EXPERIENCE AND INFORMATION, RELEVANT ISSUES, AND OTHER CONSIDERATIONS SUPPORTING THE STAFF OPTIONS ANALYSIS FOR APPROPRIATENESS OF ALLOWING INTENTIONAL MIXING OF CONTAMINATED SOIL UNDER THE LICENSE TERMINATION RULE

1. BACKGROUND

The Commission directed the staff in Staff Requirements Memorandum (SRM), SECY-01-0194, June 18, 2002, to conduct an analysis of License Termination Rule (LTR) issues, with particular emphasis on resolving the restricted release and institutional control issues and with the goal of making the LTR provisions for restricted release and alternate criteria more available for licensee use. The staff also evaluated other issues dealing with the relationship of the LTR release limits to other release limits, realistic exposure scenarios, and measures to prevent future legacy sites.

On October 1, 2002, the staff provided the Commission with an initial analysis that described the scope of each LTR issue and the staff's plans for evaluation (SECY-02-0177). At that time, staff had not identified the intentional mixing of contaminated soil issue. On May 2, 2003, SECY-03-0069 provided the results of the staff's analysis of the LTR, including the results of evaluations of the eight issues identified in SECY-02-0177. The paper also identified a ninth issue on intentional mixing of contaminated soil. Because the issue was identified late in the staff analysis of other LTR issues, only an initial analysis was provided that described the scope of the issue and the staff's plans for evaluating it. On November 14, 2003, the SRM on SECY-03-0069 approved the recommendations of the staff on the eight issues and the planned evaluations for the intentional mixing issue.

Uncontaminated soil is inevitably mixed with contaminated soil on many occasions, during the course of cleanup at sites, as a result of excavation operations. This mixing is taken into account in the scenarios for evaluating the dose from residual material left at facilities undergoing license termination by averaging the concentrations of contaminated soil assumed to be mixed by excavation. However, intentional mixing of contaminated soil to purposefully achieve a different concentration is not currently being done. Staff has considered that there may be cost-saving advantages or advantages in limiting exposures to workers if it considered allowing intentional mixing at a site to meet the release criteria of the LTR. The staff has considered possible options that would implement various forms of blending and intentional mixing to achieve cleanup at some part of licensee's sites.

Therefore, the staff proposed evaluating the appropriateness of allowing intentional mixing of contaminated soil for meeting release criteria as an option under the LTR. This attachment provides the results of research into information and experiences of the U.S. Nuclear Regulatory Commission (NRC) with mixing of contaminated soil and other waste streams. It also provides information and experiences of: (a) other US agencies dealing with cleanups of sites contaminated with radioactivity; (b) domestic organizations and companies such as radioactive waste disposal facility operators; and (c) international programs. The information and experiences are evaluated for their relevance and importance in determining the appropriateness of NRC allowing for the intentional mixing of contaminated soil to meet the LTR.

Other significant issues and important considerations that staff believes are relevant to determining whether to allow licensees to mix contaminated soil are also discussed.

2. EVALUATIONS OF RELEVANT INFORMATION AND EXPERIENCE

The staff examined a large number of existing regulations, policies, guidance documents, and regulatory decisions, including actual remedial actions, to determine the relevant information and experience with intentional mixing of contaminated soil in waste management and decommissioning and decontamination (D&D) of nuclear facilities. The evaluation included regulations, policies, and experiences of NRC; the U.S. Department of Energy (DOE); the U.S. Environmental Protection Agency (EPA); the U.S. Army Corps of Engineers (USACE); other domestic sources, and from international activities related to waste management and D&D. The staff also examined the other issues concerning their relevance and importance in helping to resolve the intentional mixing issue. Table 2.1 presents a summary of the conclusions of each of the sections that follow.

Table 2.1 - Summary of Conclusions

Conclusions - Evaluations of Experiences and Information

NRC
- Dilution not forbidden in LTR or in any regulation.
- Intentional mixing and dilution addressed on several occasions:
  - Not for changing waste classification.
  - Some dilution expected from waste processing.
  - Mixing contaminated with uncontaminated material unacceptable.
  - Dilution considered on a case-by-case basis.
  - Case-by-case considerations include dilution in context of overall approach.
- Rubblization issues show stakeholder involvement necessary.
- GEIS supporting LTR does not address intentional mixing.

DOE
- Dilution not addressed in DOE rules, policies, nor other directives.
- Guidance addresses dilution:
  - Not to be used to change waste classification (similar to NRC).
  - Stakeholders may find it objectionable.
- NTS disposal facility WAC is flexible concerning characterization; recognizes dilution from processing.
- DOE-equivalent Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process has approved limited reburial of excavated/mixed media.

EPA
- Dilution forbidden as a sole remedy for some hazardous wastes and Polychlorinated Biphenyls (PCBs), and to avoid treatment.
- CERCLA-approved remedies include soil mixing as part of treatment train at many sites; however, radioactive materials not included in any examples described.

Table 2.1 - Summary of Conclusions (continued)

Conclusions - Evaluations of Experiences and Information (continued)

USACE/FUSRAP

- Used intentional mixing at limited sites - small amounts - buildings on top of disposal areas.
- USACE experience with commercial disposal facilities shows WACs are flexible.

Other Domestic Sources

- ANSI standard on clearance advises against blending to meet clearance criteria.
- Conference of Radiation Control Program Directors (CRCPD) Technologically Enhanced Naturally Occurring Radioactive Material (TENORM) rules advise that dilution should not be used, but if it is, it is approved by regulator.
- WAC of commercial disposal facilities are flexible with: waste characterization; treatment of hot spots; and averaging over containers.

International Sources

- Top-level guidance documents address dilution:
- - Both "dilute and disperse" and "concentrate and contain" should be used.
- - Concentrate and contain is preferable for solid waste.
- - Dilution for the purpose of circumventing regulatory requirements is inappropriate.
- - Regulatory agency should approve any uses of dilution.

Conclusions - Evaluation of Significant Issues

- GEIS does not address intentional mixing - either generic or site-specific NEPA analysis is needed.
- Allowing intentional mixing could interfere with establishing clearance and unimportant quanities of Source Material [10 CFR 40.13(a)] policies.
- Environmental and health effects are troublesome for some scenarios that could be used for mixing.
- Allowing intentional mixing could be viewed as change in NRC policy and inconsistent with other US Agencies and the International community.
- Public could find intentional mixing unacceptable.

Conclusions - Evaluation of Other Considerations

- Relationship to Four NRC Performance Goals:
- - Viable option for restricted release/alternate criteria of LTR;
- - Improves risk-informed regulation;
- - Increases NRC flexibility;
- - Could use funds more efficiently; and
- - Could decrease public confidence in LTR cleanup decisions.
- Framework for remedy selection under CERCLA similar to NRC LTR decision framework.
- Could be viewed as unfair since intentional mixing is for release under LTR only, not for operating facilities.

2.1 NRC

The information and experience of the NRC relevant to considering allowing intentional mixing of contaminated soil is contained in rules and guidance on rules issued by NRC; in policy statements and in position statements made in correspondence; in case-specific licensing actions and reviews and approvals of specific proposals for waste management; and in generic safety assessments performed by the NRC staff. Additionally, recent developments concerning complex decommissioning sites are also germane when considering whether to allow

intentional mixing of contaminated soil under the LTR. The following sections present these experiences.

2.1.1 NRC Regulations and Regulatory Guidance

The LTR provisions are evaluated first to provide the context for further evaluations of intentional mixing or blending of contaminated media under the regulation. Then, other NRC D&D and waste disposal requirements are evaluated for any provisions that are applicable to the issue.

2.1.1.1 Subpart E - 10 CFR Part 20 - Radiological Criteria for License Termination

The LTR criteria found in Subpart E of Part 20 generally apply to the D&D of most NRC licensed material except as specifically noted in individual parts of the regulation.

> 10 CFR 20.1402 provides that a site will be considered acceptable for unrestricted use if the residual radioactivity results in a total effective dose equivalent that does not exceed 0.25 millisieverts per year (mSv/y) [25 millirem per year (mrem/y)] and is as low as is reasonably achievable (ALARA).
>
> 10 CFR 20.1403 provides that a licensee may terminate its license under restricted use if it can be shown that institutional controls will provide reasonable assurance that the dose will not exceed 0.25 mSv/y (25 mrem/y), and if the controls were no longer effective, would not exceed 1 mSv/y (100 mrem/y), the doses are ALARA, and applicable administrative requirements are met.
>
> 10 CFR 20.1404 provides that the Commission may terminate a license using alternate criteria greater than the dose criterion in the other provisions of the rule, providing assurance that public health and safety would continue to be protected and it is unlikely that the dose from all man-made sources combined would be more than 1 mSv/y (100 mrem/y), the dose is ALARA, and applicable administrative requirements are met.

The LTR criterion are performance-based and the licensee can achieve successful termination through many approaches. Thus, since the regulation contains no prescriptive requirements, neither intentional mixing of contaminated media nor any specific methodology to achieve the dose standards is prohibited. Intentional mixing is not discussed in the "Statement of Considerations" for either the draft or the final regulation.

2.1.1.2 10 CFR Part 40, Appendix A - Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for their Source Content

Part 40, Appendix A provides technical requirements for the management and disposal of 11e.(2) byproduct material (i.e., mill tailings). Two criteria and their considerations are applicable to a discussion of intentional mixing of contaminated soil.

> Criterion 2 states: To avoid proliferation of small waste disposal sites and thereby reduce perpetual surveillance obligations, byproduct material from in situ extraction

operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above-ground extraction operations must be disposed of at existing large mill tailings disposal sites, unless, considering the nature of the wastes, such as their volume and specific activity, and the costs and environmental impacts of transporting the wastes to a large disposal sites, such offsite disposal is demonstrated to be impracticable or the advantages of onsite burial clearly outweigh the benefits of reducing the perpetual surveillance obligations.

Criteria 6(1) contains specifications for an earthen cover over the tailings that will reduce the release of radon-222 to the atmosphere to less than 20 pCi per square meter per second, and Criteria 6(6) contain the specific concentration levels of radium in land for which no radon barrier is required. These levels are: (i) 5 pCi/g of radium-226 (Ra-226), or, for thorium byproduct material, radium-228 (Ra-228), averaged over the first 15-centimeters (cm) below the surface; and (ii) 15 pCi/g of Ra-226 or -228 averaged over 15-cm thick layers more than 15 cm below the surface. The concentrations of radio nuclides other than radium in the byproduct material must not result in a dose equivalent to the cleanup of radium as specified in the above standards. The criteria specify compliance with the concentrations of radium in the land is the average over a 100 square meter area.

Therefore, for mill tailings disposal, the rule states a preference for disposal of tailings at the existing large mill tailings disposal sites, but allows that individual small waste disposals may be done after considering the nature of the waste and the costs and environmental impacts of the disposal. The criterion for acceptable concentrations of radium remaining in soil specify the numeric parameters for which averaging shall be done to determine compliance.

2.1.1.3 SECY 86-328, Advance Notice of Proposed Rulemaking on Definition of the term "High-Level Radioactive Waste"

SECY 86-328 requested approval to publish an Advance Notice of Proposed Rulemaking (ANPR) that would result in changing the definition of the term "high-level radioactive waste," to more closely match the statutory definition in the Nuclear Waste Policy Act. The Commission approved publication of the ANPR in a memorandum to the staff on January 21, 1987.

Commissioner Asselstine sent a memorandum on December 18, 1986, to the staff, asking whether the approach contemplated in the ANPR would allow dilution of high-level waste so that the wastes could be classified as low-level waste. The staff responded to the Commissioner on January 15, 1989, by first stating that the ANPR neither allows nor specifically prohibits dilution of radioactive wastes. The staff goes on to say,

> The staff's view with regard to dilution has been, and continues to be, that dilution, solely for the purpose of altering the classification of a waste, is unacceptable[1]. While dilution might reduce the risk to an individual potentially affected by the wastes, in many cases, dilution would increase the overall burden on society by making the wastes more

[1] 10 CFR 61.58 allows for the NRC to authorize other provisions for the classification and characteristics of waste on a specific basis. Staff has authorized mixing of waste streams to meet the waste acceptance criteria of disposal facilities (see Section 2.1.3.4).

> difficult to manage (e.g., by increasing the number of shipments required for transportation of wastes to a disposal facility). Nevertheless, some dilution of wastes may result from waste processing (e.g., incorporation of wastes into a glass matrix) which is beneficial for the long-term safety of a waste disposal system. For this reason, the staff has handled the issue of dilution, and will continue to do so, on a case-by-case basis.

