VOLUME 2: APPENDIX I

RISK INFORMING THE MATERIALS AND WASTE ARENAS:

A Case Study on the Seismic Exemption for the
DOE/INEEL Three Mile Island - Unit 2 Fuel Debris
Independent Spent Fuel Storage Installation

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ABSTRACT

As a part of the effort to risk-inform regulation in the nuclear material and waste arenas, the NRC staff identified candidate regulatory applications within the Office of Nuclear Material Safety and Safeguards (NMSS) and used them as case studies to test screening criteria and develop safety goals. To illustrate what has been done and what could be done to risk-inform the regulatory approach to spent nuclear fuel storage, the staff examined the storage of the Three Mile Island Unit 2 (TMI-2) spent fuel debris at the Department of Energy (DOE) Idaho National Engineering and Environmental Laboratory (INEEL) site. The report follows the outline in the Case Study Plan that was developed by the NMSS Task Group. This report discusses the use of risk information in spent fuel debris storage at TMI-2 and the preliminary responses to the Draft Questions for Case Studies and the Draft Screening Criteria.

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1. INTRODUCTION

In Commission Paper SECY-99-100, “Framework for Risk-Informed Regulation in the Office of Nuclear Material Safety and Safeguards,” dated March 31, 1999, the staff of the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards (NMSS), proposed a framework for risk-informed regulation in the nuclear materials and waste arenas. The Commission approved the staff's proposal and directed the staff to develop appropriate safety goals for these arenas, and to use an enhanced participatory process that includes regular public meetings with all stakeholders who are involved in or affected by regulation of these arenas. At the first such meeting, the NRC staff suggested that screening criteria were needed to identify issues for which risk information would be productive. The staff further suggested that the development of safety goals and screening criteria would be enhanced by studying actual regulatory cases in the materials and waste arenas, to see how risk information was, or could have been, used. The NMSS staff adopted this suggestion and, as part of the overall risk-informing effort, is conducting case studies of a spectrum of activities in the nuclear materials and waste arenas, including the transportation of radioactive materials.

1.1 Objectives and Approach

The NMSS staff will consolidate the results of this case study with those from the other case studies to further the following objectives:

(1) Produce final screening criteria for the materials and waste arenas.

(2) Illustrate how the application of risk information has improved or could improve particular areas of the regulatory process in the materials and waste arenas.

(3) Determine the feasibility of safety goals in the particular areas studied. If feasible, develop safety goal parameters and a first draft of safety goals. Otherwise, document the reasons why this is infeasible.

(4) Identify methods, data, and guidance needed to implement a risk-informed regulatory approach.

It is not an objective of this or any other case study to reconsider the regulatory actions that the NRC took in the case being studied. The objectives are strictly those listed above.

The NMSS staff is conducting all of its case studies using a standardized approach. The case studies are largely retrospective; that is, they involve regulatory and physical actions that the NRC has already taken. Each case is studied by a member of the NMSS Risk Task Group or a contractor with risk expertise. Advisors include subject matter experts from the NRC staff who have knowledge of the particular case. The reviewers also consult with licensees and other stakeholders having knowledge of the particular case.

The basis for each case study is the review of information from NRC and licensee source documentation, through which the staff answers a standardized list of questions that address aspects of the four objectives listed above. After the investigative phase of the study, the NMSS staff generates a set of preliminary conclusions on the basis of the answers to these questions. The staff then presents its preliminary conclusions at a public meeting in which all stakeholders are invited to participate. For this case study, a public meeting was held on July 31, 2001. The meeting transcript[(1)] is given in the reference section. After incorporating information and ideas that emerge from this meeting, the NMSS staff produces a report documenting the case study. This document is one such case study report. In addition, the NMSS staff will consolidate the results from all of the case studies to prepare a final summary report.

1.2 Scope of Case Study

The storage of spent nuclear fuel is one of the eight case study areas selected for analysis. The subject of this case study is the storage of the Three Mile Island Unit 2 (TMI-2) spent fuel debris at a Department of Energy (DOE) Idaho National Engineering and Environmental Laboratory (INEEL) independent spent fuel storage installation (ISFSI) facility. The TMI-2 spent fuel debris has been stored in an INEEL spent fuel pool since 1985. To move the nuclear fuel out of the state, DOE and the State of Idaho entered the Idaho Settlement Agreement,[(2)] by which DOE agreed to move the TMI-2 fuel debris from the spent fuel pool to a dry storage facility on site. DOE, as the licensee, submitted an application to NRC to construct an ISFSI for storage of the TMI-2 spent fuel debris in 1996. Based on the results from both deterministic and probabilistic seismic hazard analyses, DOE requested an exemption to the 10 CFR 72.102 (f)(1) seismic requirements for the proposed TMI-2 ISFSI at INEEL in 1997. NRC reviewed the request and granted the exemption in 1998.

