

Nuclear Regulation

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Regulatory Challenges in Using Nuclear Operating Experience

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FOREWORD

The Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency (NEA) is an international committee composed primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations and for the review of developments which could affect regulatory requirements. The Committee is responsible for the NEA programme concerning the regulation, licensing and inspection of nuclear installations. In particular, the Committee reviews current practices and operating experience.

The NEA/CNRA Senior Level Expert Group was formed in 2004, based on CNRA member consensus, to produce a report on *Regulatory Challenges in Using Nuclear Operational Experience*. The fundamental objective of all nuclear safety regulatory bodies is to ensure that nuclear utilities operate their plants in an acceptably safe manner at all times. In meeting this objective, learning from experience has been a key element throughout the history of nuclear power, and the CNRA has recognised that there is a continuing need to further enhance international exchanges in this area.

This report is not intended to be a handbook on collecting and analysing operating experience, and avoids duplicating information well-presented elsewhere. Its purpose is to serve as a guide for regulatory bodies to help ensure that operating experience is used to promote safety. While focused on nuclear power plants, the principles in this report may apply to other nuclear facilities as well. It therefore follows that the audience for this report is primarily nuclear regulators, although the information and ideas may also be of interest to nuclear operators, other nuclear industry organisations and interested members of the public.

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1. INTRODUCTION

As the nuclear programmes in OECD countries have matured over the four decades of commercial nuclear power operation, this maturation has brought steady improvements in the operational safety of nuclear power plants. This improvement is demonstrated by several performance indicators, but most notably by the reduced frequency and severity of accident precursor events relative to the events of, say, ten to twenty years ago.

One of the major reasons for this improved performance has been the extensive use of lessons from operating experience to backfit safety systems, improve operator training and emergency procedures, and to focus more attention on human factors, safety culture and nuclear quality management systems. Indeed, a prominent lesson from the TMI-2 accident in 1979 was the need for systematic evaluation of operating experience on an industry-wide basis, both by the nuclear industry, which has the greatest direct stake in safe operations, and by the nuclear regulator [1].

The practice of collecting and analysing operating experience (OE) information has grown in depth and sophistication over the years, and by now there is an extensive literature on the methodology for collecting and analysing operating experience [2,3]. In general it can be stated that nuclear operators and regulators are familiar with these methods.

Now, however, questions are being raised about whether the lessons from operating experience are being used commensurate with their importance to safety. For example, recent concerns have been voiced that:

- lessons may be learned but they are subsequently forgotten over time;
- often nothing is done in response to information learned about others' experiences;
- there is a tendency to consider foreign operating experience as not relevant to one's own situation; and
- more generally, operating experience reporting is not meaningful if it is not used to promote operational safety.

To give an example for these concerns, the NEA Working Group on Operating Experience (WGOE) has recently noted, “Almost all the recent significant events reported at the international meetings have occurred earlier in one form or another. Counter-actions are usually well known, but information does not always seem to reach end users or corrective action programmes are not always rigorously applied [4].” A separate concern that has been raised is that not all important operating experience is reported to established international reporting systems in a timely manner. One reason given for this lack of timely reporting is the relatively large resources needed (both for the operator and the regulator) for the preparation and translation of the reports in the proper format. Another reason given is the concern for possibly providing incomplete or inaccurate information on operating events or conditions before they are fully analysed and understood.

Thus, it appears that a challenge to maintaining the recent good operational safety performance is to ensure that operating experience is promptly reported to established international reporting systems and that the lessons from operating experience are actually used to promote safety. It was for this reason that the Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency has commissioned this report.

The primary focus of this report, therefore, is on how regulatory bodies can assure that operating experience is used effectively to promote the safety of nuclear power plants. One must keep in mind that the operator has the responsibility for safely operating a nuclear power plant, and hence it is important for the operator to have an active programme for collecting, analysing and acting on the lessons of operating experience that could affect the safety of his plant. It is the nuclear regulator’s responsibility to oversee the operator’s activities to assure the plant is operated safely. Therefore, a key topic for this report is the role of operating experience in the regulator’s management system.