2.1.1.4 Comments on Part 40, Proposed Rule on Unimportant Quantities of Source Material

On August 8, 2002, the Commission published the proposed rule, "Transfers of Certain Source Materials by Specific Licenses'" in the Federal Register (67 FR 55175) proposing to amend Sections 40.13(a) and 40.51 of 10 CFR Part 40. The Commission proposed to amend Part 40 to address the situation of licensees' specific requests to transfer less than 0.05 percent source material to non-licensees. Dilution was among the issues discussed in the proposed rule; the public was specifically requested to comment on this issue:

> Additionally, NRC does not permit licensees to intentionally dilute licensed source materials without specific approval. Section 40.41(c) states that "each person licensed by the Commission pursuant to the regulations in this part shall confine his possession and use of source or byproduct material to the locations and purposes authorized in the license." Although it is recognized that inadvertent dilution may occasionally occur (e.g., during the process of preparing contaminated material for shipment, some mixing with cleaner material may result as it is "dug up" and loaded for shipment before sampling), this natural dilution of the concentration of uranium and thorium is in contrast to the intentional dilution of contaminated material for the purpose of reducing its concentration below 0.05 percent, which is not acceptable in the absence of prior authorization. Intentional dilution of licensed source material, without prior NRC authorization, would be considered a violation of §40.41(c). The NRC is seeking public comment on whether this policy should be better clarified by adding rule language specifically prohibiting intentional dilution without prior authorization in the regulations.

This discussion in the "Statement of Considerations" for the proposed rule and in the request for public comment about intentional dilution of contaminated material was in response to direction from the Commissioners in their voting records on SECY-00-0201, the SECY paper asking for the Commissioners' approval to publish the rule amendments. Commissioner Merrifield expressed concern that a plain language reading of the rule, as proposed in SECY-00-0201 would allow licenses to dilute licensed source material to unimportant concentrations so that it could be transferred to an exempt person. His specific comments included in his Voting Record (March 29, 2002) state:

> First, I am strongly opposed to the notion that source materials can be diluted with non-source material to achieve unrestricted release criteria. I recognize and accept that some dilution resulting from the mixing of source materials can occur as part of an approved process. But, once the process is complete, I do not generally support the notion that the waste product can be intentionally diluted in an attempt to bypass more strict disposal requirements. . .

NRC received comments from a total of 20 commenters on the proposed rule, seven of whom addressed the specific request for comment about the policy on prohibiting intentional dilution. Of these, four commenters supported the inclusion of language in the rule expressly prohibiting dilution, and three commenters opposed such specificity.

Comments from the States of New Jersey[2] and Illinois, plus the collective comments from the public interest groups Nuclear Information and Resource Service; Committee to Bridge the Gap; and the Snake River Alliance supported the inclusion of the specific prohibition against dilution. Illinois explained that this would help ensure that future licensees, who would not have the "Statement of Considerations" readily available, understand that there was a specific prohibition regarding intentional dilution.

The Nuclear Energy Institute (NEI) did not oppose a specific requirement prohibiting dilution; however, NEI submitted comments on specific parts of the proposed rulemaking, while opposing the entire rulemaking as unnecessary.

American Ecology's comments opposing the inclusion of specific language prohibiting dilution state:

> American Ecology strongly recommends that the Commission take no general position on dilution. A general position or specific restrictions are unnecessary given the NRC's existing case-specific transfer approval authority. Conversely, stated restrictions would reduce future NRC and Agreement State flexibility. In specific cases, controlled dilution may allow accelerated closure and decommissioning of non-operating facilities by providing access to economical disposal. This, in turn, may offer direct public health and safety benefits at specific licensed facilities.
>
> Under the circumstances addressed by the proposed rulemaking, dilution cannot be used to avoid regulation. This is because the NRC and Agreement State programs must approve transfers of licensee source material. In the case of approved transfers to a Subtitle C disposal facility, material approved for transfer would be subject to full RCRA regulatory controls as well as applicable disposal facility permit requirements for acceptance of radioactive materials. NRC or the reviewing Agreement State program would presumably consider these regulatory controls and relevant performance assessment information prior to approving or disapproving a transfer. Whether or not licensee source material is diluted prior to transfer is irrelevant to protection of public health and safety at the receiving disposal facility. Given the overcapacity of well-regulated disposal space, we see no advantage to general restrictions.

2.1.1.5 Guidance on 10 CFR Part 61, Licensing Requirements for Land Disposal of Radioactive Waste

Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," includes provisions that address waste characteristics and waste forms for low-level waste. Guidance provided to

[2] Staff notes that New Jersey has promulgated regulations allowing for mixing of contaminated soils in depth to reduce the concentrations of radioactive materials to meet soil remediation standards (See Section 2.1.2.7).

licensees for characterizing and classifying their waste so that it is acceptable at a licensed Part 61 site (or Agreement State-licensed site) addresses some of the issues associated with intentional mixing.

In the January 1995 "Branch Technical Position on Concentration Averaging and Encapsulation," the issue of mixing contaminated soil is directly addressed. Section 3.1, "Mixing of homogeneous waste types or streams," says:

> Mixing of similar waste types (e.g., spent ion-exchange resins or contaminated soils) is permissible as described below. Note, however, that a designed collection of homogeneous waste types from a number of sources within a licensee's facility, for purposes of operational efficiency or occupational dose reduction, is not considered "mixing" for purposes of this position. Under the guidance in the position, the classification of a mixture, using the sum of fractions rule specified in 10 CFR 61.55, should be based on either: (a) the highest nuclide concentrations in any of the individual waste types contributing to the mixture; or (b) the volumetric- or weight-averaged nuclide concentrations of the mixture, provided that the concentrations of the individual waste type contributors to the mixture are within a factor of 10 of the average concentration of the resulting mixture.

No other waste management- (10 CFR Parts 60, 62, 63; Subpart K of Part 20; Appendix G to Part 20; other requirements in Appendix A of Part 40; and Appendix A, Section VI of Part 50) or non-financial assurance-related D&D and remedial action (10 CFR 40.27 and 40.28) Commission regulations contain requirements that discuss contaminated soil or waste characterization/classification in a context that is applicable to license termination and mixing of contaminated soil to meet release criteria.

2.1.1.6 10 CFR Part 62, Criteria and Procedures for Emergency Access to Non-Federal and Regional Low-Level Waste Disposal Facilities.

The NRC's regulation established under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) that provides for emergency access to commercial low-level waste disposal facilities contain criteria that will be used in evaluating a licensee request for emergency access. Two criteria concern the amount of volume reduction that has already occurred and any remaining alternatives for additional volume reduction that could be done. These are:

> 10 CFR 62.12, Contents of a request for emergency access: General Information, Criterion (6) Description of the volume reduction and waste minimization techniques applied to the waste which assure that it is reduced to the maximum extent practicable, and the actual reduction in volume that occurred; and
>
> 10 CFR 62.13, Contents of a request for emergency access: Alternatives, Criterion (6) - Reducing the volume of the waste;

These criterion are included in Part 62 because Congress mandated in Section 6.(i) of the LLRWPAA that, “Any low-level radioactive waste delivered for disposal under this section shall be reduced in volume to the maximum extent practicable . . . .”

2.1.1.710 CFR 20.1406. Minimization of Contamination

Based on the analysis in the GEIS supporting the LTR (See Section 2.1.4.4 of this attachment), the final LTR included a requirement at 10 CFR 20.1406, which states:

> Applicants for licenses, other than renewals, after August 20, 1997, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

2.1.1.8 Technical Position on Disposition of Cesium-137 (Cs-137) Contaminated Emission Control Dust

On March 19, 1997, the NRC staff published the “Final Technical Position on Disposition of Cs-137 Contaminated Emission Control Dust and Other Incident-Related Material.” The position allows for case-by-case disposals of a mixed-waste stream generated when Cs-137 sources are inadvertently melted with steel scrap at electric arc furnaces or foundries. The position allows for the disposal of this waste stream following stabilization at Subtitle C, Resource Conservation and Recovery Act (RCRA)-permitted hazardous waste disposal facilities.

The Technical Position Paper contains the following guidance on allowing aggregation of Cs-137-contaminated emission-control dust with other incident-related materials:

> If applicable, aggregation of Cs-137 contaminated emission control dust and other incident-related material, before stabilization treatment, is acceptable if performed in compliance with a radiation protection program, as described at 10 CFR 20.1101, and provided that:
>
> (1) Aggregation involves the same characteristic or listed hazardous waste and the wastes must be amenable to and undergo the same appropriate treatment for land-disposal restricted waste;
>
> (2) Aggregation does not increase the overall total volume nor the radioactivity of the incident-related waste; and
>
> (3) Materials, when aggregated, are subjected to a sampling protocol that demonstrates compliance with Cs-137 concentration criteria on a package-average basis.

2.1.2 NRC Policies and Position Statements in Correspondence

The NRC has addressed dilution and mixing and subjects important to the NRC staff options analysis in generic letters and information notices to NRC licensees, and statements contained in correspondence.

2.1.2.1 Generic Letter No. 81-39, NRC Volume Reduction Policy

On October 16, 1981, the NRC published a policy statement on Low-Level Radioactive Waste Volume Reduction in the Federal Register (46 FR 51100). The NRC issued Generic Letter No. 81-39 to all power reactor licensees and applicants for operating licenses and holders of construction permits notifying them of the policy and enclosing a copy for their use. The Policy states:

> The Nuclear Regulatory Commission (NRC) considers it desirable that licensees reduce the volume of low-level radioactive waste generated and shipped to commercial waste disposal sites. Such action would:
> 1. Extend the operational lifetime of the existing commercial low-level disposal sites;
> 2. Alleviate concern for adequate storage capacity if there are delays in establishing additional regional sites;
> 3. Reduce the number of wastes shipments.

2.1.2.2 NRC Information Notice No. 89-13: Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites

On February 8, 1989, the Office of Nuclear Material Safety and Safeguards issued Information Notice (IN) No. 89-13, providing information to licensees about the possible denial of access to operating low-level radioactive waste disposal sites because of provisions in the LLRWPAA. The IN re-emphasized the value of waste generation minimization as one way to alleviate impacts to a licensee's activities if disposal capacity for waste was limited. Item No. 4 in the Discussion section of the IN says:

> 4. Review alternatives to minimize generation of waste shipped to burial grounds, for example:
>
> a. Carefully segregating long-lived radioactive waste from short-lived and non-radioactive waste.
>
> b. Stopping unnecessary work which generated waste.
>
> c. Changing processes, procedures, or radionuclides to reduce volume of generated waste.
>
> d. Using volume reduction techniques, such as compaction.

2.1.2.3 NRC Information Notice No. 94-23: Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program

On March 25, 1994, the Office of Nuclear Material Safety and Safeguards issued IN No. 94-23, providing the interim final guidance from the U.S. Environmental Protection Agency to assist hazardous waste generators and others in complying with the waste minimization certification requirements of RCRA sections 3002(b) and 3005(h). The IN states:

. . . . this interim final guidance may be useful to radioactive waste generators who wish to develop or enhance a program to minimize the generation of radioactive and/or mixed waste (waste that contains both radioactive material and hazardous waste) at their facilities. It is expected that recipients will review this information notice for applicability to their activities and consider actions, as appropriate, to minimize waste generation.

2.1.2.4 Use of Rubblized Concrete Dismantlement as a Decommissioning Option

In SECY-00-0041, NRC staff informed the Commission that the staff had received an application from Maine Yankee that included the in-situ disposal of building rubble at the reactor site. This procedure, called "rubblization," can be briefly described as the process whereby the above-grade parts of concrete structures at a facility undergoing decommissioning are emptied and partially decontaminated, then these structures are demolished and disposed of in the intact and partially decontaminated below-grade structure. The desired goal is to achieve a site which can be released using the unrestricted release criteria of the LTR.

The SECY paper also informed the Commission of a number of technical and policy issues involved in the review and approval of the Maine Yankee license termination plan, and any others that may be received, including the mixing of rubble:

> "Using the rubblized material from the above-grade building rubble as fill, and placing it in the below-grade structure results in a heterogeneous mix of contaminated and non-contaminated concrete blocks. The mixing results in diluting the contaminated material as noted in the GEIS. The GEIS did not address the environmental impacts of leaving a substantial amount of contaminated concrete on site . . . ."

The SECY paper provided comments to the Commission that were requested and received from various stakeholders concerning the use of rubblization for license termination. Comments from the EPA Office of Air and Radiation directly addressed the issue of mixing contaminated and non-contaminated rubble together:

> Rubblization would represent a break from NRC's present policy and preference for off-site disposal of radioactive waste. From a public standpoint, leaving radioactive waste on-site, in areas that may not have been originally contaminated, could be difficult to explain. Moreover, rubblization engenders 'Dilution as the solution,' a remedial practice that other agencies do not commonly employ or encourage. Finally, although NRC's decommissioning guidance provides a working definition of ALARA, it may be difficult to convince the public that burying radioactive waste on-site constitutes a reduction of dose to a point 'as low as is reasonably achievable.'

Comments from the Environmental Coalition on Nuclear Power also addressed this issue:

> Of great concern is the likelihood that this approach would be consistent with, and could lead to, the mixing of clean and heavily contaminated soils in order to reach NRC's "acceptable concentration limits." If merely surface or shallow (a few inches) burial readings are allowed to be used, under the NRC's Regulatory Guide DG-4006, "Demonstrating Compliance with the Radiological Criteria for License Termination," or

> averaging of concentrations is allowed, the buried rubble and contaminated soils could in reality be substantially higher than was supposedly the intent of the Commission's Decommissioning Criteria.

Despite these stakeholder concerns, staff still concluded that it was technically possible to approve a license termination plan that included rubblization.