1.3 Organization of the Report

This case study covers the seismic exemption to 10 CFR 72.102(f) for the DOE TMI-2 ISFSI at INEEL. In particular, the case study focuses on the risk information used to grant the seismic exemption. This is one of the first spent fuel storage licensing activities for which NRC utilized risk information to provide a safe alternative to the existing regulations.

Section 2 contains background information on the seismic design requirements for an ISFSI. Section 3 discusses the case study approach. Sections 4 and 5 contain the preliminary responses to the Draft Case Study and Draft Screening Criteria Questions, respectively. Section 6 summarizes the storage case study and the preliminary conclusions drawn from the study. Finally, Section 7 lists the references used in this study.

2. BACKGROUND

The TMI-2 reactor near Harrisburg, Pennsylvania, experienced an accident in March 1979. As a result, part of the reactor fuel melted and became fuel debris. The TMI-2 spent fuel debris was transferred from the reactor site to a DOE INEEL spent fuel pool in 1985. The spent fuel pool, constructed in the 1950s, did not meet the standards of the current DOE Order 420.1 "Facility Safety". Major deficiencies were the lack of redundant containment of pool water and no provision for detecting leakage from the pool.

In an effort to improve spent fuel storage safety, DOE proposed to build a dry cask storage facility to store the TMI-2 spent fuel debris. This dry cask storage facility would be located at another part of INEEL site, approximately 10 miles from the nearest site boundary. Putting the TMI-2 fuel debris into dry storage supported the Idaho Settlement Agreement between DOE and the State of Idaho, which intended to move all spent fuel from the DOE INEEL out of Idaho by 2035. Consequently, in accordance with 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste", DOE submitted a TMI-2 ISFSI license application to NRC in 1996. A year later DOE requested an exemption to the seismic design requirements of 10 CFR 72.102, "Geological and Seismological Characteristics" for the TMI-2 ISFSI.

Paragraph (b) of 10 CFR 72.102 requires that seismicity evaluations of sites located west of the Rocky Mountain Front be conducted pursuant to Appendix A of 10 CFR Part 100. Paragraph (f)(1) of 10 CFR 72.102 states: "For sites that have been evaluated under the criteria of Appendix A of 10 CFR Part 100, the DE (*design earthquake*) must be equivalent to the safe shutdown earthquake (SSE) for a nuclear power plant." The reason that an ISFSI should be designed using seismic design requirements equivalent to the requirements for a nuclear power plant (NPP) is that when Part 72 was first promulgated in 1980, ISFSIs were expected to be spent fuel pools or single massive dry storage structures. If this were the case, it would be appropriate to require that the seismic design requirements for an ISFSI be equivalent to those for a NPP. However, the Statements of Consideration (SOC) did address the use of ISFSIs that were not massive structures, such as dry storage casks and canisters. The SOC stated that the design earthquake for such facilities would "be determined on a case-by-case basis until more experience is gained with the licensing of these types of units." Since that time, most ISFSIs have been designed using dry casks that are passive and typically more robust than spent fuel pools. Dry storage casks do not require retention of water to maintain shielding and confinement of spent nuclear fuel after an earthquake.

If DOE/INEEL TMI-2 ISFSI were designed for the 10 CFR 72.102 requirements, then it should be designed to withstand an SSE of an NPP, as evaluated by deterministic methods of Appendix A of 10 CFR Part 100. A deterministic evaluation yields an SSE magnitude based on the local fault conditions irrespective of the frequency (return period) of an earthquake. For the DOE/INEELTMI-2 ISFSI site, the SSE peak ground acceleration (PGA) is 0.56 g,[3] where g is the acceleration of earth's gravity.

In addition to the deterministic seismic hazard assessment studies, DOE also commissioned several probabilistic seismic hazard assessment (PSHA) studies near the TMI-2 ISFSI location. A PSHA takes the earthquake frequency into consideration and predicts earthquakes of different magnitudes at various return periods (frequencies). For example, based on a 1996 PSHA,[4] an earthquake with a 2,000-yr return period has a PGA of 0.3 g.

