POLICY ISSUE
INFORMATION

SECY-00-0182

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FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: TECHNICAL REPORT ON A PERFORMANCE ASSESSMENT METHODOLOGY FOR LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES

PURPOSE:

To provide, as information: (1) the proposed final technical report, on a performance assessment methodology for low-level radioactive waste (LLW) disposal facilities; (2) the staff resolution of comments on the report; and (3) specific information sought by the Commission on time of compliance and the use of dose discounting.

SUMMARY:

Completion of the report is an output measure in the NRC's Performance Plan for fiscal year 2000. Accordingly, the report has been revised to address public comments received in response to a *Federal Register* notice (FRN) published in 1997, when the report was issued as a draft Branch Technical Position (BTP). Over 175 comments were received from 17 different organizations touching on a broad range of issues. A response to all comments is included as an appendix to the report. Although several comments were made concerning key regulatory positions put forth in the report, after careful consideration, the Performance Assessment Working Group (PAWG) did not see the need to change any of these positions based upon the comments. However, to allow consistency with approaches used in other NRC program areas and to conform better to the agency's risk-informed regulatory philosophy, the PAWG is proposing a different approach for addressing the treatment of sensitivity and uncertainty in performance assessments. Staff, at the direction of the Commission, also sought public views on the use of discounting in relation to potential future doses to members of the public. However, the PAWG does not believe there are any compelling arguments for the use of such an approach, and therefore, it is not put forth as a position in the proposed final technical report.

A number of public comments expressed concern that the proposed document, particularly in the area of recommended policy approaches, once finalized, would be viewed by LLW disposal facility developers and other regulatory entities as *de facto* NRC standards. This was not the staff's intent; therefore, to avoid confusion in this regard and given the agency's reduced role in licensing activities for LLW disposal (most of the LLW licensing responsibilities now reside with the Agreement States), staff now believes that publishing a document of the stature of a BTP is not warranted. However, the document can be used to share with the Agreement States and LLW disposal facility developers some of the staff's experience and insights on conducting performance assessments. Further, it may provide information and recommendations that may be useful to NRC staff conducting performance assessments in other program areas; therefore, staff believes that it is useful to publish the report as a NUREG and not as a BTP.

BACKGROUND:

In the late 1980s and early 1990s, States were in various stages of forming compacts, and siting and trying to license LLW disposal facilities in an attempt to meet the milestones of the Low-Level Radioactive Waste Policy Amendments Act of 1985. To

ensure that the NRC would be able to meet its statutory requirements of reviewing a license application within 15 months after an application was received, the Commission, in a Staff Requirements Memorandum (SRM) dated June 14, 1991, directed staff to develop a plan for developing and enhancing staff's ability to conduct a performance assessment of an LLW disposal facility. In response to this SRM, in SECY-92-060, staff proposed a plan that included developing guidance on conducting performance assessments of LLW disposal facilities.

Through the mid-1990s, the PAWG, consisting of staff from the Office of Nuclear Material Safety and Safeguards (NMSS) in conjunction with staff from the Office of Nuclear Regulatory Research (RES) and contractors, developed a draft BTP on performance assessment of LLW disposal facilities. A preliminary draft of the BTP was prepared and distributed for comment to all Agreement States; the Advisory Committee on Nuclear Waste (ACNW); the U.S. Department of Energy (DOE EXIT); the U.S. Environmental Protection Agency (EPA EXIT); and the U.S. Geological Survey. The PAWG also held public workshops with the States, other Federal agencies, and the ACNW. The draft BTP was revised to address comments and issues raised through this effort. In conjunction with development of the draft BTP, the PAWG also conducted a performance assessment of a "mock" LLW disposal facility to test approaches proposed in the draft BTP, gain additional insights in resolving key issues, and enhance staff performance assessment capabilities.

