



## **SOME ASPECTS OF DIAGNOSTIC SYSTEMS PERSPECTIVE**

**D.KOROŠEC**

Slovenian Nuclear Safety Administration,  
Ljubljana, Slovenia

### **Abstract**

The integrity and safety of all nuclear power plant systems and components is guaranteed by the high requirements to quality assurance during all phases of design, fabrication, construction and operation. Many of the countries operating nuclear facilities, introduced advanced, sophisticated diagnostic systems for continuous monitoring safety important process parameters. The licensee should perform an assessment of the existing diagnostic systems, often supplied by the original design, their reliability and the need for the introduction of the additional monitoring/diagnostic systems. The operating experience should be taken into account and the assessment of the further needs. On this field has to be made on the results of PSA studies. In addition to the cost benefit analysis the evaluation of the new diagnostic systems in the light of nuclear safety should be also made. Experience, gained from the utilities, which have already installed this kind of the equipment should be very useful. Introducing new diagnostic systems will require often a safety assessment of the necessary modifications. Licensing process should be based on the existing nuclear legislation with certain additional requirements.

### **1. PERFORMANCE AND RELIABILITY OF SAFETY EQUIPMENT**

The nuclear power plant components and systems have high requirements for the quality and reliability during the operation. To fulfill the requirements of the existing regulation, codes and standards it is necessary to have actually on line data about the condition of the safety most important components [1].

Monitoring of the safety important process parameters is very important in the last few years. The world wide practice shows that introducing some of the monitoring and diagnostic systems has very good results. Licensee avoids specific situations, that can lead to transients or damage of safety important equipment.

Some of the countries with nuclear power plants have already installed advanced, sophisticate systems to follow the behavior of key parameters, affecting reliability of safety important equipment. The direct consequence of using such systems is improvement of the performance indicators.

The years of experience gained in the operation and application of the monitoring systems help to the further development of this systems and new methods of evaluation.

Monitoring and diagnostic systems therefore should be treated as an effective tool to maintain the performance and reliability of the nuclear power plant at the high level.

The aging phenomena becomes more and more present in the majority of the nuclear power plants. The general vision in the nuclear world is nuclear power plant life extension. The data, obtained from monitoring systems could be of great value in such decision making process and cost benefit studies.

## 2. THE NEED FOR INTRODUCTION OF MONITORING SYSTEMS

It is common that nuclear power plants western type have some of the monitoring systems built in by the original design. The operating personnel have to have a variety of physical parameters on-line to be able safe operate the nuclear power plant.

The operational events, like transients, scrams, failures etc. leads the owner of the nuclear power plants to the fact, that existing monitoring systems are not sufficient to prevent the system or equipment against failure.

The good experience with monitoring systems at some nuclear power plants should help the management of the power plant, which do not have them yet, to make the decision introducing them.

The essential features of the diagnostic system are:

- detection
- localization
- analysis

The need for introduction of such systems should be based on these features. The detailed analysis of operational events should lead the licensee to allocate the potential systems/components, which are suitable to be monitored with additional system.

The producers of monitoring systems have generally two basic strategies, designing them [2]:

- monitoring and recording of influences on the system during typical plant process and over its total service life with determination of the collective loads for typical operation
- recording the primary and secondary parameters which characterize system performance and which change significantly when an anomaly occurs

In accordance with this approach, the measurement locations, measurement chain and the method of data verification and evaluation should be done.

## 3. THE ASSESSMENT OF MONITORING/ DIAGNOSTIC SYSTEMS

The reliability assessment of monitoring systems is necessary due to the reason that licensee needs the reliable system with high confidence level. The false alarms, uncertainty and unreliable signals could lead to the wrong decisions.

Appropriate selection of the systems and methods of the signal evaluation is very important. It is expected, that new introduced monitoring system will be tested and selected on the all available data from the manufacturer and some users, if they exist.

The specific criteria should take into account the compatibility of new obtained signals with the existing monitoring systems signals, built in system by the design.

The overall assessment of monitoring system should be done on the basis of [3]:

- monitoring system type
- measurement transducer selection

- measurement parameter selection
- measurement location
- time interval between measurements
- spectrum interpretation and fault diagnosis
- trend analysis
- computer software/hardware requirements

#### **4. MONITORING SYSTEMS IN THE LIGHT OF LICENSING PROCESS**

Safety evaluation of the diagnostic system is necessary. It allows licensees to change the design, revise the procedures or conduct tests or experiments without prior regulatory authority approval in the case there no unreviewed safety question exist. But often happened, that new installed system introduce safety important question, not yet reviewed. Regulatory authority approval is necessary in such case to implement the activity.

The nuclear power plants have to use existing national or international guidelines to perform adequate safety evaluation.

Among others, the licensee have to answer on questions, contained in safety evaluation process guidance [4], like:

- may the proposed activity increase the probability of occurrence of an accident evaluated previously in the Safety Analysis Report (SAR)
- may the proposed activity increase the consequences of an accident evaluated previously in the SAR
- may the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the SAR
- may the proposed activity increase the probability of the consequence of a malfunction of equipment important to safety evaluated previously in the SAR
- may the proposed activity create the possibility of an accident of a different type than any evaluated previously in SAR
- may the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously in the SAR
- does the proposed activity reduce the margin of safety as defined in the basis of technical specification

In fact, a change, that involves an unreviewed safety question may be a safety improvement by significantly reducing the risk on one area at the expense of a slight increase in risk in another area.

The responsibility lies with the utility to assure that changes are safe.

## **5. FURTHER PERSPECTIVE OF THE DIAGNOSTIC SYSTEMS**

The introduction of monitoring system into nuclear power plant system is at the present time the need very strongly present in nuclear countries. The new approach in the maintenance activities (on-line maintenance, the effectiveness of the maintenance) and the requests of the nuclear regulatory authorities on the field of reliable operation are the bases for introduction of monitoring systems.

The nuclear events databases are very good sources to allocate the potential systems and components to be monitored. New developed methods in measurement systems and their computerized support are more developed than in the past years. A data acquisition system is needed for the collection of all required data, their conditioning, trending and storage. Probabilistic safety analysis allocate the most safety significant systems and their components. Using the data of these analysis there is a possibility to select most vital locations at the systems and their components to be monitored.

The operational, maintenance and engineering personnel at the nuclear power plants is problem solving oriented and the monitoring systems with diagnosis capabilities are the tools for improving nuclear safety.

Diagnostic systems can be seen as a particular category of the operator support system. The use of diagnostic systems can play important role in preventing accident conditions and can play very important role in nuclear power plant condition monitoring programs and tracking of the aging effects during the plant life cycle.

## **6. REFERENCES**

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