Instead of designing the TMI-2 ISFSI with an SSE magnitude of 0.56 g, DOE proposed a design earthquake of 0.36 g acceleration to conform to the DOE INEEL internal Architectural and Engineering Standards.[5] DOE justified the use of a lower acceleration for the TMI-2 ISFSI by arguing that (1) the risk of dry cask storage of spent nuclear fuel is inherently lower, and (2) the public exposure rate at the site boundary in the event of a nonmechanistic release of radioactive material would be below regulatory limit. DOE estimated that the dose to a member of public would be 75 mrem at the site boundary in the event of a nonmechanistic release of the radioactive material upon the failure of a spent fuel canister.[6] This is well below the regulatory limit of 5 rem accident exposure (10 CFR 72.106(b)).

Based on its in-house review of the DOE's seismic exemption request and an independent evaluation by the Center for Nuclear Waste Regulatory Analyses,[7] NRC granted the exemption to DOE in 1998.[7] The TMI-2 spent fuel debris was moved from the spent fuel pool to the dry storage ISFSI between 1999 and 2001. The fuel was largely moved on INEEL site roads not accessible to the public. Hence, issues related to transportation of the nuclear fuel were not considered in this case study.

NRC staff recognized the need to revise the 10 CFR Part 72 seismic requirement to allow the use of PSHA in seismic evaluations of an ISFSI. The revision was needed because 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," permits the use of PSHA in the seismic evaluation of an NPP. The Rulemaking Plan (SECY-98-126) to incorporate the use of PSHA in the seismic criteria for Part 72 and conform with 10 CFR Part 50 seismic requirements was approved by the Commission. Currently, staff is in the process of proposing to the Commission to modify certain aspects of SECY-98-126 to account for lower risks in a dry cask storage facility than in an operating NPP. The Commission is currently evaluating this proposal.

It should be noted that, had PSHA been allowed at the time of the exemption to 72.102(f)(1), the TMI-2 ISFSI would have been either designed to a 0.47 g PGA (for a 10,000-yr return period earthquake) if it were treated as a building-like NPP, or to a 0.30 g PGA (for a 2,000-yr return period earthquake) if treated as a cask-based ISFSI. The 0.36 g PGA value selected by DOE exceeded the 0.3 g PGA value for a 2,000-yr return period earthquake in the proposed revised 10 CFR Part 72.

3. CASE STUDY APPROACH

This case study comprised (1) a staff review of pertinent documents, (2) a field visit to the TMI-2 ISFSI location, and (3) interviews with key DOE, NRC, and contractor staff members and local news media personnel.

The documents reviewed included, but were not limited to, (1) SECY-98-071, “Exemption to 10 CFR 72.102(f)(1) Seismic Design Requirement for Three Mile Island Unit 2 Independent spent Fuel Storage Installation,[8] (2) the DOE Safety Analysis Report,[9] (3) the TMI-2 Material License,[10] which included the safety evaluation report, and (4) the environmental impact statement report.[11] The staff interviewed included the former NRC TMI-2 project manager and the NRC seismic subject matter expert, the DOE licensing manager and facility manager, the INEEL contractor seismic subject area expert. News media personnel interviewed included staff from the local Channel 8 News (ABC affiliate) and the Post Register (a local newspaper), both of which are based in Idaho Falls, ID.

4. PRELIMINARY RESPONSES TO DRAFT CASE STUDY QUESTIONS

4.1 Screening Criteria Analysis/Risk Analysis Questions

(1) What risk information is currently available in this area? (Have any specific risk studies been done?)

Because DOE INEEL used to be the home of the Navy Nuclear Program, the site has been relatively well characterized in the seismic area. Numerous deterministic and probabilistic seismic hazard analyses have been performed at various locations throughout the site since the 1970s.[3,4 , and 12 - 18] Two of them[3,4] deserve special mention: The first Woodward-Clyde Federal Services (WCFS) study[3] (1996) was based on a deterministic approach that resulted in a design earthquake peak ground acceleration value of 0.56 g for the TMI-2 ISFSI. The second WCFS study,[4] also conducted in 1996, reported a DE PGA value of 0.3 g for a 2,000-yr return period earthquake at the TMI-2 ISFSI location.

(2) What's the quality of the study? (Is it of sufficient quality to support decision-making?)

The studies were of sufficient quality. Generally speaking, however, reports completed before 1990 [12 - 18] covered multiple areas of the INEEL and were not specific to TMI-2 ISFSI site. The empirical formulae used in those studies were less precise. The post-1990 studies were more site-specific and included sensitivity analyses that could isolate the contribution to the total seismic hazard from various potential sources.[7]

(3) What additional studies would be needed to support decision-making and at what cost?