This report is not intended to be a handbook on collecting and analysing operating experience (OE), nor will it duplicate information better presented elsewhere. Rather, it is intended to be a guide for regulatory bodies to help in assuring that operating experience is used to promote safety. While focused on nuclear power plants, the principles in this report apply to other nuclear facilities as well. It follows, therefore, that the audience for this report is primarily nuclear regulators, although the information and ideas may also be of interest to nuclear operators, other nuclear industry organisations and the general public.

2. THE IMPORTANCE OF OPERATING EXPERIENCE FOR SAFETY

The fundamental logic supporting the need for a vigorous operating experience programme is that serious accidents are almost always preceded by less serious precursor events and that by taking actions to prevent recurrence of similar events, one is thereby reducing the probability of serious accidents. In this report “precursor event” is an actual event or condition that has some of the characteristics of a serious accident but falls short of being a serious core damage accident. It implies that more serious events could follow in the future if no changes are made.

Nuclear power plants are highly complex installations, with several redundant and diverse mechanical, electrical and control systems. There are dozens of such systems and thousands of individual components in a typical plant. Experience over the years has shown that all plants experience individual component and system failures from time to time, almost always with no safety consequences. Many of these operating events at nuclear power plants include contributions from human and organisational factors. If no steps are taken to correct the root causes of these failures, they will recur and, accompanied by other failures or perhaps human errors, will lead to a more serious event or accident. Therefore, an effective operating experience (OE) programme must be understood as a key factor in maintaining the strength of the defence in depth concept. There is a need for a programme at each nuclear power plant to collect and analyse this experience and take steps to reduce the likelihood of similar precursor events.

The IAEA Report [2] provides an excellent rationale for the importance of a vigorous OE programme to promote nuclear safety:

- to identify and quantify events and conditions that are precursors to more serious events;
- to identify the root causes of these events and suggest corrective actions;
- to discover emerging trends or patterns of potential safety significance;

- to assess the seriousness of the events and conditions by analysing what could have happened;
- to assess the generic applicability of events; and
- to recommend steps to prevent the recurrence of similar events.

In this report we shall define operating experience as all events, conditions, observations or new information that could affect nuclear safety. This broad definition of operating experience includes the following categories under its umbrella:

1. actual operating events, typically plant transients accompanied by equipment failures, human errors or other anomalous behaviour;
2. actual failures of systems, structures or components, or human errors, that may or may not have caused a plant transient;
3. adverse safety conditions such as design weaknesses, degraded safety equipment or aging effects that could lead to failures of systems, structures or components;
4. external challenges such as vulnerability to severe weather, flooding, high winds or security threats;
5. organisational or human factor issues such as a degraded safety culture at a plant, high human error rates, weak quality assurance (QA) programmes, inadequate procedures, inadequate training or inadequate control of contractors at a plant site;
6. new information, such as research results or new safety analyses, showing a previously unknown weakness in a safety system or a fuel failure vulnerability; and
7. non-nuclear experience such as equipment flaws or seismic effects on non-nuclear structures and equipment.

It is self-evident that, in order to make use of this array of operating experience information to promote safety, one must have formal programmes for collecting and analysing this operating experience data. The responsibility for these programmes will be discussed in later chapters.

3. REGULATORY APPROACHES FOR ASSURING EFFECTIVE OPERATING EXPERIENCE PROGRAMME

The fundamental objective of all nuclear safety regulatory bodies is to assure that nuclear utilities operate their plants at all times in an acceptably safe manner. The main focus of this report is on how the regulatory bodies can assure that operators use operating experience effectively to support the objective of safe operation. While there are differences in the laws, regulations and customs among OECD countries, all regulatory bodies have the means to oversee the operators' system for collecting, analysing and acting on the lessons of operating experiences that could affect the safety of their plants. As discussed in Chapter 5, the regulatory body must have its own internal system for collecting and analysing operating experience, but this cannot substitute for the need for the operator to have an effective operating experience (OE) programme.

