Conference Date & Place: April 3 - 7, 1989 -- Rome, Italy

TRENDS OF SIGNIFICANT OPERATING EVENTS IN ASSESSING PROGRAMMATIC ISSUES

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ABSTRACT

This paper describes one part of the U. S. Nuclear Regulatory Commission's (NRC's) program for evaluating significant events and the process for identifying trends that may be indicative of programmatic weaknesses at operating nuclear power plants. A database management system was developed to permit analyses of significant operating events, events of potential safety significance, and certain reactor scrams. The analyses were based on events and problems reported by telephone to the NRC by licensees within hours of the events and, therefore, provided current operational data trend information. The regulatory requirements for reporting significant events, the screening criteria, and the process for identifying outliers for formal evaluation are described herein. This process contributed to an understanding of the underlying causes for events and problems. Examples are included of operating experience assessments that identified plants with a poor operating experience history that was attributable to procedural inadequacies, operator training deficiencies, inadequate root cause analysis, and inadequate control and planning of activities.

RESUME

Ce document decrit une partie du programme utilise par (le) "U. S. Nuclear Regulatory Commission" (NRC) pour evaluer les incidents importants ainsi que le processus d'identification des tendances qui peuvent indiquer des faiblesses programmatiques dans les centrales nucleaires en operation. Un systeme de gestion de bases de donnees a ete develope pour permettre l'analyse statistique des incidents d'operation importants, des incidents ayant un potential de surete important et de certaines chutes de barres. Les analyses out pour base les incidents et problemes qui sont communiques par telephone a NRC par les centrales nucleaires dans les heures qui suivent un incident et qui, de ce fait, fournissent des renseignements sur les tendances des donnees d'operation en cours. Cet expose decrit les exigences des reglements de securite qui s'appliquent au compte-rendu des incidents importants, aux criteres de selection et au procede d'identification des centrales nucleaires qui different de la moyenne pour proceder a une evaluation en profondeur de ces centrales. Ce processus aident a comprendre les causes profondes des incidents et des problemes. Cet expose donne des exemples de centrales nucleaires selectionnees par ce processus et dont le fontionnement mediocre a ete attribue a de mauvaises procedures, a un training insuffisant des operateurs, a une analyse des causes premieres incomplete et a un controle et une planification des activites insuffisants.

This paper describes one part of the U. S. Nuclear Regulatory Commission's (NRC's) program for evaluating operating events and problems at nuclear power plants and the process for identifying trends that may be indicative of programmatic weaknesses. Although the primary emphasis is on the prompt evaluation of events (usually less than 24 hours after the event) to determine their safety significance and generic implications, the operational data can provide useful information, when considered in combination with other symptoms, regarding weaknesses in programs that affect plant performance and safety. The methodology includes the prompt screening of operating experience, the classification of the events according to established criteria, the entering of the events into a database management system, and then the periodic analyzing of the trends of the operating experience for outliers for further analysis and evaluation.

The importance of operating experience and the lessons it provides are recognized throughout the nuclear industry and by government agencies in all countries. The collection, assessment, and dissemination of operating experience contribute significantly to improving and ensuring nuclear safety, reliability, and economy of commercial nuclear power plants. In the past, the analyses of operating experience have been used primarily to identify and provide feedback of the safety-significant lessons learned to minimize the potential for similar events, reduce challenges to safety systems, and reduce the likelihood of more serious core-damaging precursors. This observation is still true; the evaluation of operating experience is one of the primary objectives of the NRC to ensure that all licensed facilities are constructed, operated, and maintained to protect the public health and safety.

The NRC is an advocate of the pursuit of excellence in nuclear safety. In addition to compliance with NRC regulations, the NRC monitors the performance of operating reactors to ensure that operational safety is enhanced. The trends of certain operating experience parameters are monitored for symptoms of potential programmatic weaknesses that could adversely affect plant safety performance and operational reliability. Thus, operating experience is analyzed with a perspective to enhance operational performance.

