

Fostering a Risk-Informed Environment in Nuclear Reactor Regulation

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ABSTRACT

In risk-informed regulation, risk insights are considered together with other factors to establish requirements that focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety. Fully implementing a risk-informed approach in nuclear reactor regulation requires significant cultural change to integrate the historically distinct “deterministic” and “probabilistic” categories of technical work. Therefore, the U.S. Nuclear Regulatory Commission (NRC) launched a “risk-informed environment” initiative to improve training and communications throughout the reactor regulation organization. An inter-office focus group developed two new training courses for technical staff and managers. These one-day courses introduce the concept of risk-informed regulation through policy discussion, risk modeling basics, and examples of the application of risk information. Additionally, risk-informed regulation topics were added to technical reviewers’ qualification programs. Finally, the internal website has been updated to include an extensive archive of training materials and reference documents. Another new effort also shows the risk-informed environment in action. Risk analysts in the Office of New Reactors (NRO) developed “risk insights” related to each new reactor design and discussed them with reviewers at a series of meetings, emphasizing how risk insights can be used to improve the quality and effectiveness of the safety review. The NRC expects the cultural change to continue as more staff receives training on risk-informed regulation and sees its positive impact on daily work. As a result, the agency will more efficiently protect people and the environment.

Key Words: risk-informed regulation, training, communications, cultural change

1 BACKGROUND

In its Probabilistic Risk Assessment (PRA) Policy Statement (60 *Federal Register* 42622; August 16, 1995), the U.S. Nuclear Regulatory Commission (NRC) provided high-level guidance regarding the use of PRA technology in a manner that complements the NRC’s deterministic approach. The staff was directed to implement a framework that places emphasis on the areas of highest risk while reducing focus on areas of lower risk, thereby conserving resources and reducing unnecessary regulatory burden.

Toward that end, the NRC subsequently developed the PRA Implementation Plan to ensure the increased use of PRA in regulatory activities. In particular, the PRA Implementation Plan was intended to provide an overview of each office’s activities in the field of PRA. The PRA Implementation Plan was updated periodically until it was replaced by the Risk-Informed Regulation Implementation Plan (RIRIP). In 2007, the RIRIP was replaced by the Risk-Informed and Performance-Based Plan (RPP), which currently provides guidance and direction regarding the activities that the U.S. Nuclear Regulatory Commission (NRC) undertakes to integrate risk

information and performance measures into the agency's regulations, regulatory guidance, and oversight processes.

In the course of implementing the Commission's policy on the use of PRA, the NRC staff determined that changes in the infrastructure of its own organization could improve the efficiency and effectiveness of its implementation program. Consequently, the Office of Nuclear Reactor Regulation (NRR) initiated a program in 2001 with the objective of creating an environment within the regulatory organization that would foster integration of risk-informed methods into staff activities and development of staff plans and actions that are naturally based on the principles of risk-informed regulation. This program and its initial results were presented at the 2002 International Topical Meeting on Probabilistic Safety Assessment (PSA 2002) [1].

The goals of the program were first to understand the current environment, then address the weaknesses and build on the strengths. In 2001, NRR staff, with contract assistance from WPI, Inc., conducted interviews and focus groups with nearly 100 employees at headquarters and in all four regions. The goal of the discussions was to understand staff perceptions of risk informed regulatory practices in the reactor program. Respondents represented all professional levels within the reactor program (e.g., managers, engineers, PRA analysts, and inspectors), providing a broad array of perspectives and experience.

The evaluation resulted in several insights, as discussed in the PSA 2002 paper:

- NRC staff increasingly accepted a risk-informed approach in the reactor program.
- Debate had moved beyond whether risk insights should be integrated into activities to discussion of how and when to implement risk-informed approaches.
- NRC staff and managers varied widely in their understanding of and experience with risk-informed approaches, as well as their acceptance of them. Staff ranged from being experts at conducting PRAs to admitting a lack of familiarity with risk technology and applications.
- Barriers to implementation spanned a range of issues, including technical, organizational, communications issues, as well as levels of staff knowledge and experience.