2.1.2.5 Response to Envirocare, Inc. on 10 CFR 2.206 Petition

In a September 20, 2001 letter, the Office of Nuclear Material Safety and Safeguards (NMSS) responded to two letters from Envirocare, Inc., dated February 22, 2001, and May 16, 2001, concerning issues that arose from the NRC response to a 10 CFR 2.206 Petition submitted by Envirocare on disposal of Formerly Utilized Sites Remedial Action Program (FUSRAP) waste in the form of mill tailings. Part of this response concerns dilution, which was one issue discussed in the February 22, 2001, Envirocare letter:

> . . . It is recognized that the process of preparing contaminated material for shipment may result in some mixing with cleaner materials as it is "dug up" and loaded for shipment before sampling. This natural dilution of the concentration of uranium and thorium in contaminated material is in contrast to the intentional dilution of contaminated material for the purpose of reducing its concentration below 0.05%, which is not acceptable in the absence of prior authorization.

2.1.2.6 Response to PADEP Comments on Draft EA for Decommissioning of Molycorp Facility, PA

The Molycorp facility is undergoing decommissioning in two phases. Phase I and II address the remediation of currently contaminated portions of the site to criteria for unrestricted release. In comments on the Draft Environmental Assessment (EA) for Phase I of decommissioning, the State of Pennsylvania Department of the Environment (PADEP) was concerned about the intentional mixing of clean soils with contaminated soils to reduce their concentrations. PADEP comment 15 says:

> Although mention is made in the EA of erosion control practices, further emphasis needs to be placed on the need to preclude inadvertent contamination of clean soils as the remediation proceeds. In addition, the NRC should specify the procedures and oversight that need to be in place to ensure that deliberate mixing with clean soils to reduce the concentrations of contaminated volumes of soils or other materials does not occur.

The NRC response to this comment includes the following:

> "Regarding the comment on intentional dilution of soils, NRC will not allow Molycorp to demonstrate compliance by dilution and NRC inspectors will ensure this does not occur to the extent practicable."

2.1.2.7 Response to New Jersey Department of Environmental Protection

By letter dated July 1, 1999, New Jersey's Department of Environmental Protection asked NRC for comments on the State's proposed rule, entitled, *Soil Remediation Standards for Radioactive Materials,* and associated supporting documentation. Section 7:28-12.9(b) of the proposed rule generically allows facilities to mix (with depth) contaminated soil with uncontaminated soil to meet the allowable soil concentrations in the rule. NRC commented on this part of the proposed rule in a letter from NRC Chairman Dicus, dated September 16, 1999:

> While NRC does not explicitly prohibit soil mixing and dilution, NRC staff does not generally permit soil mixing as a means of reducing radionuclide concentrations in soil. NRC views the use of dilution within the context of an overall approach to the site cleanup, which includes application of the as low as is reasonably achievable principle. Clearly it would be appropriate to remove significantly elevated contamination where reasonable. NRC staff would consider the use of soil mixing and dilution as a means of reducing radionuclide concentrations only in those cases in which it was demonstrated that removal of the soil would not be reasonably achievable.

New Jersey provided additional information to NRC on this issue in response to the NRC comment. The State indicated that the intent is that soil mixing may be used in cases where a clean soil cover is applied, and the soil mixing is used instead of relying on institutional controls that might otherwise be necessary. Staff indicated to the Commission, in a November 27, 2000, memorandum, that it has no further concerns regarding the topic.

2.1.2.8 March 1998 Response to Texas Department of Health

By letter dated March 23, 1998, the Texas Department of Health (TDH) wrote to the Office of State and Tribal Programs (OSP) regarding topics that included the mixing of soil contaminated with Atomic Energy Act (AEA) Section 11e.(2) byproduct material. In the NRC's response provided by the Uranium Recovery Branch of the Office of Nuclear Material Safety and Safeguards (NMSS), the staff says:

> In general, there is no statute or NRC rule that forbids mixing of contaminated and clean soils to comply with decommissioning cleanup standards. However, it has been a long-standing NRC staff practice to discourage compliance with environmental standards by dilution with uncontaminated material. Rather, the NRC staff encourages the cleanup of contamination to applicable standards. . . . If the NRC staff were presented with a proposal to use mixing as a method of complying with applicable cleanup standards, we would treat it as an alternative to the requirements in 10 CFR 40, Appendix A, and would require the applicant to show that the economic benefit and equivalent protection requirements specified in the "Introduction" to 10 CFR Part 40, Appendix A, have been met.

2.1.2.9 October 2000 Response to TDH

By letter dated October 25, 2000, TDH wrote to OSP, concerning its review of a request by one of TDH's in-situ uranium mine licensees to use soil homogenization as an alternative method for reclamation of a former irrigation project which was used to dispose of bleed waters from the

in-situ mining. The TDH was reviewing the project under the rules for alternative proposals in Part 40, Appendix A. The proposed method would use a Roto-Mixer that would blend several layers of soil into one homogeneous mixture. TDH was writing to NRC to obtain conditional concurrence on the implementation of this method to reduce the soil concentrations of radium and uranium to release the site for unrestricted use. The licensee had performed the process successfully on a test plot on the site.

NMSS performed a review of the information submitted to OSP and provided a response on January 17, 2001, which OSP forwarded to TDH. The response referred to the letter to New Jersey (see subsection 2.1.2.7, above), and also provided additional discussions:

> The NRC staff views the use of dilution within the context of an overall approach to the site cleanup, which includes application of the as low as is reasonably achievable (ALARA) principle, and considers only those cases which demonstrate that removal of the soil would not be reasonably achievable.

The staff stated that before it could concur on the acceptability of the soil homogenization method, the following information would be needed:

> (1) A description of ALARA efforts; and (2) how the short-term and long-term protection resulting from the mixing method provides protection equivalent to the contaminated soil removal method at the site. The consideration of long-term protection appears appropriate given the long half-lives of the radionuclides involved. However, the requested site-specific comparison of protection between two remediation methods might be questioned, because sites performing soil removal could leave levels of residual radionuclides similar to those resulting from mixing. In any case, the demonstration of ALARA would still be of concern. The State should also provide assurance that the cost savings of the proposed method . . . is realistic and therefore soil removal and disposal is not reasonably achievable.

2.1.3 NRC Reviews and Approvals of Specific Cases

NRC has considered intentional mixing, blending, and dilution for resolving site-specific radioactive waste management problems at several NRC-licensed facilities.

2.1.3.1 Response to Wyoming on American Gas Hills Tailings Site

By letter dated March 1, 1996, Shepherd Miller, Inc. proposed performing windblown material cleanup at the American Nuclear Corporation Gas Hills uranium mining and milling site in Wyoming by tilling the upper 45.4 cm [(18 inches(in)] of soil in certain areas, resulting in blending of the windblown contaminants with otherwise clean soil to meet cleanup criteria for Radium-226 (Ra-226). This alternative was proposed to minimize costs and maximize the site reclamation work that could be accomplished within the available Wyoming Department of Environmental Quality (WDEQ) budget.

NRC responded to this letter on April 18, 1996, informing the WDEQ that NRC would consider this approach in reviewing and approving the reclamation plans for the Gas Hills site, with certain constraints. The constraints set by the staff included: a fairly flat surface, uniform low-

level surface contamination, and a test plot with extensive surface and subsurface samples to demonstrate that compliance can be achieved. Ultimately, this method of cleanup was not used.

2.1.3.2 Approval of Honeywell International Transfer of Pond Materials

By letters dated July 20, and August 8, 2001, Honeywell International, Inc., notified NRC of the intent to transfer a synthetic flourspar and lime mixture from the "A" Pond at the Honeywell Metropolis, IL, facility to the Hastle Trucking and Mining Company, for use as a commercial product. NRC responded on September 14, 2001, that as long as the mixing took place as described in the proposal, and all other local, State, and Federal regulations were followed, the transfer was approved since the mixture would contain source material less than 0.05 percent by weight, as specified in 10 CFR 40.13(a), and as required in its NRC License (SUB-526).

2.1.3.3.ATK Proposed Disposal of Unimportant Quantities of Source Material at WCS

In a December 13, 2002, request, Alliant Integrated Defense Company, LLC (ATK) proposed to ship radioactive waste to Waste Control Specialists (WCS) in Texas under the provisions of 10 CFR 40.51(b)(4). NRC responded to the request with some concerns in a March 18, 2003, letter. The second of the concerns was NRC's interpretation and objection to ATK's use of the term, "container," in reference to the railcar in which individual super sacks were being shipped to WCS. ATK's use of "container" for the railcar (rather than an individual super sack) allowed them to combine a super sack which had greater than 0.05 weight percent source material with several super sacks with less than 0.05 weight percent source material in the railcar in a way that allowed the exempt quantity limit in Part 40 to be met. NRC staff's concern stated:

> "The NRC's regulations do not authorize the intentional dilution of radioactive materials for the purpose of reducing waste concentrations to demonstrate compliance with 10 CFR Part 40.13(a)."[3]

2.1.3.4 Approval of Kaiser Aluminum Request for Disposal Approval

By letter dated September 15, 2003, Kaiser Aluminum requested that NRC approve its request for disposal of unimportant quantities of source material from the Kaiser Tulsa, OK facility. To meet waste acceptance criteria (WAC) for each waste container at the disposal site to which it was planning to ship its waste, Kaiser said that it might have to blend the waste before placement in the container. NRC's October 29, 2003, response approved the blending as an acceptable method for meeting disposal facility WAC.

2.1.3.5 Approval of Amendment to 10 CFR 20.302(a) Disposals at Vermont Yankee

By letter dated June 15, 2000, NRC approved an amendment to previously approved onsite disposals at Vermont Yankee under 10 CFR 20.302(a). The approved amendment allowed Vermont Yankee to dispose of 25.5 cubic meters (m^3) [33.15 cubic yards(yd^3)] of soil

[3] In SECY-01-0194, staff noted, on the other hand, that dilution of source material to levels below the unimportant quantity threshold was not prohibited in the Atomic Energy Act, as amended, or in NRC regulations. See discussion on unimportant quantities of source material (Section 3.3).

contaminated with Cobalt-60 (Co-60) and Cs-137 by land (layers of soil) spreading on designated fields. This method of disposal was previously approved at Vermont Yankee, for cooling tower silt and septic waste.

For the analysis of the impact of the land spreading of the soil, Vermont Yankee assumed, after control of the land had been relinquished in the future, that the thin layer of contaminated soil had been plowed under and would form a uniform mix with the top 15.2 cm (6 in) of clean soil. The analysis takes into account the buildup of all disposals of cooling tower silt and septic waste, as well as the layer of soil that will be spread over the designated fields throughout the operating life of the plant, and mixes all the wastes into one homogeneous layer for purposes of determining a potential dose to a maximally exposed individual.

2.1.3.6 Approval of 10 CFR 20.2002 Disposal at Big Rock Point

By letter dated January 4, 2002, NRC approved a request to dispose of contaminated demolition debris from the Big Rock Point Nuclear Plant, pursuant to 10 CFR 20.2002. The approval allowed Big Rock to dispose of approximately 38.32 million kilograms (kg) [84.50 million pounds (lbs)] of debris potentially contaminated with Tritium (H-3), Co-60, and Cs-137 in a State of Michigan permitted landfill.

For the analysis of the impact of the disposal in the landfill, Big Rock Point assumed that the material would be a homogeneous mixture of 19.16 million kg (42.25 million lbs) of contaminated debris and an equal amount 19.16 million kg (42.5 million lbs) of non-contaminated debris, with a density of 2,402.77 kg per m^3 (150 pounds per cubic foot). The analysis assumes the material will be commingled with other materials in the landfill.

2.1.4 Generic Safety Assessments Performed by NRC

NRC has also included mixing or dilution of waste in generic safety assessments for determining the appropriate regulatory criteria to promulgate in some of its regulations.

2.1.4.1 10 CFR 20.1302, “Compliance with dose limits for individual members of the public”

20.1302 provides the methods by which a licensee can show it meets the dose limits for individual members of the public from exposure to its licensed activities with radioactive materials. The method explained in paragraph (b) subparagraph (2) is by demonstrating that the annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed values in Table 2 of Appendix B to Part 20.

The average concentrations listed in Table 2 for both gaseous and liquid effluents assume dilution of the radioactivity in the effluent from the source to the receptor in the modeling used to derive the limits. The modeling that was performed to derive the concentrations in Table 2 is discussed in the proposed rule for Part 20, “Standards for Protection Against Radiation; Proposed Rule; Extension of Comment Period and Republication” (51 FR 1105).

2.1.4.2 Intruder Analysis in 10 CFR Part 61 EIS

The intruder analysis in the Environmental Impact Statement (EIS) in support of Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," assumes that the inadvertent intruder would dig a 3-meter (9.84-ft) -deep foundation for a home. The scenario modeled was that the first 2 meters (6.56 ft) of material removed for the foundation consisted of soil cover and the last 1 meter (3.28 ft) consisted of degraded low-level waste. The analysis assumes, for the purposes of calculating the potential dose to this intruder, that the radionuclide concentration of the material is one-tenth the concentration of the waste when it was disposed of, because of mixing (another factor is applied to account for radionuclide decay).