Sufficient quality seismic studies at or near the TMI-2 ISFSI were available at the time for NRC to make a risk-informed decision regarding granting the seismic exemption to DOE. In the future, if a seismic exemption for another ISFSI were submitted to NRC for approval, it will be necessary to gather additional seismic data specific to the location of interest to support an NRC decision.

The costs of collecting site-specific data vary from site to site and are difficult to predict a priori. Judging from the DOE/INEEL TMI-2 fuel debris ISFSI and other nuclear facilities built around the countries, the collection of pertinent data for seismic hazard analysis could be done at a reasonable cost. Generally speaking, costs vary from $100,000 to $500,000 (in 2001 dollars) per analysis depending on the location of the site.

(4) How is/was risk information used and considered by the NRC and licensee in this area?

The licensee (DOE) had used the results of probabilistic seismic hazard studies (0.3 g for an earthquake with 2,000-yr return period) and the potential consequences of a seismic event to justify the PGA value (0.36 g) selected for the TMI-2 ISFSI site. NRC considered the probability of earthquakes within different time frames (return periods) in combination with possible dose consequences.

NRC's finding of adequate protection of public health and safety with the lower acceleration (0.36 g) for this facility was based on several considerations:

(i) The spent fuel cask was designed to maintain confinement of the fuel inside the cask at a PGA of 0.36 g.

(ii) DOE's design criterion of 0.36 g was conservative because it exceeded the 0.3 g PGA for an earthquake with a 2,000-yr return period as evaluated using state-of-art PSHA techniques. The 0.3 g PGA for an earthquake with a 2,000-yr return period will be the PGA value for this ISFSI if the proposed 10 CFR Part 72 revision is accepted by the Commission.

(iii) The use of a 2,000-yr return period earthquake for an ISFSI, instead of the 10,000-yr return period for an NPP under 10 CFR Part 50, was acceptable because the consequences of a radiological release resulting from a postulated damage to an ISFSI following an earthquake were far smaller than at an NPP.

(5) What is the societal benefit of this regulated activity?

The spent fuel debris was moved from an active storage system (spent fuel pool) to a passive and inherently safe one (dry cask storage). Also, an ISFSI designed to a lower acceleration value is less costly to the licensee (and hence the tax payers of the country) than a facility designed to a higher acceleration value.

Additionally, removing the fuel from the spent fuel pool also supported the overall Idaho Settlement Agreement and minimized the adverse consequences of ground water contamination as a result of a potential spent fuel pool water leakage.

(6) What's the public perception/acceptance of risk in this area?

The public perception/acceptance of risk associated with nuclear fuel handling and movement was generally positive in Idaho Falls and surrounding areas due to the historical tie between the local community and the INEEL site. According to local newspaper and TV station reporters, local readers and viewers were largely mute about the TMI-2 ISFSI despite the fact that this event had been covered several times in the news. Similarly, environmental activists from neighboring communities (e.g., Sun Valley or Jackson Hole, Wyoming) were generally silent regarding the same issue.

(7) What was the outcome when this application was put through the draft screening criteria? Did this application pass any of the screening criteria? Does the outcome seem reasonable? Why or why not?

This spent fuel storage activity passed through all the draft screening criteria (see Section 5 for further discussion). The outcome looks reasonable because NRC made a decision based on risk information available at the time.

4.2 Safety Goal Analysis Questions

(1) What is the basis for the current regulations in this area (e.g., legislative requirements, international compatibility, historical events, public confidence undermined, etc.)?

The basis for the current Part 72 regulations in the seismic area is that the risk level at a spent fuel storage facility is same as an operating NPP. The requirements are based on using a deterministic method for seismic hazard analysis. However, the seismic requirements for an NPP have been changed to require a PSHA.

(2) Are there any explicit safety goals or implicit safety goals embedded in the regulations, statements of considerations, or other documents (an example would be the acceptance of a regulatory exemption based in part on a risk analysis and the outcome)?

No explicit safety goals were found in the current regulation 10 CFR Part 72. However, the Part 72 Statement of Consideration(19) states: "For ISFSIs which do not involve massive structures, such as dry storage casks and canisters, the required design earthquake will be determined on a case-by-case basis until more experience is gained with the licencing of these facilities." This sentence implicitly recognizes the fact that for an ISFSI, seismic criteria different from those for a NPP are reasonable.