An essential foundation of an effective operating experience programme is the need for each operating organization to report events and conditions that occur at its own plant. After many years of experience each regulatory body has developed requirements governing operating experience reporting requirements, and for the purposes of this report it is assumed that these requirements are satisfactory to meet the regulator's needs. The scope of reporting requirements should be broad enough that it includes reporting by design organisations, equipment suppliers, fuel suppliers and other nuclear service providers. The regulator may choose to request information on component and system failures having little or no safety consequences in order to analyse other events and conditions. In some countries regulatory authority extends to all companies that supply safety relevant material to nuclear power plants. Where this is not the case, the regulator will have to ensure that the operator reports safety significant operating experience information from its suppliers according to established procedures.

The elements of an effective programme are described in Reference 2 and they include (a) collecting all relevant operating experience information, (b) screening for safety significance, (c) analysis of significant events or conditions, (d) assigning actions to correct any problems or weaknesses found, (e) tracking of actions, and (f) follow-up to ensure the actions are completed satisfactorily. There are a number of methods and techniques that regulators can

use to analyse and draw lessons from operating experience [5]. For example, some regulatory bodies have found that the Case Study method is a powerful tool for understanding complex events and for teaching new regulatory staff many of the nuances of nuclear safety. Some regulators have found it beneficial to encourage their licensees to consider human and organisational factors causes when analysing operating events and conditions. An especially effective tool for analysing and understanding complex events is PSA methodology. While not absolutely necessary for an effective OE programme, many regulatory bodies find it of benefit to require operators to have the capability for PSA analysis of their plants and for analysis of operating experience information.

In some countries having several nuclear power plants with different operating organisations or at different sites, they have found it beneficial to use probabilistic methods for analysis of precursor events. A reliable source of information for assessing the actual risks from nuclear plants comes from a careful retrospective examination of the frequency and severity of actual operating events at those plants. This is done by using the accident sequence precursor (ASP) methodology. Accident sequence precursors are actual initiating events or conditions that, when coupled with other postulated subsequent events, could result in a core damage accident. PSA methods are used to estimate a conditional probability of core damage associated with each precursor event. This conditional core damage probability (CCDP) can be considered a measure of the residual protection against severe core damage during the actual precursor event. By adding the sum of all CCDPs for a year and comparing with the sum of yearly CCDPs for earlier years, one can deduce trends in the overall safety performance of the nuclear plants. There are limitations on the accuracy of ASP methodology, notably the limits of PSA methodology and data, the completeness of event reporting, and the absence of actual data on rare events such as earthquakes. Nevertheless, some regulatory bodies find ASP methods highly valuable for analysing operating experience for overall safety trends.

An operating experience programme cannot be maximally effective unless it includes worldwide operating experience. For many OECD countries, the majority of operating experience will come from foreign countries, and for that reason it is essential that both the regulator and operator have access to international information such as the IAEA/NEA Incident Reporting System. In addition, the World Association of Nuclear Operators (WANO) and the Institute of Nuclear Power Operations (INPO) conduct many analyses of operating events each year and make the results available to nuclear operators around the world. These reports and analyses are a supplement but not a substitute for individual operating plant OE programmes. The regulator should be aware of these analyses and those of other industry and government organisations.

4. REGULATORY APPROACH FOR ASSURING THAT OPERATING EXPERIENCE IS USED TO PROMOTE SAFETY

In the introduction it was noted that concerns have been raised recently that often nothing is done in response to information learned about others' experiences. That is, although an operator may have a process for collecting and analysing operating experience information, there is often no follow up with effective actions to prevent the same event or condition from occurring at the operator's own plant. This, then, is the fundamental challenge for the regulator. How can the regulatory body assure that operating experience is used effectively to promote safety?

The actual legal basis for requiring each operator to have an operating experience programme varies among OECD countries. But regardless of the precise regulatory basis, the regulator has the means for emphasizing the importance of operating experience within the operator's organisation just through the mere fact of placing it on the agenda of the highest level of plant management. The operator's priorities are influenced by those matters regarded as important by the regulatory body and, by including operating experience in the normal regulatory inspection programme and in meetings with senior plant managers, the regulator can ensure that the operating experience programme receives the operator's attention.

