 카 드 o Loop Controller(PA03A-06-2632)로 입력되는 신호 처리를 위한 디지털 입력카드	오신호	RCP로의 CCW공급 실패로 Rx Trip	TC-1
752	Digital I/O Card	26-3-5 (PA03A-06-2632-5)	AFS-IO-11N : 4채널 DI/2채널 125vdc 출 력 카 드 o Loop Controller(PA03A-06-2632)로 입력/출력 신호를 처리함	오신호	RCP로의 CCW공급 실패로 Rx Trip	TC-1

The failure's effect on plant is classified using the following Table.2

Table 2 SPV Class

SPV Class	Description
TC-1	◦ Reactor/Turbine Trip by single failure ◦ Power down to 50% by single failure
TC-2	◦ Reactor/Turbine Trip by two failures ◦ Power down to 50% by two failures ◦ Tech. Spec. LCO
TC-3	◦ Reactor/Turbine Trip by 3 or more redundant trains failure ◦ Power down to 50% by 3 or more redundant trains failure
NC	◦ No Reactor/Turbine Trip ◦ No Reactor/Turbine Trip

2.5 Fault Tree Analysis

The fourth step is FTA to find potential SPV combination and their priorities on plant. For developing the fault tree for SPV scenarios, the SAREX Code which KEPCO-ENC has developed was used.

The following Fig.3 shows the example of Fault Tree.

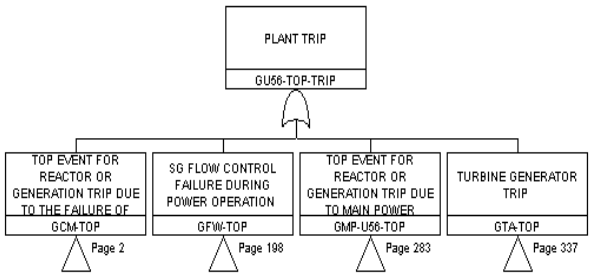

Figure 3 SPV Fault Tree

2.6 Integration of Results

The fifth step is integration of the results of FMEA and FTA. In this step, final SPV list and combinations were obtained.

2.7 SPV Monitoring Program

The last step is developing the SPV monitoring program using FMEA and FTA.

This program provides the information for permanent SPV and potential components becoming SPV when a component failed.

The main display of SPV monitoring program is shown in Fig.4.

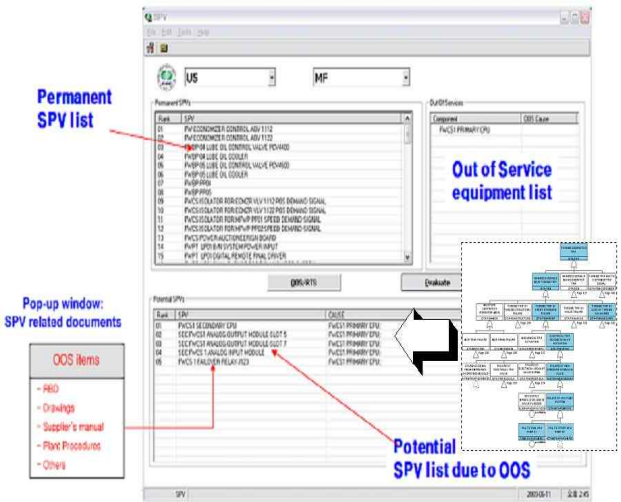

Figure 4 Main Screen of SPV Monitoring Program

3. Conclusions

The blend method is very effective to find SPV and to determine their priorities for developing reliability improvement.

The merits of this method and monitoring program are as follows;

1) to ensure the completeness of SPV identification,

2) to identify not only permanent SPV, but also potential SPV,

3) to obtain the result easily by using this monitoring program

REFERENCES

[1] L. Loflin, "Advanced Nuclear Technology: Equipment reliability for New Nuclear Project: Industry Recommendations - Design," EPRI-1019214, 2009.

[2] US Department of Defense, "Procedures for performing a Failure Mode, Effects, and Criticality Analysis," MIL-STD-1629A.