The essence of a PSHA is that it incorporates uncertainties and consequences in earthquake hazard analysis. Consequently, one possible safety goal is that the magnitude of radiation exposure to humans should be lower for more frequently occurring events with smaller magnitudes (e.g., an earthquake with a 2,000-yr return period). Conversely, the radiation exposure to humans could be higher for a less frequently occurring event (e.g., an earthquake with a 10,000-yr return period) with a larger magnitude. Regardless of the frequency of an event, all exposures must be less than the regulatory limits (10 CFR 20.1201(a)(1) for workers and 10 CFR 72.104 (a) and 106(b) for the public).

In this particular case, the licensee performed a bounding calculation to show that maximum offsite radiological exposure rate during a nonmechanistic release scenario was at least an order of magnitude lower than the regulatory limit.(6) A nonmechanistic release is a release that does not depend on any driving force (e.g., an earthquake, etc.) at the same time. Such a release is analogous to a spontaneous failure of a fuel canister confinement boundary and releasing material. NRC deemed the protection to be adequate due to the absence of any credible mechanism for releasing the fuel contents.

(3) What was the basis for the development of the strategic goals, performance goals, measures, and metrics? How are they relevant/applicable to the area being studied and how do they relate to or compare with the regulatory requirements? How would they relate to safety goals in this area?

The present design earthquake (equivalent to the SSE for an NPP) has a mean annual probability of exceedance of approximately 1.0E-04[1]. The NRC staff has determined that for new ISFSI facilities, a design earthquake with a mean annual probability of exceedance of 5.0E-04 (i.e. an earthquake with a return period of 2,000 yr) is appropriate. In comparison with a nuclear power plant, an operating ISFSI facility is a relatively simple facility in which the primary activities are waste receipt, handling, and storage. An ISFSI facility does not have the variety and complexity of active systems necessary to support an operating nuclear power plant. After the spent fuel is in place, an ISFSI facility is a static operation. During normal operations, the conditions required for the release and dispersal of significant quantities of radioactive materials are not present. There are no high temperatures or pressures present during normal operations or under design basis accident conditions to cause the release and dispersal of radioactive materials. This is primarily due to the low heat-generation rate of spent fuel that has undergone more than one year of decay before storage in an ISFSI, and to the low inventory of volatile radioactive materials readily available for release to the environs. The long-lived and potentially biologically hazardous materials present in spent fuel are tightly bound up in the fuel materials and are not readily dispersible. The short-lived volatile nuclides, such as I-131, are no longer present in aged spent fuel. Furthermore, even if the short-lived nuclides were present during an event of a fuel assembly rupture, the canister surrounding the fuel assemblies would confine these nuclides. Therefore, the radiological risk associated with an ISFSI facility is significantly less than the risk associated with an NPP and the use of a lower design earthquake ground motion is justified (0.56 g vs. 0.3 g).

(4) Are there any safety goals, limits, or other criteria implied by decisions or evaluations that have been made that are relevant to this area?

A possible quantitative criterion for ISFSIs implied by the decision is as follows: Had the proposed revised 10 CFR Part 72 been in place at the time of the TMI-2 seismic exemption request in 1998, this ISFSI would have been designed with a PGA capable of withstanding an earthquake with a 2,000-yr return period. A 2,000-yr event can be roughly converted to an event with 5E-4 annual frequency. This implies that for a passive ISFSI (i.e., canister and casks), any seismic event exceeding the design criteria should have a mean annual probability of exceedance of 5E-4 or less.

The rationale for the proposed mean annual probability of exceedance of 5.0E-04 (return period of 2,000 years) for a design earthquake is based on several points:

[1]The mean annual probability of exceedance, p, of an event is the reciprocal of the return period of that event (i.e.,, p = 1/t). As an example, the mean annual probability of exceedance of an earthquake with a return period of 10,000 years is 1E-04 (1/10,000).

- The critical element for protection against radiation release is the confinement boundary for containing the spent fuel assemblies. Because the casks are rigid and have high natural frequencies, the damage from a drop or tip-over accident is expected to be far greater and more severe than the seismic inertial acceleration loads. Therefore, seismic inertia loads are bounded by other loads. The dry storage cask designs are very rugged and robust, and are expected to have substantial design margins to withstand forces from a seismic event greater than the design earthquake.

- During a seismic event, a cask may slide if lateral seismic forces are greater than friction resistance between the cask and the concrete pad. The sliding and resulting displacements are computed by the applicant to demonstrate that the casks, which are spaced to satisfy thermal requirements, are precluded from impacting other adjacent casks. Furthermore, the applicant is required to demonstrate that during a seismic event equal to the proposed design earthquake, the cask will not tip over. However, it follows from the discussion above that even if the casks slide or tip-over and then impact other casks or the pad during a seismic event greater than the proposed design earthquake, the casks have adequate design margins to ensure that they maintain their structural integrity to meet the Part 72 exposure limits for radiological protection.