In assessing the adequacy and effectiveness of an operator's operating experience programme, the regulator can begin by using the IAEA Safety Guide [2] as a template to judge whether the programme includes the essential elements. Based on experience, it appears there are several key attributes of successful operating experience programmes:

1. a detailed OE procedure and adequate resources to implement the procedure;
2. a dedicated, conscientious operating experience co-ordinator who is responsible for assuring the programme is effective and is diligent in making the procedure work and in following up on corrective actions;

3. ready access to a wide range of sources of operating experience, including international and non-nuclear experience;
4. a procedure that assures that important safety issues passing a significance screening test are placed in a tracking system until acted upon and closed out;
5. a staff that is competent in conducting event and causal analyses;
6. an attitude on the part of plant management that values operating experience, is receptive to all sources of operating experience (especially outside sources), and supports the need to take corrective actions based on operating experience lessons; and
7. periodic self assessments and external assessments to check the effectiveness of their operating experience programme.

The regulatory body can focus attention on operating experience programmes by making it part of the regular inspection programme, especially part of reactive inspections the regulator would normally conduct following operating events. In addition to examining whether the programme includes the necessary elements, the inspection programme can look into questions such as the following:

- Does the operator have staff who are competent in root cause analysis and similar methodologies?
- Does the operating experience information reliably reach the end user in a form that can be acted upon?
- Does the operator include regular audits of operating experience in its QA oversight programme?
- Does the operator have an effective corrective action programme for capturing significant operating experience lessons, formulating corrective actions and tracking them to completion?
- Is operating experience information used in training control room operators and other plant staff?

- Is operating experience data used for plant system and component reliability trend analyses?
- Does senior plant management take an interest in and actively support the OE programme?

In conducting its inspections the regulator must have complete access to proprietary and confidential information related to safety from its licensees, nuclear fuel and equipment suppliers, plant designers and other nuclear service providers.

The regulatory inspections should be especially sensitive to signs that the operating experience programme at a plant may be weak or ineffective. Some of these signs might be minimal staffing and a perfunctory implementation of the programme, few or no actions resulting from lessons learned, lack of support for operating experience from senior management, and a prevailing attitude among the staff at the site that operating experience feedback is not really important for nuclear safety.

After the results of the inspection are assimilated, the regulator will have to reach a preliminary judgment on the adequacy and effectiveness of a plant's operating experience programme. If weaknesses are found, they must, of course, be communicated to the operator, and the regulator may choose to schedule a follow-on inspection or a meeting with plant management, or both. Usually these actions will be sufficient to prompt corrective actions by the operator, but if serious weaknesses in the operating experience programme persist, the regulatory body may have to consider other enforcement actions.

5. THE ROLE OF OPERATING EXPERIENCE IN A REGULATOR'S MANAGEMENT SYSTEM

One of the lessons from the TMI-2 accident in 1979 was the need for systematic evaluation of operating experience by the nuclear regulator [1]. As part of its responsibility for assuring safety, the regulator must be confident that safety relevant operating experience, especially accident precursor events, are not overlooked by operators. This report further emphasises that the regulator has the duty to oversee the effectiveness of the operator's operating experience programme.

For purposes of this discussion, the term "regulatory body" refers not only to the regulatory authority itself, but also to its technical support contractors. Indeed, the regulatory authority may find it most effective to rely on contractors for the expertise needed to analyse complex events, for example using PSA methodology. The regulator may choose to have a unit of its organisation dedicated to collecting and analysing operating experience. Alternatively, the regulator may choose to have most of this work done by contractors. In any event, the regulatory body should have adequate resources to implement the OE programme, some staff trained in the skills of operating experience evaluations, and a conscientious OE coordinator as the key elements of a successful regulatory operating experience programme.

