Selection of Accident Monitoring Variables for a Research Reactor

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1. Introduction

An accident monitoring system provides the necessary information for operators to monitor and take actions during and following a design basis event [1].

ANSI-4.5-1980, IEEE 497, and Reg. Guide 1.97 have been developed for dealing with the variable selection requirements, performance requirements and design requirements of the accident monitoring system as part of post-Three Mile Island(TMI) requirements[3][4]. Therefore in designing an accident monitoring system, first of all, accident monitoring variables to provide the key information based on these regulatory requirements to the operators should be selected. These variables are composed of primary information to assess the reactor conditions whether reactor safety functions are being performed and maintained, to indicate the potential breach or the actual breach of the fission product barriers, to indicate the performance of the safety systems for the mitigation of design basis events, and to verify safety system status, and to monitor the release of radioactive material to the environment [2].

In this paper, we select the accident monitoring variables for the KJRR(KIJANG Research Reactor) according to the regulatory requirements, and the results are presented.

2. Method and Results

In this section some of the criteria and methods used to select the accident monitoring variables are described.

2.1 Selection Criteria

The criteria to select the accident monitoring variables is defined as 5 variable types in Section 4.0 of IEEE 497[2]. The Type A is variables that are required for pre-determined operator actions in certain accidents.

The Type B and C are variables that are necessary for overall accident monitoring through identification of the upper critical safety functions. Also, the Type C variables were additionally provided for extended area monitoring of defense-in-depth variables.

The Type D and E are variables for monitoring the performance of safety and radiation monitoring systems.

The selection criteria of an accident monitoring variables are presented in Table I. The selection of accident monitoring variables should be in accordance with the plant's unique emergency operating procedures (EOP) and abnormal operating procedures (AOP).

However, since the EOP and AOP for KJRR were not issued yet, we have selected the accident monitoring variables by referring to the safety analysis licensing documents of KJRR and the EOP and AOP of the JRTR, which is the preceding research reactor. We selected the minimum variables necessary to evaluate the performance of the safety-related functions and the proper operation of the safety system.

Table I: Selection Criteria for the Variable Type

Variable Type	Selection Criteria
Type A	-Planned manually controlled actions for accomplishment of safety functions for which there is no automatic control.
Type B	-Access the process of accomplishing or maintaining plant critical safety functions.
Type C	-Indicate the potential for breach or the actual breach of fission product barriers.
Type D	-Indicate the performance of those safety systems and auxiliary supporting features. -Indicate the performance of other systems necessary to achieve and maintain a safe shutdown condition. -Verify safety system status.
Type E	-Use in determining the magnitude of the release of radioactive materials. -Continually assessing such release.

2.2 Selection of Accident Monitoring Variables

2.2.1 Type A variable

There are no specific planned manually-controlled actions, in KJRR, for which no automatic control is provided and that are required for safety systems to perform their safety functions as assumed in the plant accident analysis. Therefore, there are no Type A variables in KJRR.

2.2.2 Type B variable

Type B variables provide primary information to the operators to assess the safety function of the plant. The safety functions of the KJRR are as follows:

- Reactivity control
- Maintenance of auxiliaries (AC and DC power)
- Reactor pool water inventory control

- Core heat removal
- Confinement isolation
- Radioactive effluent control

The Type B variables selected as key information to accomplish or maintain the safety function of KJRR are summarized in Table II.

Table II: Type B Variables

Safety Function	Variable
Reactivity control	CIC neutron linear power CIC neutron log power CIC neutron log rate
Core heat removal	Core Differential Pressure Flap valve closed position Reactor outlet temperature SRHRS temperature SRHRS flow PCS Pump Circuit Breaker
Reactor pool water inventory control	AMS pool level Spent fuel storage pool water level
Confinement isolation	CID close position FMPB Isolation Damper
Maintenance of auxiliaries	120V UPS AC Common Fault 125V UPS DC Common Fault 480V UPS AC Common Fault
Radioactive effluent control	PCS neutron Reactor Pool surface radiation

2.2.3 Type C variable

Type C variables provide primary information to the operators to indicate the potential for breach or the actual breach of fission product barriers. The fission product barriers of KJRR are composed of fuel cladding, reactor pool water, and confinement.

The selected variables represents a minimum set of plant variables that provide the most direct indication of the integrity of fission product barriers and provide the capability for monitoring beyond the normal operating range.

Table III: Type C Variables

Fission Product Barrier	Variable
Fuel cladding	PCS neutron
Reactor pool water	AMS pool level Reactor Pool surface radiation Reactor Pool Sump Level
Confinement	CID close position FMPB Isolation Damper FMPF RMS

2.2.4 Type D variable

Type D variables provide primary information to the operators to indicate the performance of those safety systems and to verify safety system status. The variables selected as Type D variables of JRTR are summarized in Table IV.

Table IV: Type D Variables

Safety System	Variable
SRHRS	SRHRS Pump SRHRS temperature SRHRS flow
Flap Valve	FV pool water temperature Flap valve open position
Siphon Break Valve	Siphon Break Valve open position
Spent Fuel Storage Pool	Spent fuel storage pool water temperature Spent fuel storage pool water level
Electric System	120V UPS AC Common Fault 125V UPS DC Common Fault 480V UPS AC Common Fault 4.16kV VCB Bus M Voltage 4.16kV VCB Bus N Voltage Diesel-Generator failure Diesel-Generator Voltage Diesel-Generator Current
Confinement	CID close position FMPB Isolation Damper
PCS	PCS Pump Reactor outlet temperature Core Differential Pressure
Reactivity Control System	CAR lower limit switch position SSR down position

2.2.5 Type E variable

Type E variables provide primary information to the operators and are required for use in determining the magnitude of the release of radioactive materials and continually assessing such releases. These variables are composed of information for monitoring the magnitude of releases of radioactive materials through identified pathways, and monitoring radiation levels and radioactivity in the control room and selected plant areas where access may be required for plant recovery.

Table V: Type E Variables

Area	Variable
Reactor Hall	Reactor Hall Duct Monitor Reactor Hall Stack Monitor (P) Reactor Hall Stack Monitor (I) Reactor Hall Stack Monitor (G)
RCI	RCI Duct Monitor
Reactor Building	Reactor Building Stack Monitor (P) Reactor Building Stack Monitor (I) Reactor Building Stack Monitor (G)
FMPF	FMPF Stack Monitor (P) FMPF Stack Monitor (I) FMPF Stack Monitor (G)
RIPF	RIPF Stack Monitor (P) RIPF Stack Monitor (I) RIPF Stack Monitor (G)
RWTF	RWTF Stack Monitor (P) RWTF Stack Monitor (I) RWTF Stack Monitor (G)

3. Conclusions

Accident monitoring system provides the information that operators and other response personnel need to manage accident conditions. The selection of monitoring variables that make up these information is very important for the accident response of operators. We selected the accident monitoring variables to evaluate the safety functions and to indicate the status of the fission product barriers and the safety system, and to monitor the release of radioactive material to the environment. However, the AOP and EOP of KJRR, which are the key documents used to select the accident variable, have not yet been issued and couldn't be applied in the variable selection. Therefore, the selected accident monitoring variables will be verified after the EOP and AOP for KJRR have been issued.

REFERENCES

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