Operational safety data is reported, developed, and analyzed by the NRC to provide feedback into the licensing, inspection, and safety information systems. The primary sources of operational data for U.S. facilities include licensees' telephone notifications, licensee event reports, NRC inspection reports, and NRC regional daily reports.

Depending on the type of the event or problem, the U. S. regulations require licensees of operating nuclear power plants to provide telephone notification of a significant event within either 1 hour or 4 hours. The NRC maintains an Operations Center on a 24-hour basis to screen events and problems, notify senior NRC staff and management of emergencies, and enter the reports into a computerized database management system. These notifications, together with daily reports from the five NRC regional offices, provide the bases for the short-term event screening and evaluation that is the primary focus of this

paper. Typically, in 1988, about 5000 reports were evaluated during this process for the 111 operating nuclear power plants in the United States.

Within 30 days after an event, the licensees submit to the NRC a written licensee event report (LER), which provides definitive information describing the event, its causes, and the corrective actions. Because the LERs contain the most complete and factual information concerning operating events, LERs form the bases for several important database management systems that have multiple applications throughout the NRC. The NRC's Office for the Analysis and Evaluation of Operational Data has the primary responsibility for maintaining these databases and for performing long-term engineering evaluations and trend and pattern analyses. The primary objective of these operating experience assessments is to identify significant safety concerns and generic problems. In recent years, the operating experience databases have been used to provide additional insight into the overall assessment of a licensee's operational performance.

Each working day, the Events Assessment Branch in the Office of Nuclear Reactor Regulation evaluates and screens operating experience reported by utilities and NRC regional offices. The primary objectives are to (1) evaluate the safety significance of operational experience and identify generic problems, (2) identify actions to ensure safe plant operations, and (3) report operating event information to the NRC staff and the nuclear industry.

The first step in the evaluation of operating experience reports is to assess the safety significance of the event and the need for followup actions. The events are categorized as either safety significant, potentially significant, not understood, or too insignificant to warrant followup activities. The characteristics of significant and potentially significant events are listed in Tables 1 and 2, respectively. After additional information is obtained about the potentially significant event and the event is understood, all operating events will then be categorized as either significant or insignificant for the purposes of this evaluation. For example, in 1988, 82 of the approximately 5000 reported events were found to be significant events. The significant events are then entered into a database and periodically analyzed for each operating plant.

A second parameter that is evaluated is certain reactor scrams. Both manual and automatic scrams are considered because they represent challenges to plant safety. Reactor scrams at low power levels are excluded from the database to eliminate feedwater and other transients during startup that are of less safety significance. Thus, scrams for

pressurized-water reactors (PWRs) below 20 percent full power and scrams below 30 percent full power in boiling-water reactors (BWRs) are excluded. The number of scrams per unit was normalized by the number of hours the unit was critical to account for the exposure time to scrams.

The third parameter that is considered for performance insights is regulatory issues. These includes recent hardware, licensing, technical, or other issues that relate to licensees' performances. This information is usually provided by the NRC regional offices through daily reports to NRC headquarters.

The operating experience information is evaluated to determine plant-specific statistics. The operating plants that had the most safety-significant experience or displayed a pattern of events that could indicate a trend leading to a potential safety-significant event are identified for further study.

For each plant identified, every event is categorized by cause and the system affected. Particular emphasis is placed on understanding human performance problems because these problems are frequently attributed to weaknesses in programs such as training, control of activities, procedures, labeling, planning, and scheduling. The databases are searched to provide a historical trend for each plant for specified periods, usually for the previous year by quarters. A one-page summary of the performance data for each plant is then prepared.

The final step in the evaluation process is performed by a group of senior engineers who review the summary data for each plant to identify potential weaknesses in such areas as operations, maintenance, training, root cause analyses, or design. This assessment also reduces the number of plants for in-depth evaluation by eliminating some of the outliers which, when evaluated, did not appear to be performing in a manner that required further evaluation. The performance of each plant is discussed to obtain a collegial perspective of the safety, operational implications, and management effectiveness based on operating experience.

