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Proposed Reactor Operating Experience Feedback System Development

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1. Introduction

Most events occurring in nuclear power plants are not individually significant, and prevented from progressing to accident conditions by a series of barriers against core damage and radioactive releases. Significant events, if occur, are almost always a breach of these multiple barriers.

As illustrated in the “Swiss cheese” model [1], the individual layers of defense or “cheese slices” have weakness or “holes.” These weaknesses are inconstant, i.e., the holes are open or close at random. When by chance all the holes are aligned, a hazard causes the significant event of concern.

Elements of low significant events, inattention to detail, time or economic pressure, uncorrected poor practices/habits, marginal maintenance and equipment care, etc., make holes in the layers of defense; some elements may make more holes in different layers, incurring more chances to be aligned. An effective reduction of the holes, therefore, is gained through better knowledge or awareness of increasing trends of the event elements, followed by appropriate actions.

According to the Swiss cheese metaphor, attention to the Operating Experience (OE) feedback system, as opposed to the individual and to randomness, is drawn from a viewpoint of reactor safety. Development of a reactor OE feedback system is proposed herein, with the following expectations:

i) To decrease the probability that the events of risk significance will occur
ii) To reduce the number of event occurrences related to the plant performance and often incurring unfounded apprehensions of the public
iii) To improve regulatory program and practices to concentrate on more risk significant matters

In addition, it may help compensate for increase of total risk to be caused by increase in the number of domestic operating plants.

2. OE Feedback System

In this section an OE feedback process is proposed with three main elements: collection and screening, analysis and evaluation, and feedback. These elements are implemented in the respective stages, and involve the actions directed at identifying safety issues, assessing their safety significance, and taking actions to resolve the issues. Figure 1 shows the OE feedback process. In the process, some events may require immediate actions just after event notification. In this case, appropriate action items is delivered directly to the feedback stage, while the other steps in the first stage continue with licensee’s event reporting and/or KINS event inspection to take some time.

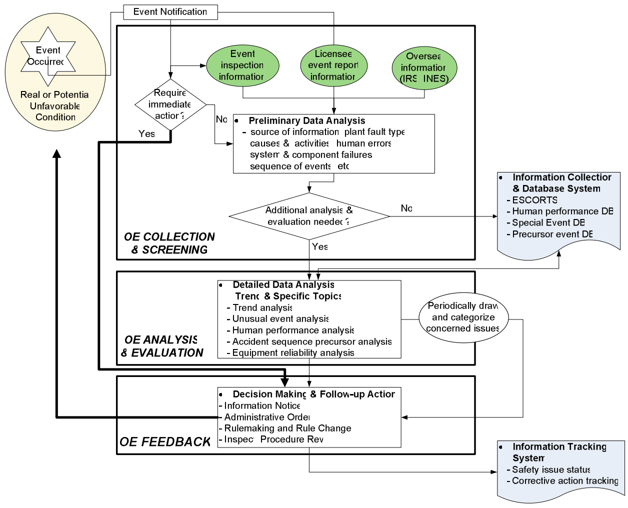

Figure 1. Proposed OE Feedback Process

2.1 OE Collection and Screening

The proposed program considers a part of various sources of the OE information, licensee’s reporting and KINS event inspection, and oversea information. In this stage, a preliminary analysis is performed to classify and screen the data; as a result, it is decided whether more detailed analysis is necessary or not. If an additional analysis is required, the second stage starts; otherwise, the relevant data is stored to the Information Collection System (ICS) and all the process ends.

The ICS and the data bases aim at managing the event data effectively and at supporting OE analysis and evaluation of the second stage. KINS developed a drafted version of the ICS, called as Event Sequence COding and ReTrieval System (ESCORTS).

2.2 OE Analysis and Evaluation

In this stage the ICS and various database systems are utilized to identify and prioritize safety vulnerability at specific plants, designs, sites, etc. The analyses in this stage have continuous interactions with the ICS and the database systems, and some information, incomplete or incorrect at the first stage, can be supplemented or corrected. Types of the analyses in fig.1 are described only for a demonstration purpose, but possibly regarded as valuable to identify safety vulnerability and risk significance.

2.4 OE Feedback

The follow-up actions are implemented in this stage, which are suggested through a decision making process. Decision making is made to find most appropriate actions to resolve concerned issues drawn in stage 2. Consultation of expert groups, if necessary, can help decide the follow-up actions. Various kinds of actions may be expected: notification of information to the licensee, change of plant operation (design, procedures of maintenance/repair, management of subcontractors, organization, etc.), change of the rule and regulations, modification of regulatory inspection procedure and practice, etc.

To manage the history and status of the issues and to increase the effectiveness of the follow-up actions, the Information Tracking System (ITS) is needed.

3. Reporting Criteria

It is crucial for success of the OE program to determine which operational events are reported to follow the OE feedback process. There can be a sharp conflict of opinion among interested parties on this matter because the licensees usually hesitate to release the OE information. Actually, a regulatory monitoring of all types of operational events is not possible and not advisable.

It can be deduced in the Swiss cheese model that the larger size of the holes will increase the probability of their alignment. The events with the larger holes can be potential precursors against core damage or radioactive release. After reviewing other organizations' reporting requirements ([2], [3]), the following five criteria are proposed: a) radioactive release to on- and off-site and exposure to the personnel, b) damage of the safety barriers, c) plant conditions affecting the safety analysis results, d) occurrence of initiators with potential impact on safety, and e) external conditions affecting safety.

4. ESCORTS

The current version of the system is composed of four categories: general information, initial plant fault and impacts, cause and its related plant activity, and Event Sequence and Cause Analysis (ESCA).

Category 1, general information describes operating status, e.g., reactor operating condition just before event or reactor trip, and pre- or post-event operational modes.

In category 2, initial plant faults, impacts on decay heat removal and radioactive barrier functions are described. The initial plant faults were grouped into categories that matched event groupings in the domestic PSA, using to the NUREG/CR-5750 classification method [4]. The initial plant fault group contains 71 mutually exclusive categories (50 reactor trip or Decay Heat Removal Function (DHRF) affecting events and 21 other events), under 11 headings.

In category 3, the root causes were classified as 18 categories, which are grouped into five major categories: design, fabrication and installation-related problem, personnel error, managerial, equipment reliability, and external problems. It was modified from IRS [3] and DOE [5] classification. Classification of the plant activity related to the cause is intended to identify the area to be corrected, often complementing the classified root causes; if an event occurred due to communication during periodic equipment test, the cause-activity pair would be recorded as communication & supervision problem-test & calibration.

The last category ESCA describes the system-, train-, component-level failures as well as the analysis results of a sequence of events based on the events and causal factor analysis method. During ESCORTS development, the physical system hierarchy from IEEE Std 1413.1[6] was taken and was re-adjusted for the three level, system, train and components. The failure modes and causes are applied to the component-level only, bounding different lower levels. By applying principles aforementioned, ESCORTS includes codes of more than 110 systems, 70 components, 40 failure modes, and 30 failure causes.

The ESCA also describes the results of ECF charts describing cause and effect chains for the time sequence of events. All types of events reported, single event to multi-sequence events are realized in the ESCA.

5. Concluding Remarks

It is recognized that the OE information important to safety must be utilized in broader regulatory areas, e.g., risk informed regulation, maintenance rule, etc. A program for development of the national OE feedback system was recently launched in KINS, under support of MOST. As a preliminary study, the OE feedback system was proposed, however, still far from the destination.

REFERENCES

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