In SECY-96-103 (Attachment 1), staff requested permission from the Commission to publish the draft BTP for public comments. In addition, SECY-96-103 specifically identified four regulatory positions, taken by staff in the draft BTP, which may have policy implications. These regulatory positions are summarized as follows (see SECY-96-103 for more detail):

Timeframe for LLW performance assessments

10 CFR 61.41 does not specify a time of compliance for meeting the performance objectives. This creates a dilemma in carrying out the performance assessment because the analysis needs to be sufficiently long to permit an evaluation of the performance of the natural site conditions once the engineering can no longer be relied on-- yet short enough that inherent uncertainties in processes and events and in the natural setting will not invalidate the evaluation. In the draft BTP, the PAWG proposed a two-part approach to establishing the timeframe for the performance assessment. The first part uses a 10,000-year compliance period for determining compliance. The second part uses a qualitative evaluation of the analysis beyond 10,000 years, to identify any significant deficiencies in the performance of the disposal system.

Consideration of future site conditions, processes, and events

A key aspect of the performance assessment of an LLW disposal facility is assumptions made regarding site conditions, processes, and future events. Consideration of societal changes and changes in the natural setting could result in large, but unquantifiable speculation about the performance of the disposal system. In the draft BTP, the PAWG proposed the use of a reference natural setting and biosphere, based on a set of reasonably anticipated conditions, processes, and events.

Performance of engineered barriers

Engineered barriers are expected to play a significant role in the overall performance of LLW disposal facilities by limiting the influx of water into the facility and reducing the release of radionuclides from the facility; however, there are significant uncertainties in predicting how long such barriers can be relied on. In the draft BTP, the PAWG proposed that engineered barriers should be assumed to be physically degraded after 500 years; however, credit could be taken for longer periods for structural stability and chemical buffering. In either case, an applicant for a license to dispose LLW will have to provide technical justification for the engineered barriers' lifetimes.

Treatment of sensitivity and uncertainty

It is recognized that uncertainty is inherent in all performance assessment calculations and needs to be considered in assessing the performance of the disposal system in meeting the performance objectives. In the draft BTP, the PAWG proposed the use of either deterministic or probabilistic analyses. For deterministic analysis, the performance assessment needs to demonstrate clearly that the results bound the potential doses. For probabilistic analyses, the mean of the distribution should be less than the performance objective and the 95th percentile of the distribution should be less than 1 millisievert (mSv).

Through an SRM dated August 7, 1996, the Commission approved the staff request to publish the draft BTP and directed staff to provide technical justification for truncating the analysis at 10,000 years and to seek public views on the use of discounting. A notice of the availability of the draft BTP (NUREG-1573) was published as a FRN on May 29, 1997 (62 FR EXIT 29164-29165). After the FRN was published, the Illinois Department of Nuclear Safety (IDNS) requested a meeting with then NRC Chairman Jackson to express concerns with the staff proposed position on the time of compliance. On January 20, 1998, NRC staff met with representatives of the IDNS to discuss their concerns. The State's primary concern was its belief that credible "prediction" of long-term performance of a LLW disposal facility, beyond 500 years, was not possible because of the uncertainty associated with the analysis. The NRC staff presented its technical and policy basis for proposing a 10,000-year timeframe and noted that the specification, in part, was in response to comments received from several States on the preliminary draft of the BTP. The staff also noted that the 10,000-year timeframe was consistent with recommendations of the scientific community and international approaches to LLW disposal performance assessment(1).

Finally, as background, it should be noted that although the FRN was published in May 1997, because of significant budget constraints in the LLW Program and other Agency priorities, completion of the report has been delayed until this fiscal year.