The regulator's operating experience programme should be guided by a detailed procedure and it should include all of the elements discussed in Chapter 3; namely, collection, screening, analysis, corrective actions, tracking and follow-up. The regulator's programme must be independent of operators' programmes, and there undoubtedly will be differences. For example, it is not likely that an operator's operating experience collection programme would include worldwide research results or extensive non-nuclear experience. In these cases, the challenge for the regulator is to assure that this relevant research and non-nuclear operating experience is collected, analysed and disseminated, either by operators, industry organisations or through the regulator's own operating experience programme. The regulator should request a response from the operator concerning its analysis of each issue for its own plant and what actions it plans to take.

In general, the regulator's analysis of an operating event or condition need not be as detailed as the operator's analysis at the plant where the event occurred, in order to avoid unnecessary duplication. On the other hand, the regulator may decide that its own detailed analysis is needed if it judges that the operator's analysis is inadequate. In particular, the regulator should develop the capability for analysing human and organisational factor issues and industry-wide trending. The regulator's operating experience staff will have to stay in close touch with industry operating experience activities as well as with its international regulatory counterparts regarding operating experience.

The regulatory body can make a significant contribution to promoting safety by making the results of its operating experience collection and analysis activities widely available throughout the nuclear industry, both nationally and through international bodies such as IAEA and NEA. Of course, the regulator's operating experience procedure must provide for protection of proprietary, confidential and sensitive security information.

In addition to its notification responsibility, the regulator should review event analyses for safety insights that can be used to guide its inspection programme and licensing procedures. Another major objective of the regulator's operating experience programme is to determine the need for new or amended regulations, standards and regulatory guidance, including the need for additional safety research. Frequently the review of operating events will challenge the regulator to judge whether to require safety backfits for the plant that has experienced the event or condition [6]. In some cases the analysis may point to a broader, generic safety issue that may require more widespread backfits and even a change in its regulatory requirements. This means that the operating experience analysis should carefully consider the generic applicability of its conclusions. Some regulators find it useful to categorise operating experience information according to its impact on specific safety functions and level of defence in depth, in order to make any gaps in safety information more obvious.

Yet another responsibility of the regulatory body is the need for careful trending of operating experience, for example equipment failure rates, system failure rates, aging effects such as stress corrosion cracking, and even safety culture and organisational issues. A regular review of this trend information should be a part of the regulator's operating experience procedure.

When new backfits are imposed, either on single plants or on a wider basis, the regulator must follow the progress of the operator's implementation of the backfits. This tracking responsibility should be included in the regulator's normal management system for tracking licensee commitments and requirements.

From this discussion, it is evident that the operating experience function plays a vital role in the nuclear regulator's safety oversight responsibilities, and therefore the regulator should assure that operating experience is a well defined component of the regulator's management system and that it is supported with adequate resources. In this regard it would be a good practice for the regulatory body to conduct periodic self assessments or sponsor external assessments to ensure that its procedures and practices are meeting this responsibility.

6. SUMMARY AND CONCLUSIONS

There can be no doubt that the systematic evaluation of operating experience by the operator and the regulator is essential for continued safe operation of nuclear power plants. Recent concerns have been voiced that the operating experience information and insights are not being used effectively to promote safety. If these concerns foreshadow a real trend in OECD countries toward complacency in reporting and analysing operating events and taking corrective actions, then past experience suggests that similar or even more serious events will recur.

This report discusses how the regulator can take actions to assure that operators have effective programmes to collect and analyse operating experience and, just as important, for taking steps to follow up with actions to prevent the events and conditions from recurring. These regulatory actions include special inspections of an operator's operating experience programme and discussion with senior plant managers to emphasize the importance of having an effective operating experience programme.

In addition to overseeing the operator's programmes, the regulator has the broader responsibility for assuring that industry-wide trends, both national and international are monitored. To meet these responsibilities, the regulatory body must have its own operating experience programme, and this report discusses the important attributes of such regulatory programmes. It is especially important for the regulator to have the capability for assessing the full scope of operating experience issues, including those that may not be included in an operator's operating experience programme, such as new research results, international operating experience, and broad industry trend information.

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