In 2004, the project team developed a plan to create an environment in NRR that could better facilitate the inclusion of risk-informed approaches in the mainstream regulatory process. This plan included strategies for achieving its objective that were keyed to specific functional areas and specific tactics for implementing each strategy. The activities proposed in the plan were put on hold because of resource limitations.

In February 2006, the Office of the Inspector General (OIG) issued the results of the 2005 NRC Safety Culture and Climate Survey. These results demonstrated the need for additional efforts to enhance the risk-informed environment in the reactor program [2]. After analyzing responses from the 2269 employees who took the survey, the survey contractor provided this key opportunity for improvement:

“It appears from the results that the Agency's focus on the Regulatory Effectiveness Process, specifically questions related to risk-informed and performance-based regulation, has decreased since 2002. There is a significant increase in Question Mark [Don't Know/No Opinion] response to questions in this category.”

A second recent OIG report provides additional motivation to enhance the risk-informed environment [3]. Several of the “areas for consideration” in the report relate directly to the risk-informed environment:

- Consider developing and implementing training to address staffing changes, continuous staff development, and to bridge the gap between PRA and deterministic backgrounds.
- Develop a PRA strengths and limitations course and establish requirements for taking the course.
- Consider enhancing the current PRA Training program to explicitly address the relationship of deterministic, PRA, and risk-informed practices. In addition, this training should consider uncertainties and scope as noted above. Should also consider adapting some courses to video / electronic training media so that they can be offered more frequently.

2 ACTION PLAN

On December 11, 2006, the directors of NRR and the Office of New Reactors (NRO) jointly issued an action plan for fostering a risk-informed environment in reactor regulation. This plan identified actions that would help the two offices meet the Commission’s goals for establishing a risk-informed framework and address some aspects of the OIG reports.

The actions outlined in the plan focus on training and communications throughout the reactor regulation organization. Five actions were proposed:

1. Add units on risk-informed regulation to qualification plans.
2. Increase risk knowledge among first-line supervisors.
3. Educate NRR and NRO technical staff via enhanced formal training.
4. Provide an informal information resource with web-based training.
5. Exchange and manage knowledge on a web-based forum of expertise.

Since the plan was issued, each of these actions has been completed. The following sections describe each action in more detail.

2.1 Qualification Plans

The 2005 OIG survey indicated that employees were not receiving the appropriate processes, tools, and training to enable implementation of risk-informed regulation. Therefore, the first action was to integrate information on risk-informed regulation into technical staff qualification plans.

An individual study activity on risk-informed regulation was included in the qualification plans for technical staff in NRR and NRO. This activity provided staff with a list of references to review on the history and application of risk-informed regulation. Several evaluation criteria focus the qualifying employees’ study:

- Define: “risk,” “risk-informed regulation,” and “core damage frequency.”
- Discuss the NRC’s policy on the use of PRA in regulatory activities.

- Recall the Commission’s Quantitative Health Objectives that are defined in the NRC Policy Statement, “Safety Goals for the Operation of Nuclear Power Plants”—especially sections II and III (51 FR 30028).
- Explain how and why both deterministic and probabilistic approaches are used in risk-informed regulation.
- Discuss current risk-informed regulations or licensing initiatives and how they relate to your technical area.

As with all other qualification elements, employees discuss the study activity with their supervisors before receiving a signature. (Note that an alternative method for fulfilling the study requirements is now available in the form of formal training, as discussed in Section 2.3.) An oral qualification board at the end of the qualification process confirms employees’ knowledge of relevant regulatory subjects.