2.1.4.3 Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586)

The abstract of the Generic Environmental Impact Statement prepared as part of the considerations for changes in regulations on decommissioning of commercial nuclear facilities prepared in 1988 includes the following conclusions:

> Decommissioning has many positive environmental impacts such as the return of possibly valuable land to the public domain and the elimination of potential problems associated with increased numbers of radioactively contaminated facilities with minimal use of resources. Major adverse impacts are shown to be routine occupational radiation doses and the commitment of nominally small amounts of land to radioactive waste disposal.

2.1.4.4 Generic Environmental Impact Statement (GEIS) in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities (NUREG-1496)

The principle conclusions of the analysis in the GEIS in support of the LTR rulemaking includes the following:

> (5) Minimization of Contamination
>
> There should be specific attention given to design features and procedures that facilitate decommissioning the site, reduce the amount of radioactive waste, and minimize the overall public risk associated with decommissioning.

2.1.5 Evaluations of Implementation of Intentional Mixing at NRC Decommissioning Sites

The staff reviewed the status and regulatory record of Site Decommissioning Management Plan (SDMP) and complex decommissioning sites and conducted discussions with site Project Managers to determine if mixing had been an alternative discussed, what issues arose in the discussion, the resolution of the issues, if any, and the potential impact that intentional mixing could have on meeting the criteria for release in the LTR if it were implemented. Staff concentrated, but did not limit, this effort to sites currently considering restricted release, described in SECY-03-0069, because it provides an additional context for sites that might be affected by the staff's recommended options in SECY-03-0069. After evaluation of the

circumstances at each site, staff has determined that a few sites could potentially utilize intentional mixing of contaminated soil or a policy that addresses intentional mixing significantly towards meeting decommissioning goals in accordance with the LTR. Basic site descriptions and circumstances in which intentional mixing could be employed are provided.

The table included as Attachment 11 to SECY-03-0069 was not updated for use with this paper because of the preliminary state of evaluating the intentional mixing issue and the site-specific nature of any uses of intentional mixing.

2.1.5.1 Decommissioning Site 1

At this formerly licensed site, part of the approach for decommissioning assumes limited mixing of contaminated soil will take place, resulting in homogeneous contamination rather than pockets of highly contaminated soil. The staff agreed with this approach because grading and leveling (causing mixing of contaminated with non-contaminated soils) of the areas of the site where contamination exists will have to occur for the scenarios evaluated in the dose analyses to take place. NRC contractors are currently conducting studies to affirm concentrations of contamination used by the former-licensee in its dose analysis. The decommissioning plan for this site has not been approved.

2.1.5.2 Decommissioning Site 2

At this site, contaminants include natural uranium and thorium and their decay products, as well as several heavy metals and other hazardous materials. The soil contamination is non-uniformly distributed at the site.

The licensee's current approach for remediating contaminated soil is to "draw a box" around areas with measured contamination above release limits, and excavate everything in the box. This "pile" will then be spread out in a staging area and resurveyed; that material that "passes" is to be put back in the hole as fill. Some mixing will occur with this process and contamination will necessarily be "homogenized" as a result. Whether this procedure is "intentional dilution" must be determined. Additional intentional mixing of some soils to meet release criteria could provide a safe solution to the issues preventing progress at this decommissioning site since funding to accomplish any remediation is limited.

2.1.5.3 Decommissioning Site 3

The manufacturing process at this site generated slag and baghouse dust, both of which could be used advantageously in further industrial processes. A limited amount of this material has been blended with clean soil to create the necessary feed mix for a potential application. However, future plans for reuse of the material are in doubt, and decommissioning will likely involve an onsite disposal cell for the slag and dust. If all or part of these streams could be removed from the site, then the facility likely could be released for unrestricted use; however, the cost to remove all the material is very high (in the millions of dollars). The staff is contemplating an alternative of restricted use, using a possession-only specific license for long-term control (discussed by the staff in SECY-03-0069).

2.1.5.4 Decommissioning Site 4

This site is licensed to perform site characterization and decommissioning activities associated with contamination from an earlier manufacturing process involving Ra-226, Cs-137, Strontium-90, and Americium-241. There is still an active license at the site.

Work with radioactive materials began at the site in 1948, with the use of Ra-226. Radioactive waste was disposed of onsite in three primary locations: silos, lagoons, and a waste dump. In the fall of 1999, the licensee began removal of the radioactive material from the two underground silos, and this material is currently stored on site awaiting further processing before disposal.

NRC staff continues to coordinate activities with EPA and the state regulatory authorities regarding remediation of the site. An EPA Administrative Order of Consent (AOC) for the sorting, characterization, and re-packaging of the drums of mixed waste and radioactive waste that were removed from the silos is currently in effect. A separate EPA AOC is likely to be necessary for disposal of the waste, because disposal costs are expected to exceed the licensee's funds. Additionally, at present, there is no path to disposal for the silo waste, because it does not meet the waste acceptance criteria for available commercial disposal facilities at this time. (The presence of Ra-226 in the waste stream limits the disposal options for the waste because one available disposal facility (Barnwell, SC) cannot receive Ra-226 in the concentrations that will be present after treatment). Also, because of the lack of funds and the need for additional treatment, the waste needs to be placed in a more secure and radiologically safe location, which will use decommissioning funds that might otherwise be spent on disposal.

2.1.5.5 Conclusions

The NRC has not specifically prohibited dilution or mixing of contaminated soil or waste in any of its regulation nor has it specifically included dilution as a waste management approach. The most recent rulemaking addressing the issue was the proposed Part 40 on "Transfers of Certain Materials by Specific Licenses." The proposed rule requested comments on whether to specifically include a provision in the rule that would allow dilution of source materials to achieve levels that would allow transfer to non-licensees, with prior NRC authorization. In accordance with the SRM on SECY-03-0106, further action on the final rule amending 10 CFR 40.51 is postponed until the Commission has an opportunity to review associated issues that could impact the action taken in the final rule. The staff will continue its current practice of reviewing licensees' requests for transfer or disposal of unimportant quantities of source material under 10 CFR 40.13(a), and, when justified, issue case-specific exemptions based on previous Commission guidance.

The NRC has addressed the subject of intentional mixing or dilution on several occasions in correspondence and in policy-making. The following can generally be concluded concerning whether permitting intentional mixing was consistent with NRC policy and rules: (1) intentionally diluting waste to alter its classification [e.g., from Class B to Class C low-level waste (LLW)] is not permitted; (2) some dilution of wastes is expected as a result of waste processing (including excavation of contaminated media during remedial activities), and is acceptable; (3) intentional mixing of contaminated material with uncontaminated material to achieve a goal in

waste management or cleanup is generally unacceptable; (4) the staff will consider the issue of dilution regarding waste management goals on a case-by-case basis, and (5) dilution approaches for cleaning up sites will be approved on a case-specific basis, considering the use of dilution within the context of an overall approach to the site cleanup, which includes application of the ALARA principle, and considers only those cases that demonstrate that removal of the soil would not be reasonably achievable.

The Commission's deliberations on rubblization as a decommissioning alternative for nuclear reactors revealed stakeholder negativity toward allowing mixing of contaminated material to achieve remediation goals, especially where it was previously understood by stakeholders that waste would be removed and disposed of elsewhere. The generic analysis (GEIS) the Commission used in support of regulatory decisions on decommissioning of reactors did not include this alternative. An analysis of decommissioning sites indicates that intentional mixing could have an impact on meeting the release criteria of the LTR at a small number of sites (approximately 4 to 6), if it were allowed.

2.2 DOE

The staff reviewed selected key DOE documents and discussed DOE's programs for radioactive waste management and environmental restoration with personnel from the Department's Office of Environmental Management. Based on this information, key insights relevant to the LTR restricted release issues are summarized below.

2.2.1 DOE Order 435.1, Radioactive Waste Management.

Guidance on meeting the requirements for managing LLW and transuranic waste (TRU) in DOE Order 435.1, "*Radioactive Waste Management,"* addresses the issue of dilution of waste in discussing the proper classification of waste streams as TRU or LLW:

> Dilution of a transuranic waste stream to reclassify the waste as a low-level waste (i.e., reducing the concentration to less than or equal to 100 nanocuries (nCi) (3700 Bq) per gram is not permitted by the Department. While it is recognized that in the course of stabilizing a waste stream some changes in waste concentration may occur, actions to dilute a waste stream below the concentration limits for transuranic waste are prohibited. It is also recognized that actions taken to process a waste stream for safety or technological reasons that are justified, may result in the waste being reclassified after processing as low-level waste.

2.2.2 Guidance on Meeting DOE Order 5400.5, Radiation Protection of the Public and the Environment.

Draft DOE Standard entitled "Applying the ALARA Process for Radiation Protection of the Public and Environmental Compliance with 10 CFR 834 and DOE 5400.5 ALARA Program Requirements," Volume 2, provides examples of applying ALARA analysis for hypothetical DOE situations to meet the requirement for this analysis that is in DOE's Order for protection of the public and the environment (DOE Order 5400.5) from radiation. Example 3 provides an example of conducting an ALARA analysis for a quarry on a hypothetical DOE site that is contaminated with uranium and the evaluations are to determine a suitable alternative for

treating the quarry water before discharging the effluents in accordance with Order 5400.5. The Base Case for the alternatives evaluated is dilution of the quarry water with water obtained from a nearby river, 4 parts to 1, which results in a derived concentration guide value for uranium that allows it to be released into the river untreated. The guidance states, "While dilution might not be an attractive alternative philosophically, it could be attractive from the economic point of view and should be presented to clearly define alternative and illustrate costs and benefits." (Later the guidance points out that this method is not likely to be acceptable to EPA or to State regulators).

2.2.3 Department of Energy Radiological Health and Safety Policy, DOE P 441.1

Department of Energy Policy 441.1 describes the overall policy of the Department to conduct its radiological operations in a manner that ensures the health and safety of its employees, contractors, and the general public and the protection of the environment. In order to adhere to this policy, the Department has included eight specific objectives that it will meet. Objective F. states that, in meeting this policy, the Department shall:

> **Conduct radiological operations in a manner that controls the spread of radioactive materials and reduces exposure to the workforce and the general public and that utilizes a process that seeks exposure levels as low reasonably achievable.** Radiological operations and activities shall be preplanned to allow fro the effective implementation of dose and contamination reduction and control measures. Operations and activities shall be performed in accordance with departmental conduct of operations requirements and shall include reasonable controls directed toward reducing exposure, preventing the spread of radiological contamination, and minimizing the generation of contaminated wastes and the release of effluents.

2.2.4 DOE Order on Environmental Protection Programs, DOE O 450.1

DOE Order 450.1, Environmental Protection Program, requires all DOE offices and facilities to have an Integrated Safety Management System that includes an Environmental Management System (EMS). The three elements of the required EMS program are:

> (a) public health and environmental protection,
>
> (b) pollution prevention (P2), and
>
> (c) compliance with applicable environmental protection requirements.

2.2.5 DOE Waste Reduction Policy Statement

DOE's Waste Reduction Policy Statement, issued June 27, 1990, states:

> " . . . . waste reduction will be a prime consideration in research activities, process design, facility upgrade or modernization , new facility design , facility operations, and facility decontamination and decommissioning."

This policy requires that all DOE program offices and filed operations"

> " . . . . institute a waste reduction policy to reduce the total amount of waste that is generated and disposed of by DOE operating facilities through waste minimization (source reduction and recycling) and waste treatment."

2.2.6 DOE Policy on Waste Minimization and Pollution Prevention

DOE's Policy on Waste Minimization and Pollution Prevention, issued on August 20, 1992, includes the following commitment:

> " . . . . inclusion of cost-effective waste minimization and pollution prevention in all of its activities . . . ."

2.2.7 Nevada Test Site Disposal Facility Waste Acceptance Criteria

Nevada Test Site Waste Acceptance Criteria (NVO-325), Revision 4 (February 2002) provides technical and administrative requirements that radioactive waste must meet to be accepted for disposal at DOE's Nevada Test Site (NTS) LLW disposal facility. Section E provides the requirements for determination of waste type, characteristics, and class in low-level waste to be disposed at NTS:

Section E.2 , "Waste Profile Instructions," says:

> "The reported activity concentrations . . must be representative of the final waste form after treatment or stabilization."

Section E.5, "Determination of Waste Volume," includes the following:

> Waste activity concentration shall be determined based on the volume of the final waste form as offered for disposal. Measurement or analysis of samples may be performed prior to final processing if the measured activity concentrations can be related to the final activity concentration. The volume of the waste can usually be taken as the internal volume of the container if the radionuclides are reasonably homogeneously distributed throughout the waste and the waste fills at least 90 percent of the waste container.

The Nevada Test Site (NTS) preference for waste concentration to be determined after it is prepared for disposal (containerized) conceptually means that a waste generator could blend homogeneous media, for example contaminated soils from cleanup, with differing concentrations that will result in a blended (i.e., lower) concentration in the container.