DISCUSSION:

In response to the request for public comments, the NRC received more than 175 comments from 17 organizations, including comments from: Agreement States (Massachusetts, South Carolina, Illinois, Nebraska, and Texas); Non-Agreement States (Pennsylvania and New Jersey); other Federal agencies (the DOE and EPA); and other organizations. The PAWG's responses to the comments are included as Appendix B to the proposed technical report (Attachment 2). The overall public reaction to the draft BTP was favorable, with commenters stating agreement with staff proposed positions, that the document fulfills a need, that the document is well-written, and that the document should be finalized. Some key concerns and staff responses are summarized as follows:

Time of compliance

Comments on this issue include suggestions that a shorter timeframe should be used (e.g., 500 years); that the 10,000-year period is appropriate; and that performance assessment calculations should be carried out to the peak dose, regardless of time. The PAWG response is that the position in the draft BTP is still considered to be appropriate because: (1) a 10,000-year compliance period will generally include the period of time when the waste is most hazardous; (2) it is sufficiently long to allow an evaluation of natural site conditions; and (3) it is consistent with other regulations, starting with 40 CFR Part 191, involving geologic disposal of long-lived hazardous materials.

Engineered barrier performance

Comments on this issue were primarily that the assumed 500-year performance life is arbitrary and without technical justification, and that it discourages research to improve the performance of engineered barriers. The PAWG response is that the position in the draft BTP is still appropriate because: (1) 500 years is generally sufficient to allow decay of short-lived radionuclides to insignificant levels; (2) any period of performance can be used, but it must be justified; (3) taking a position on the performance period helps to put the reliance on engineered barriers into the proper context, so that large expenditures of resources are not made defending the performance of engineered barriers beyond when they are needed for demonstrating compliance; and (4) reiterating the need for justifying any period assumed for engineered-barrier performance should help to encourage research in this area.

Consideration of future site conditions, processes, and events

Some commenters expressed the view that uncertainties in human activities should be considered, unless institutional controls are relied on indefinitely. Further, some commenters did not think that the PAWG's recommendation for using the critical group concept was justified. As a response, the PAWG notes that consideration of future human activities is highly speculative and can lead to problems deciding which future activities are credible and which ones are unrealistic. Such issues have no scientific or technical answer. Accordingly, PAWG has recommended the use of the "reference biosphere" and "critical group" concepts, which are consistent with international opinion and practice, and should lead to cautious but reasonable assumptions about future use of the site.

Treatment of uncertainty

Some commenters believed that the NRC had not justified the use of the mean for determining compliance. Further, some commenters thought that use of the mean for determining compliance was appropriate; however, it may be difficult to communicate to the public. Other commenters believed that the use of probabilistic analysis, in general, could be an invitation to failure in the current socio-political climate. In responding to these comments, PAWG notes that use of the mean provides the best estimate of the system performance and further placing a requirement on the upper percentile of the distribution provides additional assurance of the safety of the disposal facility. The proposed approach in the technical report provides an estimate of risk to an individual which is consistent with the Agency's policy of considering risk in making regulatory decisions. Further, probabilistic analyses provide a clear understanding of the uncertainty and the sources of the uncertainty, which should build confidence in the results. Lastly, the proposed position of using the mean for determining compliance in the report is consistent with approaches used in other NRC regulatory programs (i.e., High-Level Waste and Decommissioning).

Dose methodology

Some commenters noted that the report recommends using a conventional total effective dose equivalent (TEDE) calculation, although 10 CFR 61.41 explicitly calls for the use of the older International Committee on Radiological Protection 2 Methodology. As a response, PAWG notes that as a matter of policy, the Commission considers 0.25 mSv/year [25 millirem/year (mrem/yr)] TEDE to be an appropriate dose limit to compare with the range of potential doses represented by the older whole body dose limits.

As low as reasonably achievable (ALARA) requirements

Some commenters suggested that the report should provide guidance on how to comply with the ALARA requirements of 10 CFR 61.41. As a response, the report has been modified to include a discussion on how to address the ALARA requirements by looking at the costs and benefits of design alternatives.

Institutional controls

One commenter suggested that institutional controls should be maintained at disposal sites for as long as the waste remains hazardous. As a response, PAWG notes that although 10 CFR Part 61 conservatively limits reliance on institutional controls to 100 years, these controls can be, and in most cases will be, maintained indefinitely.