- The total probability of exceedance for a design earthquake at an ISFSI facility with an operational period of 20 years (20 years x 5.0E-04 = 1.0E-02) is the same as the total probability of exceedance for an earthquake event at the proposed pre-closure facility at Yucca Mountain with an operational period of 100 years (100 years x 1.0E-04 = 1.0E-02).

(5) If safety goals were to be developed in this area, would tools/data be available for measurements?

Yes, the PSHA techniques are mature enough to be used for other storage applications. For example, in the future when another site is selected for spent fuel storage, seismic studies analogous to the INEEL design basis earthquake (DBE) evaluation[21] may be conducted using the site-specific seismic data.

(6) Who are/were the populations at risk?

Two types of populations are at risk in/near a spent fuel storage area: workers and general public. Workers are subject to industrial and radiological hazards during the handling, movement, and storage of the spent fuel, whereas the public is subject to radiological hazards from accidental releases of the radioactive material. It should be noted that the latter risk is minimal due to the large distance of the DOE/INEEL TMI-2 ISFSI from any nearby populations. However, it was the lack of credible mechanisms for releasing the fuel contents and the confinement integrity, not the remoteness of the site, that were the main factors that persuaded the NRC to grant the seismic exemption.

(7) What are/were, and what could be/have been, the various consequences to the populations at risk?

As stated previously, the offsite exposure limit for a member of public during an accident was estimated to be 75 mrem[(5)] (based on a non-mechanistic release scenario), well below the 10 CFR Part 72 limit of 5 rem (10 CFR 72.106(b)). Therefore, the radiological consequences for general public, if any, are believed to be minimal. The consequences from the industrial hazards for the workers were not analyzed in this case study because industrial hazards are covered under the licensee's (DOE's) internal health and safety program. The radiological protection for workers was covered under the 10 CFR Part 20 (10 CFR 20.1201(a)(1)). The staff found the DOE's occupational radiation safety program to be acceptable; therefore, these consequences were not analyzed in this case study.

(8) What parameters should be considered for the safety goals (e.g., workers vs. public, individual vs. societal, accidents vs. normal operations, acute vs. latent fatality or serious injury, environmental and property damage)?

All the parameters should be given due consideration when formulating safety goals. It should be noted that the overall risk is dominated by the worker risks (radiological and industrial) because radiological risk to the general public is minimal due to the large distance of the TMI-2 ISFSI from the public.

(9) On the basis of the answers to the questions above, would it be feasible to develop safety goals in this regulatory areas?

Yes, preliminary study thus far indicates that it is feasible to develop generic safety goals in the spent fuel storage area. The changes to 10 CFR Part 72 regulations to reflect the seismic exemption have been proposed by the staff.

(10) What methods, data results, safety goals, or regulatory requirements would be necessary to make it possible to risk-inform similar cases?

The current regulation (10 CFR Part 72) only accepts deterministic seismic evaluations for ISFSI applications. Revising the current regulation accept PSHA evaluations will make future ISFSI applications more efficient because no seismic exemptions would be necessary. However, it should also be noted that this case study only focuses on the seismic area, which is only one aspect of the overall licensing process for an ISFSI application. If the purpose is to risk-inform the entire ISFSI licensing process, then additional tools, data, and methods may be needed to achieve that goal depending on the area under consideration.

4.3 Questions upon Developing Draft Safety Goals

The Commission established two qualitative safety goals applicable to the reactor safety strategic arena (51 FR 30028):

- Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

- Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

Subsequently, the Commission directed the staff to develop safety goals for the nuclear materials and waste strategic arenas analogous to the reactor safety goals (SECY-99-100).

As stated, one of the objectives of the case studies is to determine the feasibility of safety goals and, if feasible, develop safety goal parameters and a first draft of safety goals. The previous set of ten questions, and the following set of five questions, address this objective. In answering the previous set of questions (specifically, question 2 of the Safety Goal Analysis Questions), implicit and explicit safety goals were identified. These goals were embedded in regulations and other documents specific to this case study. However, they seem to fall into a general set of qualitative safety goals which have broader materials and waste applications:

- Nuclear materials use and disposal should not pose a significant additional risk to life and health of individual members of the public, and to workers associated with these activities.