2.2 First-Line Supervisor Knowledge

Change is facilitated through strong, knowledgeable leadership that is able to engage in debate, educate staff, and justify changes. A first-line supervisor with a risk background can both share that expertise with staff and support the right balance of engineering judgment and risk analysis across the organization. According to a 2004 report on the risk-informed environment, employees have expressed the opinion that “having a [branch] chief who understood risk information and applications [is] important and rare” [4]. Therefore, the second action was to increase first-line supervisors’ familiarity with risk-informed regulation.

The original action called for revising NRR and NRO branch chiefs’ position description to reflect a baseline level of risk knowledge. Including risk elements in the elements and standards (E&S) for branch chief performance provides even more emphasis on the importance of risk knowledge. The current version of both position descriptions and E&S now includes risk elements. Managers can assess during the appraisal process whether first-line supervisors have an appropriate level of knowledge of risk-informed regulation. Additionally, managers and supervisors now have better opportunities to increase their knowledge through formal training, as discussed in Section 2.3.

2.3 Formal Training

The NRC has a series of detailed training courses for staff with PRA responsibilities, on topics from system modeling to human reliability analysis to accident progression. However, the only training class that was historically available to non-PRA technical staff was a three-day “PRA Basics for Regulatory Applications” course. This course explains PRA modeling in some detail without many direct applications of the information to daily NRC work. The content was originally designed for regional inspectors who use PRA information to prioritize inspections and assess the significance of findings. However, headquarters employees in various positions have been required to take the course in the past. As a result, many students stated in their course evaluations that “most attendees will not become ‘practitioners’ of PRA” and suggested more “conceptual understanding” and “what subject matter relates to what NRC job.” The students also suggested adding an NRC instructor who could focus more on real-life examples. It was clear to the NRC training staff that the introductory training could be revised.

To educate employees on applying risk assessment in regulation and (as recommended by OIG) “bridge the gap” between risk and traditional approaches, the third action was to create a new formal training course on risk-informed regulation for technical staff. An interoffice task group, with members from NRR, NRO, the Office of Nuclear Regulatory Research (RES), and the Technical Training Center (TTC), developed this training over six months in 2007. The resulting one-day course is entitled “Risk-Informed Regulation for Technical Staff.”

PRA experts at the NRC teach the class quarterly, covering subjects that include:

- The definition of risk-informed regulation
- Current and upcoming activities
- Fundamentals of risk assessment, emphasizing the underlying engineering analyses and assumptions
- Strengths and limitations of risk assessment, as recommended by the 2006 OIG evaluation
- Approaches for understanding uncertainty in risk assessments
- Risk-informed decision-making in the face of uncertainty
- Application of engineering insights derived from risk assessments
- Communication of risk information both internally and externally

The course has been offered seven times. Evaluations have been consistently positive, with many students commenting on the practicality of the course, usefulness of examples, and experience of the instructors.

Because of the success of this introductory course development, the interoffice task group also revised the PRA course for supervisors and managers, now entitled “Risk-Informed Regulation for Technical Managers.” The course formerly lasted two and a half days and focused on PRA modeling. The revised course lasts one day and covers much of the same material as the introductory course. Because the audience is different, there is a stronger focus on risk-informed decision-making, including an interactive decision-making exercise. The course has been offered twice and was praised by the supervisors and managers from NRR and NRO who attended. Along with the performance elements discussed in Section 2.2, the course will improve the overall knowledge level of office management.

2.4 Informal Training

Informal Web-based training is a convenient and efficient way of obtaining an overview of a new topic or reviewing the key points of a topic learned previously. Therefore, the fourth action was to develop informal training on risk-informed regulation as a ready reference when questions arise or new assignments are given. This action relates directly to the OIG recommendation that the NRC consider electronic training on risk.