Ground-water protection

One commenter noted that meeting 10 CFR 61.41 will not ensure that maximum contaminant levels (MCLs) established by the EPA will not be exceeded. In responding to this comment, PAWG notes that the current NRC regulations provide adequate protection of public health and safety, that MCLs were not developed specifically for ground-water protection, and that MCLs are based on an outdated modeling approach and do not provide consistent levels of ground-water protection.

In the proposed final technical report, PAWG is proposing a different approach for addressing the sensitivity and uncertainty analyses, from that proposed in the draft BTP. In the draft BTP, PAWG recommended that in the case where a formal uncertainty analysis is used, to consider the facility in compliance, the mean of the distribution (of peak doses) should be less than the performance objective, and the 95^{th} percentile of the distribution should be less than 1 mSv (100 mrem). The 1 mSv (100 mrem) limit was selected to be consistent with the dose limits for members of the public specified in 10 CFR 20.1301. In the proposed final report, PAWG is proposing that the peak of the mean dose, as a function of time, be less than the performance objective, and that the 95^{th} percentile of dose, as a function of time, be less than 1 mSv (100 mrem). This latter approach has the advantage of generally providing a better estimate of risk, and thus is considered to be more in agreement with the Agency's risk-informed regulatory philosophy. In addition, use of the peak of the mean dose allows more consistency with approaches used in other NRC program areas (e.g., High-Level Waste and Decommissioning). The former approach, recommended in the earlier draft BTP, while generally providing a more conservative compliance demonstration, lacks the advantage of the approach proposed now in the final report.

In the August 7, 1996, SRM, the Commission asked staff specifically to provide the technical basis used to support the truncation of the performance assessment at 10,000 years. In the draft BTP, PAWG recommended that a 10,000-year timeframe be used to determine compliance; however, the analysis should continue beyond 10,000 years if the peak dose for a radionuclide has not occurred. PAWG further recommended that assessments beyond 10,000 years be used only as a means of determining whether inventory limits may be needed or whether specific waste streams are not suitable for disposal in the facility.

In a test case of a hypothetical LLW disposal facility, the PAWG gained a number of useful insights on the compliance time issue. In its test-case calculations, the PAWG used 20,000 years as a typical time period for the analysis. The PAWG also carried out some calculations to 100,000 years, to evaluate the transport of radionuclides with relatively large retardation coefficients, and to evaluate impacts from the ingrowth of uranium daughter products, principally radium-226. The test-case calculations showed that for most radionuclides, the magnitude of the peak dose decreases with the time at which the peak occurs. In addition, the test case simulations confirm that mobile long-lived radionuclides (e.g., carbon-14, chlorine-36, technetium-99, and iodine-129) tend to bound the peak dose for other radionuclides in LLW. Thus, a time of compliance that is sufficiently long to capture the peaks from these mobile long-lived radionuclides (i.e., 10,000 years) will tend to bound the potential doses at longer times. PAWG recognizes that there is a potential for getting high doses beyond 10,000 years for sites where large quantities of uranium or transuranics will be disposed of, or for arid sites with long ground-water travel times; therefore, PAWG is not recommending that the dose calculations be truncated at 10,000 years, if doses are still increasing at 10,000 years. However, PAWG also recognizes that the uncertainties in calculations increase with time, thus for very long timeframes (such as beyond 10,000 years) such calculations are best used for making qualitative evaluations.

In addition to technical considerations, as previously stated, a 10,000-year compliance period is also consistent with the time period cited, or being considered, in other final and draft regulations (e.g., 10 CFR Part 960, 10 CFR Part 60, 40 CFR Part 191, and 10 CFR Part 63). A 10,000-year compliance period was also used by several States in their performance assessments of LLW disposal facilities (e.g., CA, NE, and TX), and it was used in the analysis in the Draft Environmental Impact Statement for 10 CFR Part 61. Use of a two-part approach, as advocated in the technical report, is also consistent with the approach recommended by the ACNW in a memorandum dated February 11, 1997, to NRC Chairman Jackson. In that memorandum, the ACNW recommended the use of a two-part approach to addressing the time-of-compliance issue. The first part would require compliance with the numerical standard over a specified period. The second part would allow a qualitative evaluation of the robustness of the facility over longer time periods.