- Societal risks to life and health from nuclear materials use and disposal should not be a significant addition to other societal risks.

- Nuclear materials use and disposal should not result in environmental or property damage in excess of other means of achieving a similar end objective that is deemed beneficial to society.

Thus, for the purpose of answering the following set of five questions, these preliminary draft qualitative safety goals were considered. These preliminary draft safety goals are generally analogous to the reactor safety goals, but have been developed to include worker safety, and protection of the environment. It is stressed that these draft safety goals are preliminary and will likely be modified in the near future, but are presented to focus attention and prepare answers to the set of case study questions that follow.

1. Are the current regulations sufficient in that they reflect the objective of the draft goals? Would major changes be required?

Yes, the current regulations are sufficient to achieve the objectives of the draft safety goals and do not need additional major changes as far as the first two safety goals are concerned. The regulations for an ISFSI may not completely address the environmental and property damage aspects of the goals.

If the storage safety goals ultimately tie the consequences of an event (e.g., an earthquake) to its frequency, then the current 10 CFR Part 72 needs to be revised to reflect this change from a deterministic view to a probabilistic view. As mentioned earlier, staff has proposed to revise 10 CFR Part 72 to incorporate PSHA results in future ISFSI applications so Part 72 will be in line with 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." From the perspectives of risk and regulatory consistency, it makes sense to revise the current regulations.

2. Would the regulations need to be tightened?

On the contrary, the current regulations could be relaxed if Part 72 is revised to accept PSHA results. If PSHA results were accepted, the design earthquake could be lowered to better reflect the risk level. As the TMI-2 fuel debris seismic exemption shows, the licensee was required to design the facility using a seismic requirement equivalent to that of an NPP (i.e., PGA = 0.56 g); after the exemption, the facility was designed to withstand an earthquake with an acceleration of 0.36 g. However, if the environmental and property damage goal is adopted, the regulations may need to be further developed to reflect this objective.

3. Are the regulations overly conservative and/or too prescriptive with respect to the goals?

Yes, the current regulations (10 CFR Part 72) are overly conservative with respect to the seismic design requirements. The conservatism of current regulations in other areas of Part 72 was not evaluated in this case study.

4. If these were the safety goals, what decisions would be made?

The Commission would probably agree to the revision of the current 10 CFR Part 72 to allow the use of PSHA in future ISFSI applications if one of the safety goals tied the consequences of an event to the frequency of that event. The goals would be helpful to the staff in making decisions that are consistent and commensurate with the seismic risk the storage facility presents.

5. Would these goals be acceptable to the public?

At the Stakeholders Meeting held on October 25, 2001, there was general agreement by the stakeholders that NRC should proceed with development of safety goals in the nuclear materials and waste arenas. The goals presented in this section are cast in a framework similar to the one that has been in existence for over 15 years for nuclear power plants.

5. DRAFT SCREENING CRITERIA

5.1 Application of Draft Screening Criteria to the Spent Fuel Storage Area

The draft screening criteria were developed by the staff and revised on the basis of comments received at a public workshop, public meetings, and discussions with the NMSS Risk Steering Group. The revised draft screening criteria and preliminary responses, as they apply to the storage of TMI-2 spent fuel debris storage, are as follows:

(1) Would a risk-informed regulatory approach help to resolve a question with respect to maintaining or improving the activity's safety?

By analyzing the ISFSI at 0.36 g instead of .56 g, the licensee reduced the requirements of robustness for the ISFSI; however, based on the informed judgement of the staff and the Commission, the licensee's proposed activity still provided an adequate level of safety and only a small, but tolerable, increase in risk.

(2) Could a risk-informed regulatory approach improve the efficiency or the effectiveness of the NRC regulatory process?

Yes, regulatory efficiency and effectiveness were enhanced with the seismic exemption that allowed the licensee to design its facility using realistic PGA value (rather than an overly conservative acceleration number). However, granting an exemption to the current regulation invariably required more resources.

(3) Could a risk-informed regulatory approach reduce unnecessary regulatory burden for the applicant or licensee or the NRC?

Yes, unnecessary regulatory burden was reduced because the licensee was able to construct its facility with a more realistic acceleration value.

(4) Would a risk-informed approach help to effectively communicate a regulatory decision or situation?

Yes, this exemption puts risk in perspective. An ISFSI has fewer source terms and lower risk than an active NPP. Consequently, an ISFSI can be designed to withstand an earthquake with a 2,000-yr return period (as opposed to an earthquake with a 10,000-yr return period for an NPP).