Also, the concentration of the waste reported for characterization and disposal can be as much as 10 percent less than the actual concentration, depending on the void spaces left in the disposal container. Practically, a waste generator tries to fill the container as full as possible, to achieve cost-effective disposal. Nonetheless, some dilution of the actual concentration of the waste is acceptable as long as the generator certifies that the container is at least 90 percent full.

2.2.8 Records of Decisions for DOE Superfund Sites

2.2.8.1 Idaho National Engineering Lab

The Superfund Record of Decision (ROD) for Operable Unit 03 at the Idaho National Engineering and Environmental Laboratory in Idaho Falls, ID, evaluates several alternatives for the cleanup and disposal of waste in and surrounding a set of two abandoned underground storage tanks (the TSF-26 site). The tanks were installed in the mid-1950s and stored concentrated low-level radioactive waste from 1955 to 1981. The tanks contained sludge contaminated with radionuclides, heavy metals, organic compounds, and Polychlorinated Biphenyls (PCBs). There was no liquid present due to earlier efforts at dewatering and adding absorbent material.

The preferred alternative involves the use of a high-powered industrial vacuum to remove the sludge from the bottom of the two tanks without the addition of any water or other material to act as a catalyst in removing the waste. The ROD states that this removal action will effectively "mix the tank contents, resulting in a waste form that may be acceptable for onsite disposal without further treatment."

2.2.8.2 Savannah River Site

The ROD for Operable Unit 17 at the Savannah River Site (SRS) evaluates alternatives for the cleanup and disposal of contamination and old waste disposal in the L-Area Oil and Chemical Basis (LAOCB) and another nearby wastewater basin. The LAOCB operated as an unlined seepage basin from 1961 to 1979 for wastewater from various facilities at the SRS contaminated with oil, radionuclides, detergents, and spent degreasing solvents. Waste and contamination characterization shows that the pipelines that brought the wastewater to the seepage basin are highly radioactive.

The preferred alternative to remediate the LAOCB involves in-situ stabilization and capping. This remedy will involve in-situ grouting of the pipelines, excavation of the pipes, and sectioning the pipes into manageable pieces. These pieces will then be placed into the LAOCB, along with contaminated soils associated with the pipelines. Then pipeline soil and voids between pipeline sections will be grouted to created a monolith. The remaining depression of the LAOCB will be backfilled with clean soil.

This example is important for several reasons. First, the in-situ grouting of the pipelines and subsequent excavation, sectioning, and disposal of the sections with contaminated soils from the pipeline pathways represents intentional mixing of non-homogeneous radioactively contaminated cleanup wastes into a consolidated area, which is also already radioactively contaminated. Second, treatment of the waste by the grouting of the waste to achieve a monolithic structure is performed to provide for additional waste characteristics that protect public health and the environment. Third, the remedy is approved and implemented because it meets the decision criteria for remediation under CERCLA, rather than any internal DOE regulatory requirements.

2.2.9 Conclusions

Despite extensive remedial actions conducted at DOE facilities that have involved numerous cleanups of contaminated soil and media, the issue of intentionally mixing contaminated media or dilution is not addressed in DOE policy, rules, orders, or any other directives. The staff believes this is probably a reflection of: (1) the fact that DOE remedial actions are approved under the DOE equivalent of CERCLA, which provides a process that can handle approval of mixing contaminated media; and (2) the availability, to DOE, of cheap and unrestricted disposal capacity, for remediation wastes. Therefore, there has been no need for DOE to make a determination in its rules or policies, on either allowing or prohibiting dilution to meet remediation goals.

Guidance on meeting DOE Order 435.1 expresses a similar policy as the NRC has stated against intentionally changing waste classification (from transuranic to low-level waste, for example), while recognizing that approved waste processing may result in such a change. Guidance on meeting DOE Order 5400.5 includes intentional dilution in an example of conducting an ALARA analysis for waste management, but points out that stakeholders may view such an approach negatively.

Consistent with NRC's statements that some unintentional dilution of wastes resulting from processing contaminated media for disposal is acceptable, the waste acceptance criteria for the NTS disposal facility requires waste activity concentrations to be measured on waste as it is presented for disposal (after treatment or after consolidation in waste containers), unless the waste characteristics measured before treatment or containerization can be correlated correctly to the actual characteristics.

The examples from DOE that involved re-burial of excavated soil or mixing of contaminated media were approved under the DOE CERCLA-equivalent process. Additional discussion of CERCLA and the process used to select the preferred remedies, and its applicability to the discussion of allowing intentional mixing of contaminated soil, is provided later in this paper.

2.3 EPA

The staff reviewed key EPA guidance under the Comprehensive Environmental Response, Compensation, and Liability (CERCLA) and RCRA. The staff also reviewed key EPA radiation protection standards promulgated under the AEA and associated documents issued with the rules, such as "Background Information Documents." The staff also conducted a search of the RODs for sites remediated under Superfund and CERCLA authorizations, for remediation activities that would be relevant to intentional mixing of contaminated soil. Based on this information, insights relevant to the LTR restricted-release issues are summarized below.

2.3.1 40 Part 268, Land Disposal Dilution Prohibition

40 CFR 268.3(a) of the EPA hazardous waste "Land Disposal Restrictions" regulations expressly prohibits dilution:

> Except as provided in paragraph (b)[4] of this section, no generator, transporter, handler, or owner or operator of a treatment, storage, or disposal facility shall in any way dilute a restricted waste or the residual from treatment of a restricted waste as a substitute for adequate treatment to achieve compliance with subpart D of this part, to circumvent the effective date of a prohibition in subpart C of this part, to otherwise avoid a prohibition in subpart C of this part, or to circumvent a land disposal prohibition imposed by RCRA section 3004.

Thus, dilution of wastes or waste treatment residues to achieve a treatment standard specified under the Land Disposal Restrictions, or to circumvent any of the prohibitions under the Land Disposal Restrictions, is prohibited. [There are very limited exceptions to this, see footnote 4 about 40 CFR 268.3(b)]. Guidance on implementing this rule discusses the prohibited activity of "aggregation" of wastes that results in prohibited dilution when the wastes are not treated, or are treated inappropriately, or if the waste is diluted to the extent that it could be de-listed under EPA's de-listing procedures.

A September 2001 "Draft Interpretative Memorandum on Stabilization of Organic-Bearing Hazardous Wastes to Comply with RCRA Land Disposal Restrictions" provides the EPA staff's interpretation of whether and when treatment by stabilization of organic constituents would be considered in violation of the dilution prohibition. This memorandum provides several examples of situations that EPA staff has declared as being in violation:

> "Complying with treatment standards by mixing wastes, mixing wastes that result in a change of treatability groups (e.g., mixing a non-debris hazardous waste with a debris material), adding excessive quantities of reagants to wastes, treating wastes by ineffective or otherwise inappropriate technologies Iron filings are used to "treat" lead-containing wastes."

2.3.2 PCB Dilution

Section 761.20 of 40 CFR Part 760, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, and Distribution in Commerce," contains the use prohibitions and exemptions Some requirements of this rule applicable to an analysis of intentional mixing include:

> 761.20(a)(4) An authorization is not required to use sewage sludge where the uses are regulated at parts 257, 258, and 503 of this chapter. No person may blend or otherwise dilute PCBs regulated for disposal, including PCB sewage sludge and sewage sludge not used pursuant to parts 257, 258, and 503 of this chapter, for purposes of use or to avoid disposal requirements under this part. Except as explicitly provided in subpart D of this part, no person may dispose of regulated PCB wastes including, but not limited to, PCB remediation waste, PCB bulk product waste, PCBs, and PCB industrial sludges, into treatment works, as defined in §§ 503.9(aa) of this chapter.
>
> 761.20(c)(1)(iii) With the exception of provisions in §§ 761.60 (a)(2) and (a)(3), in order to meet the intent of §§ 761.1(b), processing, diluting, or otherwise blending of waste

[4] Paragraph (b) contains very specific provisions describing when impermissible dilution does not apply, and these have to do with treatment and pretreatment systems permitted under the Clean Water Act.

> prior to being introduced into a disposal unit for purposes of meeting a PCB concentration limit shall be done in accordance with a TSCA PCB disposal approval to comply with the requirements of §§ 761.79.

Essentially these provisions spell out that processing, diluting, and blending waste (before disposal) for purposes of meeting a PCB concentration limit in an approved PCB disposal, must be done in accordance with that approval or comply with the requirements of the cited rule sections. Processing for disposal cannot result in dilution to avoid disposal requirements.

2.3.3 Corrective Action Management Unit

In the course of several amendments to the hazardous waste regulations in Title 40 of the CFR, EPA added a specific disposal facility into the regulations known as a Corrective Action Management Unit (CAMU). The present definition of a CAMU is, " . . . an area within a facility that is used only for managing remediation wastes for implementing corrective action or cleanup" (40 CFR 260.10). Remediation wastes are, " . . . all solid and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris that are managed for implementing cleanup" (40 CFR 260.10). By definition, placing remediation wastes into or within a CAMU does not constitute land disposal [40 CFR 264.552(a)(4)], and the land disposal restrictions (LDRs) do not apply to such activities. In addition, waste disposal units located within CAMUs need not be designed in accordance with minimum technology requirements [40 CFR 264.552(a)(5)], such as liners and leachate collection systems.

Therefore, it is possible to blend or mix remediation wastes from a cleanup and manage it within a CAMU without violating the prohibition against dilution in 40 Part 268. Also, the EPA has adopted an innovative approach to treatment and disposal for wastes from a remedial action that is less restrictive than what they require for newly-generated hazardous waste from an operating facility.

The EPA has included definitions for soil and hazardous debris in the Land Disposal Restriction regulations in 40 CFR 268.2 that make it clear that mixing of hazardous waste with either soil or debris, for the purpose of changing it to either soil or debris (which would allow circumventing the LDR restrictions and disposal in a CAMU), is prohibited. This is similar to the NRC and DOE positions that altering waste classifications by mixing is not appropriate.

2.3.4 Soil Cleanup Criteria in 40 CFR Part 192

EPA promulgated Subpart B of Part 192, "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites," in January 1983. The soil cleanup standards appear in Section 192.12 of the rule:

> Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*
>
> (a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than --
>
> (1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

The concentration criterion for surface soil is a health-based standard (the source of risk being gamma radiation), whereas the concentration criterion for subsurface soil is not a health-based standard, but rather was developed to allow the use of field measurements rather than lab analyses to determine when buried residual radioactive material with relatively high activity (typically 300 - 1000 pCi/g) had been detected. In both cases, the criterion is applicable as an average over 100 square meter areas, which means that residual material with actual contamination levels higher and lower than the criterion are essentially "blended" (i.e., averaged) to determine whether the remedial measures have been completed.

2.3.5 Resource Conservation and Recovery Act - U.S. Code 42, Chapter 82, Section 6902 - Objectives and National Policy.

Section 6902(b), National Policy, of the Resource Conservation and Recovery Act, which was added to the law by the Hazardous and Solid Waste Amendments (HSWA) in 1984, states:

> The Congress hereby declares it to be the national policy of the United States that whenever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Wastes that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

2.3.6 Pollution Prevention Act, - U.S. Code 42, Chapter 133, Section 13101 - Findings and Policy.

Section 13101(b), Policy, of the Pollution Prevention Act signed into law in 1990, states:

> The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

Section 13102, Definitions, of the Act defines the term “source reduction,” as any practice which:

> (i) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment or disposal, and
>
> (ii) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

2.3.7 Proposed Policy Statement on Source Reduction and Recycling.

As part of their activities responding to the HSWA, EPA published a proposed policy statement on source reduction and recycling in the Federal Register (54 FR 3845) on January 26, 1989, which commits the agency to a preventative strategy to reduce or eliminate the generation of environmentally-harmful pollutants which may be released to the air, land, surface water or ground water. The agency further proposed to incorporate this preventative strategy into EPA’s overall mission of protect human health and the environment by making source reduction a priority for every aspect of Agency decision-making and planning, with environmentally-sound recycling as a second and higher priority over treatment and disposal.

The proposed policy statement also includes the following in discussing the meaning of the term “waste minimization:”

> Transfer of hazardous constituents from one environmental medium to another also does not constitute waste minimization. For example, the use of an air stripper to evaporate volatile organic constituents from an aqueous waste only shifts the contaminant from water to air. Furthermore, concentration activities conducted solely for reducing volume does not constitute waste minimization unless, for example, concentration of the waste is an integral setup in the recovery of useful constituents prior to treatment and disposal. Similarly, dilution as a means of toxicity reduction would be considered waste minimization, unless dilution is a necessary step in a recovery or recycling operation.

2.3.8 Records of Decisions for Superfund National Priorities List (NPL) Sites

Intentional mixing/blending of soil occurs often as a result of common remediation technologies employed at Superfund sites for treatment of the soils before disposal. A search of the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) at EPA recalled 275 RODs for Superfund sites that used or considered using some form of soil blending/washing to treat a contaminant. In some cases, for example, the soils are mixed and blended purposefully to drive off Volatile Organic Compounds (VOCs), which are captured and treated further. Many times these soils are contaminated with other hazardous chemicals and wastes, and these other contaminants remain in the blended soil. These soils

are then either shipped offsite for disposal or disposed of onsite, or both, depending on the remedial technologies that are agreed on by stakeholders and documented in the RODs for the sites. A few examples of remedial technologies employed at NPL sites are illustrative of soil mixing and blending that are approved and accomplished at Superfund sites.