In the August 7, 1996, SRM, the Commission also asked staff to seek public views on the use of discounting, in relation to potential doses to members of the public that may occur in the distant future. In the context of LLW disposal, staff has interpreted discounting to refer to weighing the present-day economic cost of design and performance features associated with LLW disposal against future health risks. To compare the monetary value of risks occurring in the future, with present-day costs, requires discounting the risks to their present-day value. Only two commenters expressed views on this issue (Attachment 3), and these were opposing views on whether discounting should be considered in an LLW performance assessment.

In the proposed final report, the PAWG has not recommended that discounting be considered in the performance assessment of LLW disposal facilities for a number of reasons. First, because of the long timeframe covered by the analysis, discounting will generally always show that it is not cost-effective to spend present-day dollars to avert future risks (e.g., $2000 per person-rem discounted at 3 percent annually for 1000 years is essentially zero). Second, there are concerns with passing present-day burdens onto future generations (i.e., imposing an undue burden on future generations).

Finally, it should be noted that the regulations for licensing LLW disposal facilities were promulgated almost 20 years ago. The differing views expressed by commenters on the issue of time of compliance, as well as the concerns raised about the dose methodology and ALARA, points to a possible need for updating the regulations to clarify the Commission's position on these issues. However, as previously noted, the agency's role in LLW licensing has been greatly diminished in recent years as more responsibility has shifted to the Agreement States. Therefore, it would be difficult to justify diverting precious resources to this activity at this time. However, publishing the attached technical report could provide useful information and recommendations to Agreement States and others on conducting performance assessments.

It should be also noted that in general the approaches for addressing regulatory issues in the proposed final report are consistent with the approaches proposed in the draft final rule (10 CFR Part 63) for disposal of high-level radioactive waste in a proposed geologic repository at Yucca Mountain. However, there are slight differences in some areas based upon differences in the regulations and licensing process (Attachment 4).

CONCLUSION:

Staff intends to publish as final the "Technical Report on Performance Assessment for Low-Level Disposal Facilities," within 10 business days from the date of this paper.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections. The proposed final report has also been reviewed by RES, the ACNW, and the NMSS Risk Group.

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Attachments:
1) SECY-96-103
2) Technical Report on a Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities
3) Public Comments on the Appropriateness of Doses to Future Generations
4) Differences between Approaches Proposed in the Technical Report and Approaches in 10 CFR Part 63

ATTACHMENT 3

PUBLIC COMMENTS ON THE APPROPRIATENESS OF DISCOUNTING DOSES TO FUTURE GENERATIONS

Commonwealth of Massachusetts LLW Management Board

The performance assessment process, as it has evolved in recent years and as detailed in the BTP, involves a complex, lengthy, and costly process. Yet it necessarily remains characterized by many uncertainties, and the results must ultimately reflect the use of considerable scientific and engineering judgment in many areas. Although the Nuclear Regulatory Comission has detailed acceptable mechanisms for dealing with the uncertainties from regulatory perspective, the **level of assurance** that the performance objectives will be met is a function of how thoroughly all of these uncertainties are addressed. The complexity, time, and cost of a performance assessment therefore is likely to be directly proportional to the degree of assurance and thoroughness demanded.

It is reasonable to ask where the point of diminishing returns lies with respect to the level of effort required to provide "adequate" assurance. Some method of "discounting potential doses" to future generations from a disposal site may be appropriate in an effort to balance potential risks and costs. This may be appropriate for not only weighing the cost of design and performance features against potential future risks, as the staff suggests, but for limiting the sophistication and complexity of performance assessments that are required, as well.

Although the Management Board staff does not have a specific mechanism to suggest for making this type of cost-benefit analysis, we believe that the objective is worthy of further consideration by NRC.