(5) Do information (data) and analytical models exist that are of sufficient quality or could they be reasonably developed to support risk-informing a regulatory activity?

Yes, proprietary probabilistic seismic modeling techniques are accepted by the technical community as valid tools to generate site response data. Naturally, the techniques can be refined as more data and expertise are developed.

(6) Can startup and implementation of a risk-informed approach be realized at a reasonable cost to the NRC, applicant or licensee, and/or the public, and provide a net benefit? The net benefit will be considered to apply to the public, the applicant or licensee, and the NRC. The benefit to be considered can be improvement of public health and safety, improved protection of the environment, improved regulatory efficiency and effectiveness, improved communication to the public, and/or reduced regulatory burden (which translates to reduced cost to the public.)

Qualitatively speaking, the answer is yes. The licensee estimated savings from constructing an ISFSI with a lower acceleration value to be in the millions of dollars, although no specific dollar figures were available. Further savings are anticipated if the licensee builds additional ISFSI facilities elsewhere in the DOE complex.

Aside from the monetary savings, there was another benefit for the licensee and the public: protection of the environment. As stated earlier, once the fuel was out of the spent fuel pool, the risk of ground water contamination by the nuclides from the pool in the event of a leakage was greatly reduced.

(7) Do other factors exist (e.g., legislative, judicial, adverse stakeholder reaction) which would preclude changing the regulatory approach in an area, and therefore, limit the utility of implementing a risk-informed approach?

No precluding factors were identified in the case study.

5.2 Outcome of Applying Draft Screening Criteria

This case study passed all screening criteria. The draft screening criteria appeared to be effective in screening a potential application for risk-informing. To make better use of the screening criteria, it is suggested that the flow chart for criteria 5 and 6 be modified to read: "If the answer to criterion 5 (or 6) is yes, proceed to additional criteria; if not, the activity may be screened out pending the outcome of other criteria." Essentially, this modification allows the user to look at the screening criteria in their entirety and make a decision based on all the screening criteria.

6. SUMMARY AND CONCLUSIONS

The conclusions are organized to address the four objectives of the case studies as numbered below.

1. What did the case study say about the effectiveness of the screening criteria?

The seven draft screening criteria appeared to be effective in either retaining or screening out activities in the material and waste areas. A suggestion was that the screening criteria be modified slightly so all seven criteria can be considered in their totality.

2. What insights did the case study provide about the current and potential value of using risk-information? What process improvements could be made to facilitate applying risk information in similar situations?

Risk information was used to support granting an exemption to the seismic design requirements in 10 CFR 72.102. In this case, the use of risk information helped the staff to make a decision that was, in retrospect, in keeping with the Agency's current strategic goals.

This case study reinforced staff's belief that 10 CFR Part 72 needs to be revised to accept the PSHA results for future ISFSI applications. The case study also illustrated the feasibility of using risk information, to supplement the current deterministic approach, in evaluating future ISFSI applications, particularly in the seismic area.

3. What did the case study say about the feasibility and utility of safety goals? What were the implicit/explicit safety goals or elements?

The TMI-2 ISFSI seismic exemption decision made by NRC was based on risk information. No explicit safety goals were found in the current regulations in the spent fuel storage area. However, implicit safety goals can be inferred from regulatory documents and decisions. One possible spent fuel safety goal might be that the mean annual probability of exceeding a natural event challenging the safety system of an ISFSI may be established as 5E-4. Another possible safety goal could be that the human exposure to radionuclides should be lower for more frequently occurring events with smaller magnitudes and higher for a less frequently occurring event with a larger magnitude.

Three tiers of safety goals similar to the Reactor Safety Goals may be devised. The first two tiers might be general qualitative and quantitative safety goals that are applicable to all material and waste areas. The third tier of safety goal might be application-specific.

In developing safety goals for dry cask storage, it should be noted that the Statements of Considerations for 10 CFR Part 72 recognized the risks of dry cask storage were lower than those at an operating nuclear power plant.

4. What insights did the case study provide on the information, tools, methods, guidance needed for a risk-informed regulatory approach in this specific case study area and (if possible) in other similar regulatory areas?

Deterministic and probabilistic seismic studies have been performed at various locations throughout the Idaho National Engineering and Environmental Laboratory site. These studies were of sufficient quality to characterize seismicity of the site and support DOE's application. Sophisticated probabilistic hazard analysis tools are available to the practitioners if another ISFSI application is submitted to the NRC for evaluation. However, site-specific data is always necessary before meaningful conclusions can be drawn from the studies.

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