2.3.8.1 Commencement Bay, South Tacoma Channel Site, WA

At Operable Unit 4 at the Commonwealth Bay, Tacoma Channel Site, the remedy chosen to cleanup soils contaminated with Arsenic, Lead, Carcinogenic Polynuclear Aromatic Hydrocarbons, Copper, and PCBs includes removal and treatment (solidification) of approximately 16,820.2 m^3 (292,000 yd^3) of soil containing "hot spots" that are above specified concentrations. After mixing with the solidification agent, the hot-spot contaminated soil is spread in 15.24 to 30.48 cm (6- to 12- inch) lifts into one of three designated disposal areas onsite. After placement of the solidified hot-spot soil, the remaining contaminated soil is excavated and consolidated in the same disposal locations and then a cap of either gravel and soil or asphalt is placed over the disposed of soil.

In the areas where the contaminated soil has been removed, excavation beyond a depth of 30.48 cm [1 foot (ft)] is not required. If confirmatory testing indicates that an area that has had the top 30.48 cm (1 ft) of soil removed is still contaminated above the action levels, then the area must be capped with an asphalt cap.

2.3.8.2 Hooker 102nd Street Site, Niagra Falls, NY

The ROD for Operable Unit 1 at the former industrial landfill site operated from 1943 to 1970 at the Hooker Chemical site in NY, also includes remedial actions that include consolidation and mixing of contaminated soils that have been approved at Superfund sites.

At Operable Unit 1 at Hooker, the remedy chosen to clean up soils contaminated with heavy metals, chlorinated single-ring aromatics, PCBs, and dioxins and dibenzofurans that were found in five locations away from the site is to excavate and consolidate them at the onsite disposal area at the Hooker site. The soils to be excavated are those found above the designated cleanup levels. After consolidation onsite, these soils will be covered by soils and other debris from onsite cleanup, after treatment (incineration), as well as an engineered cap.

2.3.8.3 Waite Park Wells Site, MN

The ROD for Operable Units 1 and 2 at the Waite Park Wells CERCLA site in MN also includes remedial actions that are illustrative of consolidation and mixing of contaminated soils that have been approved at Superfund sites.

At Operable Unit 1 at Waite Park Falls, soils beneath the former locations of lagoons where liquid and solid waste were disposed of are contaminated with VOCs, PCBs, lead, arsenic, and

petroleum products. The selected remedy includes excavation of soils and solidification and stabilization to treat for the lead and organic contamination. Before the introduction of the stabilization media, some of the soils contaminated with oil and other petroleum products are purposely blended with non-oily soils to result in a concentration in the contaminated soils that will react most effectively with the stabilizing agent.

2.3.8.4 Lot 86, Farm Unit 1, North Carolina State University, NC

At the location of the former landfill at Operable Unit 1 at the North Carolina State University site, the contaminants include solvents, pesticides, heavy metals, acids, and low-level radioactive waste (tritium from experiments). The primary problem being addressed by the remedial action is groundwater contamination, for which a common onsite "treatment train," consisting of air stripping and carbon adsorption, are being used, followed by discharge to a publicly-owned water treatment works. The soil component of the remedy does involves a two-stage process of in-situ mixing of the contaminated soils. In the first stage, the volatiles will be driven off using one of three treatment methods, and then the remaining contaminants will be fixed in place with various pozzolan-portland cement-based formulations delivered into, and mixed with the soil, as a grout.

2.3.9 Conclusions

EPA has addressed intentional dilution in requirements for management of hazardous waste and PCBs. These requirements generally prohibit the use of dilution as a sole remedy to meet the disposal standards for these wastes. In the case of hazardous waste, this means that the waste must be treated first. In the case of PCBs, the prohibition applies to specific types of disposition (e.g., management of sewage sludge), and when other disposal methods are to be used, a specific approval must be obtained. EPA created a specific waste management unit, the CAMU, which can be used to dispose remediation waste, and as long as it is managed in accordance with the applicable EPA requirements, waste placed into it is exempt from treatment requirements. However, EPA has included language that expressly prohibits dilution as a method for including other waste streams, into the CAMU, that otherwise require treatment. The intent of these requirements is essentially equivalent to the NRC-stated policy that dilution cannot be used to change the classification of wastes. Otherwise, they are not applicable to management of radioactive wastes.

The requirements and processes that govern cleanups under Superfund provide for the approval of mixing of contaminated soil and media, but only as part of the overall cleanup strategies for sites requiring remediation. Mixing of contaminated soil is actually employed on a regular basis as one of the steps in treatment that is especially effective in getting rid of certain hazardous materials. This intentional mixing of soil is almost always followed by other treatments because other contaminants that are not treated through the soil mixing must be addressed. Sometimes the alternative that is chosen for implementation includes disposal in an onsite disposal area , rather than shipment to a disposal facility located away from the site.

Several illustrative examples of this approach are provided, although none of them includes radionuclides as a contaminant that is addressed by the remedial action.

2.4 USACE

The staff researched the documentation of formerly utilized sites remedial action program (FUSRAP) cleanups by the U.S. Army Corps of Engineers (USACE) for USACE experience with determining proper disposal of soil and debris contaminated with low concentrations of low-level waste and 11.e(2) material. FUSRAP is a USACE (formerly a DOE) program to clean up low-levels of radioactivity remaining at 46 industrial sites throughout the US that performed work in the early days of the nuclear weapons and energy programs, for DOE's predecessor agencies.

2.4.1 Innovative Cleanup Technology

An innovative cleanup approach utilized in a few FUSRAP projects results in final waste configurations relevant to a discussion of intentional mixing. Because the floors of many of the 1940- and 1950s-era buildings remediated under FUSRAP are cracked and broken, contaminants have migrated beneath the floors and contaminated the sides of the cracked concrete floors and the bottom surfaces of the floors and underlying soils. The floors must be removed to reach the contaminated soils and the concrete removed during demolition must either be decontaminated by labor-intensive methods and certified to meet surface release guidelines or else shipped for disposal in high-volume shipments.

FUSRAP has used a semi-trailer mounted rock crusher to render the concrete materials from the building basements to a soil-like consistency; the resultant soil-like material has been proposed for release for use without radiological restrictions at the following FUSRAP sites:

2.4.1.1 Downtown St. Louis Site, St. Louis, MO

At the downtown St. Louis, MO. site, approximately 1146.83 m^3 (1,500 yd^3) of concrete and building rubble was crushed. These materials were processed to a soil-like consistency and used as backfill onsite. The crushed material contained an average of 114.7 becquerel/kg (Bq/kg) [3.1 picocuries/g (pCi/g)] uranium-238 (U-238), which was below the site soil cleanup guideline of 1850 Bq/kg (50 pCi/g). Savings of over $784,000 resulted from reduced transportation, disposal, and backfill material costs.

2.4.1.2 Aliquippa Forge Site, Aliquippa, PA

At the Aliquippa Forge Site, 382.27 m^3 (500 $yd^{3)}$ of brick and concrete from a foundry that had extruded uranium metal rods for the Atomic Energy Commission in the 1950s, was crushed,

resulting in an average concentration of 370 - 555 Bq/kg (10 - 15 pCi/g) U-238, well below the 1850 Bq/kg (50 pCi/g) cleanup guideline. These materials were used as fill material onsite in accordance with agreements with Pennsylvania state regulators in place of more than 458.73 m^3 (600 $yd^{3)}$ of contaminated soil removed from beneath the building, which were shipped offsite for disposal. The building rubble-fill material was covered over by a newly constructed floor.

2.4.1.3 C.H. Schnoor Site, Springdale, PA

Approximately 31.35 m^3 (41 $yd^{3)}$ of concrete floor from a building used to machine uranium metal for the Manhattan Engineering District at the Schnoor site was crushed at the same time as the Aliquippa Site material was processed. It was removed from the floor of an active industrial building at Schnoor in order to remove 478.61 m^3 (626 $yd^{3)}$ of contaminated soil from beneath the floor. The resulting crushed material had an average of 277.5 Bq/kg (7.5 pCi/g) U-238, well below the 1850 Bq/kg (50 pCi/g) cleanup guideline. These materials were also used as fill material onsite at the Schnoor Site.

2.4.1.4 Alba Craft Site, Oxford, OH

At this FUSRAP site, a concrete block, slab-on-grade single-story building which had been used for uranium metal machining in the 1950s was added onto over the years on top of contaminated soil. Additionally, uranium fires in the building had contaminated not only the block walls, but the overhead trusses and roof, as well as most of the soil beneath the slab. After the roof and trusses were removed, the building walls and concrete slab were crushed, resulting in material with an average concentration of 55.5 Bq/kg (1.5 pCi/g) U-238 (approximately 111 Bq/kg (3.0 pCi/g) total U) compared to a cleanup criterion of 1295 Bq/kg (35 pCi/g) total uranium for the site. In this case, Ohio State regulators would not approve the proposed reuse of the material onsite and it was packaged and shipped offsite for disposal as low-level waste.

2.4.2 Senate Hearing on FUSRAP Program

On July 25, 2000, the Senate Environment and Public Works Committee held a hearing on the FUSRAP program. Post-hearing questions posed to the USACE focused on the adequacy of disposal of FUSRAP materials at RCRA-permitted facilities. Some of the questions were concerned with waste acceptance criteria at the facilities used by the Corps for disposal:

> Senate Committee Ques. 4.1: Please provide any written documents indicating whether and how averaging was applied by the Corps in this case (e.g., did the Corps take the average per container, per rail car, per entire shipment).

USACE Answer: The averaging was applied to the entire shipment of contaminated wood and masonry debris from the Linde, Building 30 demolition, to the Safety-Kleen disposal facility near Buttonwillow, CA. The averaging was based on the 26 samples that were obtained in accordance with requirements established by Safety-Kleen. . . The following samples were collected: three wood and three masonry samples were collected from areas exhibiting the highest radiation levels; three wood and three masonry samples were collected from areas exhibiting low radiation levels; and seven wood and seven masonry samples were collected from random locations. The average total activity for all twenty-six of these samples was determined to be 335 pCi/g, well below the 2000 pCi/g acceptance criteria of the Buttonwillow facility.

Senate Committee Ques. 4.2: Please provide any written authorizations or legal authority from the State of California which permits such averaging.

USACE Answer: The authority for averaging is implicit in Safety-Kleen's permit from the State of California, which defines permitted levels of activity in terms of the U.S. Department of Transportation (DOT) regulations, specifically 49 CFR 173.403(y), "The Permitee shall not accept the following wastes and materials at the Facility: a. Radioactive materials which either require special placarding because they exceed 2000 pCi/g of activity as reference in 49 CFR 173.403(y), or are defined as "NRC-regulated source materials." DOT regulations provide for averaging.

Senate Committee Ques. 4.3: Your staff . . . referred to a "general rule of thumb" being the "three times rule" In . . . response to the Committee on this issue. What is the authority for that "rule," how does the rule apply (e.g., per shipment, per drum, etc.), how is it enforced on a facility-by-facility basis, and what is the scientific underpinning of that rule?

USACE Answer: The three times multiplier has been used since 1974 when the NRC's Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," was published. It has provided guidance for acceptable surface contamination levels that have been used during reactor and other decommissioning activities. Its maximum acceptable values listed in the document are a factor of three times the average acceptable levels. The Department of Energy . . . and the Department of Army . . . have also used these average and maximum criteria.

The more specific basis for use of the three times rule as an upper limit in conjunction with averaging is guidance issued by the U.S. Department of Transportation (DOT) together with the NRC. In accordance with NUREG-1608/RAMREG-003, which references International Atomic Energy Agency (IAEA) advisory material on qualitatively and quantitatively defining the non-homogeneity in a package containing low-specific activity (LSA) materials, a material may be considered *essentially uniformly distributed* when the calculated or measured specific activity difference between equal volumes

does not vary by more than a factor of three. This guidance was intended to clarify the definition of "radioactive material" provided by DOT for its regulatory purposes. . . .

The concept of essentially uniformly distributed material within each shipping container has been incorporated into the FUSRAP waste acceptance criteria for Envirosafe Services of Idaho, Inc. Additionally, the use of upper action levels that are three times the allowable average soil concentration have been incorporated in Envirosafe's permit. At the Waste Control Specialists, LLP (WCS) facility in Texas, based on meetings between the Corps and state regulators, averaging over the volume of the container is generally acceptable for soil contamination. Though it is not specified in the WCS permit, State of Texas regulators have indicated that they would allow elevated areas up to ten times the average activity in a container.

2.4.3 Conclusions

The USACE have used a form of mixing of radioactively-contaminated media at remedial action sites (FUSRAP sites) to meet regulatory criteria on a limited basis. These cases have all involved relatively small amounts of media [from 31.35 to 1146.83 m^3 (41 to 1,500 yd^3)] that were treated (i.e, crushed into soil-like consistency) and used as fill at the sites. In all cases, the fill was placed where had been removed, and building basement floors were constructed over the fill. Also, it is noted that not all the plans were acceptable to stakeholders (the State of Ohio rejected the plans for the Alba Craft Site).