The team of senior engineers will attempt to reduce the number of plants on the list to those that are judged to have operational histories that indicate a programmatic weakness in one or more areas and whose overall performance could be improved to attain a higher level of operational excellence. Additional information is necessary to reduce the number of plants because the information provided in the telephone notification is sometimes cursory and preliminary. The licensee event reports (LERs) and NRC inspection reports are examples of reports that are usually reviewed in great detail to obtain specific insights into the factors causing the operating event or to identify repetitive events

produced by similar causes or ineffective corrective actions. Frequently, the safety significance of the operating events or the potential for a more severe or core-damaging precursor event will result in the examination of the plant performance in greater detail for symptoms of programmatic weaknesses. Similarly, a series of events that are repetitive or produced by the same root cause also requires an in-depth analysis and usually results in the identification of an area requiring improvement.

The following examples illustrate the results of this evaluation methodology:

1. A programmmatic weakness at a BWR was identified when unrelated operating events during a 9-month period were found to have been the subjects of NRC generic communications and vendor information. The licensee had not effectively incorporated lessons learned from previous operating experiences at other plants into plant procedures and operator training.

2. Within a 6-month period, a BWR experienced 4 significant events involving main steam line isolation valves and 20 other reportable events. Most of the events had root causes related to operational or procedural deficiencies. The in-depth evaluation indicated weaknesses in the training programs that fostered inadequate operator knowledge of the plant design, operating equipment, and systems interactions.

3. During the first 6-months of operation, a PWR reported 55 events. Twenty-three of these events represented deficiencies in controlling steam generator level. The plant experienced 25 scrams, with 11 automatic scrams above 20 percent full power. The evaluation found that plant management did not appear to identify and correct problems or to control and plan activities to ensure operational safety. After an NRC inspection, a majority of the operational problems were attributed to inadequate operator training (particularly on the simulator) and inadequate control setpoints for the steam generator level control system. The licensee made improvements to its root cause analysis program.

This method of evaluating plant performance is not always conclusive. The indications identified during this analysis must always be substantiated or integrated with other performance information before conclusions can be formulated. However, the NRC regional office staff and resident inspectors also have identified the same plants as outliers requiring improved performance on the basis of an independent assessment of operational and other parameters. The combination of the assessments

are usually collaborative and complementary. The results of this type of analysis, when combined with other information can be used by the NRC in several ways. Inspections of the plant by the NRC could be increased, periodic meetings could be established between the licensee and NRC to discuss progress, vigilance by the NRC on the day-to-day activities at the plant could be expanded, and other actions to enhance operational excellence at the plant could be taken.

In summary, the importance of operating experience and its role in reactor safety has been re-iterated by the insights this experience can provide into the effectiveness of programs at operating plants. In the examples given in this paper, the analyses of the operating experience has lead to the identification of programmatic weaknesses in operating plants. Although the evaluation process described in this paper identified outlier plants, additional information and analyses were required before conclusions could be finalized. This process is one part of NRC's program for ensuring and enhancing reactor safety based on operating data.

TABLE 1

CHARACTERISTICS OF SIGNIFICANT EVENTS

- o Degradation/loss of important safety equipment (multiple/common mode failure)
- o Degradation of fuel integrity, primary coolant pressure boundary, containment, or important safety-related structures
- o Unexpected plant response to a transient
- o Major transient
- o Scram with complications
- o Unplanned release of radioactivity
- o Operation outside the limits of technical specifications
- o Other (recurring incidents, plant management, or programmatic breakdowns)

TABLE 2

CHARACTERISTICS OF POTENTIALLY SIGNIFICANT EVENTS

- o Some, but not all, elements of a significant event
- o New or unique event (failure mode, cause, or sequence progression)
- o Event with potential generic implications (usually involving a specific piece of equipment or procedure)
- o An event that does not conform to known design/operation features
- o Other (supervisor's judgment, management inquiry, recurring symptomatic events)