The original action plan outlined several technical topics that should be addressed in a Web-based tutorial:

- Basic terms and concepts of probabilistic risk assessment and risk-informed regulation

- A general review of the risk assessment process (core damage, containment integrity, offsite consequences, etc.)
- Descriptions of risk-informed initiatives currently under development
- Procedures for specific technical review activities, such as the regulatory guides related to risk-informed licensing basis changes

NRR and NRO have cooperated in developing a series of “reactor regulation awareness seminars” for qualifying employees. A seminar entitled “Use of Risk Information in Regulatory Activities” is included in the series. The slides from this seminar cover all of the technical topics listed above and are available on the internal webpage dedicated to the seminars. The seminar was also recorded on video, and these videos are now available on the internal website to expand their accessibility to the entire agency.

Additionally, the NRC’s internal training website has been updated to include the course manuals for all of the risk assessment courses. The combined resources of these electronic media provide a wealth of information on risk-informed regulation in locations that staff can find easily. A subset of these introductory materials is available to the public on the NRC website at <http://www.nrc.gov/about-nrc/regulatory/risk-informed.html>.

2.5 Web-Based Community of Expertise

The simplest approach to both connect risk assessment experts with other technical staff and preserve lessons learned for future projects is to create a Web-based “community of expertise.” These websites allow threaded conversations on topics related to the forum. Any conversation can be grouped into its relevant subject areas for easy retrieval. Therefore, such resources provide both for knowledge transfer and knowledge management, both of which are important to the NRC’s fast-changing work force.

Such communities already existed on the NRR internal website for subjects such as inspection and operating experience. In the fall of 2006, the “@Risk-Informed Community” was added to the internal website, fulfilling the fifth action in the risk-informed environment plan. The forum includes subject areas related to various PRA elements, review guidance, and regulatory activities. The NRC staff has been encouraged to use the @Risk-Informed Community via various internal newsletters, the internal website, and all training courses and seminars on risk-informed regulation. Staff members continue to monitor the forum to ensure that questions are identified and answered quickly.

3 ADDITIONAL ACTIVITIES

Although the initial actions proposed by the 2006 risk-informed environment action plan have all been completed, continuing attention is necessary to maintain a risk-informed environment.

To ensure the success of the initiative, several actions are currently being pursued:

- An upcoming revision to the qualification program will include “Risk-Informed Regulation for Technical Staff” in the list of required training courses, with the study activity available as an alternative if the course is not offered.

- Supervisors will encourage experienced staff to attend “Risk-Informed Regulation for Technical Staff,” even if they were not required to complete the qualification process.
- Supervisors and managers are encouraged to take “Risk-Informed Regulation for Technical Managers” as a refresher on risk-informed regulation and its current applications.
- Supervisors will encourage staff to use web-based course material and the @Risk Informed Community forum to improve their knowledge of risk-informed regulation.

In addition, the recent development of “risk insights” for new reactor reviews shows the risk-informed environment in action. These risk insights, prepared by NRO staff for each new reactor design under review, are used in conjunction with the Standard Review Plan (SRP) to focus new reactor reviews on safety-significant issues. NRO risk analysts identified design features and assumptions related to various SRP sections and systems, as well as important equipment failures and human actions. Risk analysts presented the insights to technical staff in a series of meetings, focusing on topics relevant to the individual technical branch’s review responsibility. Reviewers were told how the use of risk insights improves the quality and effectiveness of the safety review. As a result, NRO has observed an increase in communication between the risk staff and other technical reviewers seeking information on the risk significance of issues they discover during their review.

4 CONCLUSIONS

Fully implementing a risk-informed approach in nuclear reactor regulation requires significant cultural change to integrate the historically distinct “deterministic” and “probabilistic” categories of technical work. The actions described above represent a continued effort to establish a risk-informed environment at the NRC. Training and communication ensure that both technical staff and managers understand the motivation for and application of risk-informed applications. These activities, especially the one-day course for technical staff and the personalized presentations to new reactor review branches, have been well received by the participants. The NRC expects the cultural change to continue as more staff receives training on risk-informed regulation and sees its positive impact on their daily work. As a result, the agency will more efficiently protect people and the environment, as envisioned by the PRA Policy Statement.

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