The experiences with commercial disposal facilities discussed in the USACE's answers to questions after the hearing on the FUSRAP program, shows that the waste acceptance criteria for the disposal facilities take into account the blending that occurs as a result of excavation of remedial action wastes. The commercial disposal sites and their regulators account for this unintentional blending through flexibilities concerning characterization of remedial action wastes. The flexibilities are seen in the allowable methods for concentration averaging, the treatment of radioactive hot spots in remedial action waste, and the sampling necessary to show that acceptance criteria are met for large shipments of remedial action waste.

2.5 Other Domestic Information and Experience

2.5.1 Commercial Disposal Facilities

The staff examined the licenses and the waste acceptance criteria documents for the currently operating commercial low-level radioactive waste disposal facilities (Barnwell, SC, Hanford, WA, and Clive, UT) and selected other operating disposal facilities (Waste Control Specialists, Texas and US Ecology, Idaho) that have been approved to receive certain wastes containing radioactivity [e.g., 11.e(2) and source materials; Naturally-Occurring and Accelerator-Produced Radioactive Materials; and hazardous waste contaminated with exempt quantities of

radionuclides]. Three of these disposal facilities address the topic of intentional mixing and averaging over volumes for the purpose of acceptance of waste in their waste acceptance criteria documentation. These are discussed below.

2.5.1.1 Envirocare of Utah, Inc., Clive, UT

The Bulk Waste Disposal and Treatment Facilities Waste Acceptance Criteria (WAC) for the Envirocare of Utah, Inc., facility discusses the issue of dilution and/or mixing of waste streams in Section 3.3.4, "Acceptable Forms of Radioactive Waste." Section 3.3.4 explains that Envirocare's radioactive material license from Utah allows it to receive radioactive waste in the form of soil or debris. Debris includes decommissioning (cleanup) waste and also routinely generated waste from operations including, but not limited to: radiologically contaminated paper, piping, rocks, glass, metal, concrete, wood, bricks, resins, sludges, tailings, slag, residues, and personal protective equipment (PPE), all of which must conform to the debris size requirements. (Debris received at Envirocare is split into two broad categories based on size - Standard debris is less than 25.4 cm (10 in) in at least one dimension and is no longer than 3.66 m (12 feet) in any dimension. Any debris that does not meet this definition is Oversized debris).

Waste received in the form of soil can be placed directly in the disposal area in 30.48-cm (12-inch) lifts. Debris may require additional processing, depending on its size, because any lift of waste with debris in it must not interfere with the lift -compaction requirements for the facility. The WAC goes on to say,

> "In order to comply with this license mandated criteria, Envirocare must add either clean clay or radioactive soil to this debris. Depending upon the conditions of the disposal agreement, some generators that have both soil and debris may be able to achieve cost savings by delivering these materials together such that the shipping package contains enough soil to mix with the debris to achieve compaction requirements."

The disposal practice is allowed to achieve material characteristics for proper compaction and performance of the cap placed over the waste. The result may be that concentrations in the waste are reduced, but they will be reduced below levels that are already within acceptable range (for the waste to be received in the first place). The Envirocare waste acceptance documentation does not discuss the impact on the concentrations reported in characterization information and on the shipping papers (i.e., whether a correction or change is necessary) for a shipment that has both soil and debris waste streams that end up being mixed together for disposal. So, some mixing before acceptance and during disposal is allowed, but for compaction purposes, not for dose reduction.

2.5.1.2 US Ecology, Grand View, ID

At the US Ecology, Grand View, ID facility, waste acceptance criteria have been established for accepting radiologically contaminated waste material that is not regulated by NRC under the AEA. The criteria are set forth in the Hazardous Waste Preacceptance Review section (C-2a) of the facility's Hazardous Waste Permit. The concentrations of the acceptable radionuclides are provided in a set of tables included as waste acceptance criteria. The following discussion accompanies the tables:

> Based on the categories of waste described in the waste acceptance criteria, the concentration of the various radionuclides in the conveyance (e.g., rail car gondola, other container, etc.) shall not exceed the concentration limits established in the WAC. If individual "pockets" of activity are detected indicating limits may be exceeded, the Facility Radiation Safety Officer or Facility Safety Officer shall investigate the discrepancy and estimate the extent of volume of the material with the potentially elevated radiation levels. The Radiation Safety Officer shall then make a determination of the compliance of the entire conveyance load with the appropriate WAC limits. If the conveyance is determined to meet the limits, the material may be disposed.

Thus, the WAC allows the Radiation Safety Officer to average the hot spots through the entire conveyance (package or transportation container) in order to determine whether the concentration limits are met.

2.5.1.3 WCS, Andrews County, TX

At the WCS disposal facility in Andrews County, Texas, waste acceptance criteria have been established for accepting radiologically contaminated waste material that is not regulated by NRC under the AEA. The following two requirements are contained in the waste acceptance criteria documents:

> 1.1.1 Alternate Treatment Standards for Soil
>
> RCRA defines soil, in 40 CFR Part 268.2(k), as unconsolidated earth material composing the superficial geologic strata (material overlying bedrock), consisting of clay, silt, sand, or gravel size particles as classified by the U.S. Natural Resources Conservation Service, or a mixture of such materials with liquids, sludges or solids which is inseparable by simple mechanical removal processes and is made up primarily of soil by volume based on visual inspection. Any deliberate mixing of prohibited hazardous waste with soil that changes its treatment classification (i.e., from waste to contaminated soil) is not allowed under the dilution prohibition in §268.3.
>
> 1.8 Exempt Radioactive Waste as Defined by TAC- Including Natural Occurring Radioactive Material (NORM)

Other criteria for determining if a exempt material is acceptable for disposal at WCS:

The maximum volume of material over which concentration averaging can be performed is 20 yd^3

- No single measurement that exceeds 10 times the exemption criteria shall be used to calculate an average volumetric concentration.
- The samples are representative of the material (composite samples) or conservative (maximum values).
- Each waste container is considered to be a separate item and must independently meet the exemption criteria.
- Bulk analysis (counting the entire contaminated volume) is an acceptable methodology for release of bulk material for disposal.
- For the purpose of demonstrating that exempt level radioactive material meets the requirements for disposal, a sampling and/or characterization plan/methodology may require submittal with the waste profile for site-specific approval. For bulk soil or rubblized debris, a composite sample (or equivalent waste steam specific approved methodology) will normally be required for the equivalent of 20 yd^3 volume of waste. For other waste streams, such as contaminated equipment, site-specific approval of the sampling and characterization methodology may be required.
- Surface contaminated debris can be released for disposal by direct sampling only if the material is rubblized such that bulk samples can be taken and analyzed and the activity is directly expressed as pCi/g. Surface contamination measurements cannot be converted to average bulk activity concentrations for the purpose of meeting the exemption criteria. If not rubblized, contaminated debris must meet the average surface contamination release limits [Equivalent to NRC regulatory Guide 1.86 and 25 TAC [Texas Administrative Code] 289.202(ggg)(6)]. No single surface measurement may exceed 10 times the appropriate average limited in WCS procedure RS-4.4.1-T1.

2.5.2 CRCPD-Suggested State Regulations for Control of Radiation Part N

The Conference of Radiation Control Program Director's (CRCPD) "Suggested State Regulations for Control of Radiation, Part N, Regulations and Licensing of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM)" includes the following recommended requirements:

Sec. N.8 - Disposal and Transfer of Waste for Disposal

c. TENORM waste shall not be diluted for the sole purpose of making the waste exept from the disposal requirements without prior Agency approval. The criteria in N.5 shall be used by the Agency to determine whether or not to approve such a request.

Sec. N.9 - Prohibition. Purposeful dilution to render TENORM exempt shall not be performed without prior Agency approval.

2.5.3 American National Standards Institute - HPS N13.12

The American National Standards Institute (ANSI) approved ANSI/HPS N13.12, *"Surface and Volume Radioactivity Standards for Clearance*," in August 1999. In Section 4.3, entitled, "Surface and volumetric measurements," the third paragraph contains the following guidance:

> "Items known to be contaminated at activity levels that are in excess of the clearance screening levels should not be:
>
> e) Intentionally blended with lower specific activity material for the purpose of meeting this standard . . . ."

2.5.4 Conclusions

The ANSI standards written for clearance of surface and volume radioactivity advises that intentionally blending for the purposes of meeting clearance standards should not be allowed. Also, the CRCPD-recommended regulations concerning TENORM advise that dilution should not be used to exempt materials from radiological control without prior approval of the regulatory authority.

The waste acceptance criteria from the disposal facilities are illustrative of the realities that occur with processing of waste, especially soils from remediation, other cleanup waste, debris, and contaminated media, and making decisions as to whether the waste is acceptable to be disposed of in accordance with the facility's regulatory license or permit. The Envirocare facility allows for intentional blending of wastes, upon receipt, to make sure important characteristics of the waste for long-term stability of the cover are met. The US Ecology facility allows for the concentration to be determined as averaged over the entire waste container, and for case-specific decisions to be made on any individual pockets of higher concentration. The WCS facility's criteria contain the EPA prohibition on deliberate mixing of contaminated soil with hazardous waste to circumvent treatment requirements, and allows averaging of waste in containers as long as the maximum volume of material used for averaging is 15.89 m^3 (20 yd^3), specifies a limitation on the highest single measurement that can be included in the averaging, and states that counting the entire contaminated volume of bulk material is an acceptable measurement methodology. All these criteria essentially recognize that mixing, with limitations as specified, occurs with management of bulk waste, and that is is acceptable to consider this mixing in the characterization of waste, particularly contaminated soil and media excavated at remediation sites.

2.6 International Commission on Radiological Protection, International Atomic Energy Agency, and Other International Coordinating Bodies

The staff reviewed key International Commission on Radiological Protection (ICRP), International Atomic Energy Agency (IAEA), and Nuclear Energy Agency safety documents on radioactive waste management and D&D of nuclear facilities, and consulted with staff with international and IAEA-support experience. Based on this information, insights relevant to the intentional mixing of contaminated soil are summarized below.

2.6.1 ICRP Publication 60, *1990 Recommendations of the International Commission on Radiological Protection,* and ICRP Publication 77, *Radiological Protection Policy for the Disposal of Radioactive Waste*

ICRP Publication 60 presents the latest overarching recommendations of the Commission on radiological protection. Publication 60 provides the recommended framework for radiological protection, including protection from current and ongoing practices and from intervention, the systems for protection for those two different aspects of the basic framework, and the recommendations to implement the framework and the systems to result in compliant radiological protection where radioactive materials are used.

ICRP Publication 77 provides specifications and applications of these overarching radiological protection policies for radioactive waste management. It reaffirms the Commission's current policies and clarifies the practical application of those policies to the disposal of radioactive waste.

From Publication 77:

Paragraph (3) provides terminology used by the ICRP in discussing waste management policies. . . Subparagraph (c) says:

> Waste disposal strategies can be divided into two groups described by two simple labels: *Dilute and Disperse*, and *Concentrate and Retain*. Both strategies are in common use.

Later in Publication 77, the application of the overarching policy recommendations of the ICRP are discussed in terms of these two strategies commonly used in radioactive waste management: Specifically, paragraphs (61) through (63) provide considerations that are important in the current discussion of intentional mixing:

> (61) Considerations of potential exposure have a marked effect on the use of the two disposal strategies *Dilute and Disperse*, and *Concentrate and Retain*. . . .

(62) Most waste management decisions include a choice between various options for the treatment and conditioning of waste. It is thus possible to make choices between dispersal and retention. These choices also influence the form in which the waste is presented for disposal. For example, filtering a gaseous effluent reduces the activity in the effluent but creates a solid waste.

(63) In summary, the Commission recommends that waste disposal policies should be influenced by the interaction of potential and normal exposures, and that the dispersal of radioactive waste should not be automatically regarded as less suitable than retention. Both strategies are necessary and a suitable balance between the two should be sought.

2.6.2 IAEA Safety Series No. 111-F

IAEA Safety Series No. 111-F, *The Principles of Radioactive Waste Management,* Principle 2: Protection of the Environment states, "Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment."

Paragraph 308 which elaborates on this principle says,

> "The preferred approach to radioactive waste management is concentration and containment of radionuclides rather than dilution and dispersion in the environment."

The same paragraph goes on to discuss that part of radioactive waste management can include releasing radioactive substances into the air, water, and soil, and through the reuse of material, as long as the releases are within authorized limits, and have appropriate safety and control measures in place.

Paragraph 310 also elaborates on this principle:

> Radioactive waste disposal may have adverse effects on the future availability or utilization of natural resources, for example, land, forests, surface waters, ground waters and raw materials, over extended periods of time. Radioactive waste management, therefore, should be conducted in such a way as to limit, to the extent practicable, these effects.

Principle 7 of Safety Series 111-F, Control of Radioactive Waste Generation, states,

> "Generation of radioactive waste shall be kept to the minimum practicable."

