Transactions of the Korean Nuclear Society Spring Meeting
Gyeongju, Korea, October 25-26, 2012

Design Considerations for Post Accident Monitoring System of a Research Reactor

Gwi-sook Jang* , Je-yun Park, Young-Ki Kim
Research Reactor Design & Engineering Division, Korea Atomic Energy Research Institute, 989-111,Daedeok-daero, Yuseong-gu, Daejeon 305-353, Republic of Korea,
**Corresponding author: gsjang@kaeri.re.kr*

1. Introduction

The Post Accident Monitoring System (PAMS) provides primary information for operators to assess the plant conditions and perform their role in bringing the plant to a safe condition during an accident. The PAMS of NPP (Nuclear Power Plant) in KOREA provides the continuous display of the PAM category 1 parameters specified in R.G 1.97, Rev. 03. Recently the PAMS of NPP has been designed according to R.G 1.97, Rev. 04. There is no PAMS at the HANARO in KOREA, but recently RRs (Research Reactors) around the world are going to have PAMS for various multi-purposes. We should determine the design considerations for PAMS in a Korean RR based on the design state analysis. Thus, this paper proposes strategies on the design considerations for the PAMS of a Korean RR.

2. Design Considerations of PAMS

2.1 Regulatory Requirements

There are explicitly no regulatory requirements for the PAMS of RR. Thus, in the present, the PAMS for RR should meet the regularoty requirements of NPP accoring to the RR features, that is R.G 1.97, Rev. 04 [1] and IEEE Std. 497(2002) [2].

2.2 Design Scope

In the OPAL(INVAP) RR in Australia case, the PAMS provides primary information required to allow operators to take specific actions that are essential for the safety systems to meet their safety function beyond the DBA (Design Basis Accident). Moreover, it supplies information to indicate whether plant safety functions are being met, while also being a very important tool to implement manual recovery actions. The OPAL PAMS safety functions are as follows.

- Display monitoired safety variables
- Triggers evacuation alarm
- Surveillance CCTV
- Paging and Communication

However the PAMS for a Korean RR provides only indication and recording information for the PAM variables in the control room. It is not intended to support functions for an ERF (Energency Response Facilities). The ERF concern in Korea is a safety parameter display system scope of NPP or RR.

2.3 Selection Criteria and Selection Method

The PAM variables are selected according to the selection criteria for a variable type of IEEE 497(2002) [2]. The type of PAM variable consists of A,B,C,D, and E.

- *Type A : planned manually controlled actions for accomplishment of safety-related functions for which there is no automatic control*
- *Type B : assessing the process of accomplishing or maintaining plant critical safety functions*
- *Type C : indicating the potential for a breach of fission product barriers and indicating an actual breach of fission product barriers*
- *Type D : indicating the performance of safety systems, indicating the performance of the required auxiliary support features, indicating the performance of other systems necessary to achieve and maintain a safe shutdown condition, and verifying safety system status*

Also, an RR PAMS has categories as selection criteria based on the R.G 1.97 (rev 3) [3]. The criteria are separated into three separate categories that provide a graded approach to requirements depending on the importance of safety of the measurement of a specific variable.

- *Category 1 : provides the most stringent requirements and it is intended for key vaiables*
- *Category 2 : provdies less stringent requirements and generally applies to instrumentation designated for indicating system operating status*
- *Category 3 : is intended to provide requirements that will ensure that high-quality off-the-shelf instrumentation is obtained and applies to backup and diagnostic instrumentation.*

The bases documents for the selection for PAM variables are as follows.

- Plant accident analysis licensing basis
- Emergency procedure guidelines
- Plant abnomal operation procedures
- Plant critical safety function related emergency operation procedure

- Functional restoration emergency operation procedures

The selection procedures for the PAM variables of an RR are follows.

- Step 1 : extracting monitoring variables through the dynamic behavior sequence of an RR according to each design basis event
- Step 2 : assessing the process of accomplishing or maintaining plant critical safety fucnctions and extracting monitoring variables related to safety fucntions
- Step 3 : allocation of PAM variable type and category on extracting variables
- Stpe 4 : checking the various ranges of PAM variables covering the whole safety analysis
- Step 5 : verifying the appropriateness of PAM variables using the human factor verification and validation

2.4 Processing Configuration

The PAM variables of category 1 are processed and displayed as the safety system (ex. PAMS). The PAM variables of the other categories are processed and displayed as the non-safety system (ex. Information Processing System). The non-safety PAM processing system records all PAM variables. The PAMS and IPS are physically separated and electrically independent.

2.5 Common Cause Failures of safety I&C System

The PAMS are a position 4 display against common cause failures of safety I&C systems. The position 4 display should be independent and diverse from the safety I&C systems. The diversity of safety I&C equipment has led to an increase in the design and verification and validation cost. The number of category 1 variables for an RR is less than that of an NPP. Thus, the PAMS of safety system are considered as a hardwired indication system of two independent channels. Each signal input to the PAMS is provided with dual measurement channels through hardwired instrumentation channels (i.e., channel A and B), where channel A is connected to train A and channel B is connected to train B. The PAMS provides information in real-time for the operators in the control room.

2.6 Operating Time

The post event operating times for each PAM variables are as follows.

- Types A, C, D, and E : the measured variable is required by the plant's LBD (Licensing Basis Documentation)
- Type B : the instrument channels shall be at least the duration association with the longest-duration design basis event for that variable

2.7 Seismic and Environmental Qualification

Types A, B, C variables are seismically qualified in accordance with IEEE Std 344-2004, and are environmentally qualified in accordance with IEEE Std 323-2003.

3. Conclusions

There is explicitly no regulatory requirements for the PAMS of an RR. However the trend of an RR design is to add the PAMS for special purposes. Thus, we need to decide the design strategies for the PAMS of a Korean RR. This paper proposed strategies on design considerations for PAMS of an RR. These are the regulatory requirements, the design scope, the selection criteria and selection method, the processing configuration, common cause failures of safety I&C systems, the operating time, and the seismic and environmental qualification. The design considerations of this paper are going to be applied to the design of a Korean RR.

REFERENCES

[1] U.S. Nuclear Regulatory Commission, Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants, Regulatory Guide 1.97, Rev. 04, 2006.
[2] IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations, IEEE Std 497-2002.
[3] U.S. Nuclear Regulatory Commission, Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, Regulatory Guide 1.97, Rev. 03, 1983.