Golder Associates, Inc.

The NRC has requested comments on the concept of discounting of future doses. Unfortunately, the published description of the concept is somewhat unclear, and we are not able to directly comment on it. We have, however, reviewed the concept of discounting of the **costs** of future health effects from a facility, in the context of an ALARA analysis and a comparison of alternative schemes, which had different short-term,'long-term risk profiles. Our conclusion was that the concept of discounting is based on a number of unstated economic assumptions which are probably not valid for long terms (a hundred years or more).

At a deeper level, however, the assumption of dose-risk linearity at very low doses is also highly questionable, and it this fact that probably leads to people's desire to discount long-term future doses. After all, the global population-dose assumption which was the basis of [the U.S. Environmental protection Agency's] 40 CFR Part 191 high-level waste standard implies some 1000 health effects, but there are probably very few knowledgeable people who truly believe that such a consequence is credible. A risk-based standard, complemented by the sort of nonlinear dose-disk relationship that appears to be evolving in the scientific community, would automatically result in a kind of discounting of future doses.

ATTACHMENT 4

Differences between Approaches Proposed in the Technical Report for Addressing Regulatory Issues and Approaches Advocated in 10 CFR Part 63

There are slight differences between several approaches proposed in the technical report for addressing regulatory issues and approaches proposed in the draft final rule (10 CFR Part 63) for disposal of high-level radioactive waste (HLW) in a proposed geologic repository at Yucca Mountain. Slight differences can be found in the following areas: (1) the technical report does not specifically advocate assigning probabilities to scenarios; (2) the technical report suggests a 500-year engineered barrier lifetime; (3) the technical report suggests looking at doses beyond 10,000 years; and (4) the technical report recommends using both the mean and the upper 95th percentile of the distribution for evaluating compliance for probabilistic analyses.

The technical report does not intend to preclude assigning probabilities to scenarios in low-level radioactive waste (LLW) performance assessment analyses; however, the Performance Assessment Working Group (PAWG) decided against specifically recommending that probabilities be assigned to scenarios because it was felt that it may put too much of a financial burden on LLW facility developers if experts or panels of experts are needed for establishing and defending the probabilities. In addition, it was felt that the 10 CFR Part 61 siting requirements obviate the need for speculating on the occurrence of rare features and events at the site.

The PAWG considers the suggested 500-year engineered barrier performance period to be useful guidance for LLW disposal facility developers. Because the hazard associated with short-lived radionuclides for most LLW inventories is greatly diminished after 500 years and given that it is unlikely that engineered components comparable to those being considered for HLW will be used in LLW disposal facilities, it is insightful to point out the possible limited value in defending longer barrier performance periods.

The recommendations for looking at doses beyond 10,000 years and for considering both the mean and the upper 95th percentile of the distribution are intended to conform to the specific requirements in 10 CFR Part 61. Because Part 61 does not specify a time of compliance, it can be interpreted by some that doses at any time should be considered in determining compliance with the regulations. Although there are significant uncertainties associated with doses calculated beyond 10,000 years, the regulations would suggest that these doses should not be completely ignored. Also, because Part 61 has a specific deterministic dose standard that must be met, it was felt that in recommending the use of the mean for probabilistic analyses, an additional constraint should be used to provide greater assurance on limiting the doses to members of the public.

1. National Radiological Protection Board, "Radiological Protection Objective for the Land-Based Disposal of Solid Radioactive Wastes," Radiological Protection Bulletin, No. 134, pp. 21-26, July 1992.

Bragg, K., "IAEA Sub-group on Principles and Criteria for Radioactive Waste Disposal - A Status Report on Activities to Date," Waste Management - 93, Vol. 1, pp. 345-347, May 1993.

Pattello, G.K., M.J. Truex, and K.D. Wiemers, "Low-Activity Waste and High-Level Feed Processing Data Quality Objectives," PNNL-12163, Pacific Northwest National Laboratory, April 20, 1999.