Paragraph 324, which elaborates on this principle says:

> The generation of radioactive waste shall be kept to the minimum practicable, in terms of both its activity and volume, by appropriate design measures and operating and decommissioning practices. This includes the selection and control of materials, the recycle and reuse of materials, and the implementation of appropriate operating procedures. Emphasis should be placed on the segregation of different types of waste and materials to reduce the volume of radioactive waste and facilitate its management.

2.6.3 IAEA Draft Safety Guide No. DS-161

IAEA Draft Safety Guide No. DS-161, *Radionuclide Content in Commodities Not Requiring Regulation for Purposes of Radiation Protection*, currently under review by IAEA Member States, includes discussions concerning dilution as it applies to processing radioactive material in order to meet release criteria (release criteria are called "scope-defining levels" in DS-161). Paragraph 4.7 says, "Deliberate dilution in order to meet the scope-defining levels should not be permitted without the prior approval of the Regulatory Authority." Paragraph 4.7 also discusses the processing of materials (e.g., ore) that contain natural radionuclides, to obtain commodities other than the radionuclides. In some cases, this processing will result in concentrating the radionuclides, and the draft guide suggests that in cases where this happens, the regulatory authority should decide to what extent any regulatory system should apply. It suggests further that if any of the commodities that contain the concentrated radionuclides are to be traded freely, they should meet the scope-defining levels.

2.6.4 IAEA Safety Guide No. NS-G-2.7

IAEA Safety Guide No. NS-G-2.7, "*Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants*," discusses mixing in guidance provided for the management of radioactive liquid waste streams at power plants. Paragraph 4.36 (b) says, "Waste of higher activity should not be diluted with lower activity waste if it may be easier to provide containment and shielding for a small volume of higher activity waste." Paragraph 4.36 (c) says, "Radioactive waste with a higher content of dissolved or dispersed solids should not be mixed with radioactive waste with a lower content of such solids since this would complicate the processing of the latter."

2.6.5 IAEA Technical Document No. TECDOC-1000

IAEA Technical Document No. TECDOC-1000, *Clearance of Materials Resulting from the Use of Radionuclides in Medicine, Industry, and Research*, discusses the issue of mixing in discussing the conditions under which clearance of radioactive materials should be granted. Section 3.5 of TECDOC-1000 includes this paragraph:

> The formulation of clearance should not allow for circumvention of controls which would otherwise be applicable, by such means as dilution or fractionation of the waste. Although dilution in the environment is recognized as an important factor in reducing

doses to members of the public, it is not appropriate to take relatively high specific activity materials and deliberately dilute them in order to meet the clearance criteria. One way to avoid problems of this type is to limit the total activity for all kinds of waste that are disposable under a clearance, rather than to rely solely on a concentration limit.

2.6.6 IAEA Technical Document No. TECDOC-855

IAEA Technical Document No. TECDOC-855, C*learance Levels for Radionuclides in Solid Materials*, discusses the issue of mixing in discussing how to verify that clearance levels are met. Paragraph 405 of TECDOC-855 says:

> Because it is unlikely that unconditionally cleared materials will contain truly uniform levels of contamination, procedures must be developed for determining the appropriate mass or material surface over which radionuclide quantities may be averaged. In this context, a distinction is made between averaging reasonable variations in activity throughout a contaminated mass or across a surface, and reaching clearance levels by deliberately adding relatively high specific activity materials to low activity or uncontaminated materials. The latter practice, dilution, is generally not appropriate.

2.6.7 Joint Convention National Reports

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management prepared National Reports for the First Review Meeting held in November 2003. Staff performed an extensive review of these reports as part of the US participation in the Joint Convention. The National Reports of a few countries (e.g., Denmark and Germany) include summaries of documentation in those countries, that are similar to regulations in the US, which include prohibitions on intentional mixing of waste streams to meet specific waste management regulatory goals, such as for clearance.

2.6.8 Conclusions

International radiation and radioactive waste management safety guidance documents that contain discussions of dilution or intentional mixing generally conclude that dilution for the purpose of circumventing requirements (e.g., for clearance) is not appropriate. Top-level safety guidance and policy documents also provide that both the dilute and disperse and concentration and retain waste disposal strategies are used and should be used, and that most waste management systems will includes choices that result in a mixture of the two disposal strategies. They also recommend, however, that it is preferred that the concentration and containment strategy be used for solid waste. These top-level international safety guidance documents also recommend that whenever deliberate dilution is considered, that the regulatory authority governing the activity should provide specific approval before the action takes place.

The Joint Convention on the Safety of Spent Nuclear Fuel Management and on the Safety of Radioactive Waste Management National Reports from a few countries include prohibitions on

intentional mixing of waste to meet regulatory goals, such as for clearance.

3. EVALUATIONS OF SIGNIFICANT ISSUES

Based on the information and experiences from NRC and other agencies discussed above, the staff considered a number of significant issues related to allowing implementation of intentional mixing of contaminated soil at a site to meet release criteria of the LTR. Some of the issues are relevant to whether the Commission should allow intentional mixing of contaminated soil and some are relevant to the method by which the Commission might implement allowing intentional mixing if it were approved.

3.1 Analysis in GEIS

The GEIS (NUREG-1496) prepared in support of the LTR amendments issued on July 21, 1997, did not consider a scenario that appropriately covers intentional mixing as part of the required NEPA analysis. Therefore, a NEPA analysis must be completed for consideration of allowing intentional mixing of contaminated soil to meet the release criteria of the LTR. An appropriate NEPA analysis can be completed using either a generic analysis (e.g., a supplement to the GEIS) or specific analysis for a site that uses intentional mixing to meet the LTR release criteria.

3.2 Relationship to Dispositioning Solid Material

SECY-03-0069 presented an analysis of "The Relationship Between the License Termination Rule and the Current Case-By-Case Approach for Controlling the Disposition of Solid Materials" (Attachment 5 of SECY-03-0069). That paper evaluated the relationship between the LTR's 0.25 mSv/yr (25 mrem/yr) plus ALARA for unrestricted use of a site and the existing guidance for controlling the disposition of solid materials, particularly where residual contamination might be removed from an unrestricted-use site after license termination, is unclear. The staff recommended, and the Commission approved, clarifying the relationship by explaining in the RIS that will be issued on the LTR analysis that the LTR is protective of public health if materials are removed from a site after license termination for unrestricted use, mainly because of the conservatism in the LTR technical basis and current dose-modeling assumptions, ALARA, and the effect of mixing when residual radioactivity is moved to other locations.

Staff is concerned that the introduction of intentional mixing into a proposed solution for a decommissioning site could add additional negative perceptions of the Commission's case-by-case approach to dispositioning of solid materials, or any ongoing efforts to address the issue with a rulemaking, in accordance with Commission direction. The staff sees a benefit in keeping all of the recommendations from the evaluations of all of the LTR issues together in proceeding further on resolution of the issues.

3.3 Relationship to Unimportant Quantities of Source Material [10 CFR 40.13(a)]

Attachment 2 to SECY-03-0069 discussed the relationship between the LTR release limits and the unimportant quantities of source material limit at 10 CFR 40.13(a). The LTR analysis was provided as a result of the staff's broad interpretation of Commission direction in SRM-SECY-01-0194. The SRM on SECY-01-0194 approved the staff's proposal to deny the use of the exempt quantities as a decommissioning criteria for the licensee (AAR Manufacturing, Inc.). SECY-01-0194 pointed out to the Commission that an open issue in the use of the unimportant quantities of source material in the current rule was whether material could be intentionally diluted to achieve the criteria of 10 CFR 40.13(a). The staff recommendation approved by the Commission in SECY-03-0069 is that the RIS to be published on the LTR analysis will include the NRC position that the exempt quantities in 10 CFR 40.13 (a) should not be used as decommissioning criteria under the LTR.

In related actions that are discussed in the LTR analysis, an SRM dated March 29, 2002, provided Commission approval to publish a proposed rule, "Transfers of Certain Source Materials by Specific Licensees," amending 10 CFR 40.51. The proposed rule was published in the Federal Register on August 28, 2002 (67 FR 55175), and it specifically asked for comments on adding regulatory language prohibiting dilution, as directed by the SRM to an earlier Commission paper (SECY-00-0201) (See Section 2.1.1.4 of this attachment).

In a June 24, 2003, Commission paper (SECY-03-0106), the staff asked for Commission approval to postpone further action on the final rule until the Commission had an opportunity to review associated issues that could impact the action taken in the final rule. The issues were primarily related to: SECY-03-068 ("Interagency Jurisdictional Working Group Evaluating the Regulation of Low-Level Source Material or Materials Containing Less than 0.05 Percent by Weight Concentration Uranium and/or Thorium," issued on May 1, 2003; disposition of solid materials (see Section 3.2); and recent discussions between EPA and NRC that would allow certain low-level wastes to be disposed of in Resources Conversation and Recovery Act (RCRA) sites (see Section 4.4). The Commission approved postponement. As a result, this rulemaking does not resolve this dilution issue.

3.4 Environmental Impact Analysis

In considering whether to allow for intentional mixing of contaminated soil to meet the LTR release criteria, the possible environmental impacts should be evaluated. Although it is impossible to quantify any impacts without actually applying a scenario to an actual site or creating a generic site, the scenarios carried forward from the options analysis for allowing intentional mixing have certain potential ramifications regarding the environment that would need to be evaluated.

3.4.1 Groundwater Impacts - If a site were allowed to mix contaminated soil in a way that it was disposed of at a greater depth than the contamination was originally found, then this could have more impact on the groundwater at the site.

3.4.2 Land Use Impacts - The final configuration of the site following the allowed mixing of contaminated soil and how land and soil is utilized

3.4.3 Social Impacts - Intentional mixing results in a scenario where more total inventory of radionuclides is left onsite than alternatives involving disposal of wastes offsite. This could have more potential societal impacts at the site (e.g., perception of the land value diminishes).

3.4.4 Analysis of Alternatives - The impacts of intentionally mixing to meet the LTR criteria versus an alternative of no action (leaving the site as is, perhaps because of limited funds).

3.4.5 Transportation Impacts - The impacts of excavating and transporting the waste to an offsite waste disposal facility versus leaving the contamination onsite.

The possible environmental impacts of any scenarios consider for allowing intentional mixing of contaminated soil must be considered in deciding whether to allow intentional mixing to meet the LTR, and also in determining possible limitations on how it is applied at a facility that proposes to implement mixing.

3.5 Safety Evaluation

Another consideration that should be taken into account in allowing mixing of contaminated soil to meet LTR release criteria is the health impacts. Although it is also not possible to quantify any impacts without actually applying a scenario to an actual site, implementing intentional mixing has potential ramifications on health impacts in a generic sense that scenarios in which mixing is not employed do not.

3.5.1 Health Impacts of Intentional Mixing

If a site were not allowed to mix contaminated soil, it is likely that the site would excavate the contaminated areas, package the material for shipment, and dispose of it as waste at a licensed disposal facility (as long as resources are available). On the other hand, if mixing of contaminated soil were allowed, the site would be retaining the contaminated soil, thereby increasing the total inventory of radioactivity managed at the site, although the concentrations for the purposes of dose analysis would meet the applicable LTR criterion. Other health impact considerations that are different for these two scenarios include the total radionuclide inventory at the disposal facility, and the impacts of transporting the waste to the offsite disposal facility.

3.5.2 ALARA Considerations

Compared to the typical scenario, where contaminated soil is excavated and shipped offsite, allowing intentional mixing would impact the ALARA analysis for the site terminating its license. Because more inventory of radioactivity would be remaining onsite for disposal and the site operators would be required to perform mixing of contaminated soils, the tradeoffs between dose to workers, dose to a maximally exposed individuals, the population dose, and the costs to complete the cleanup will be different, resulting in different factors important to the ALARA considerations.

3.6 Consistency with NRC Positions

The practice of NRC, to date, has been to discourage intentional mixing of volume-contaminated material as a step in waste management, unless the mixing is part of normal operations, and is not solely to change waste characteristics or classification. NRC has recognized that mixing occurs as a result of standard excavating procedures that occur at sites being cleaned up, and allows consideration of this in dose analysis and in determining the characterization and classification of wastes resulting from the excavation. However, intentionally mixing a waste stream with clean materials for meeting waste management goals has not been allowed, and even intentional mixing of waste materials from different sources or with differing contamination levels would not generally be allowed if the sole reason for the blending were to change the waste classification.

Allowing intentional mixing could be perceived by stakeholders who are opposed to the nuclear industry or to the uses of radioactive materials as a change in these NRC practices. Approval of intentional mixing of contaminated soil at a decommissioning site will be done consistently with the framework for protection of public health and safety and the environment that is established in the Commission's regulations. Stakeholder involvement provided by the NEPA review or by the DP approval process should help in addressing the perception that NRC is being inconsistent.

3.7 Consistency with Other US Agencies Policies

Based on the information presented previously, no other US agencies that have a significant role in managing radioactive materials have policies that address intentional mixing, either in rules, policy statements, or similar documents. In considering allowing intentional mixing, the Commission is engaging in a precedent-setting activity. EPA has at least considered this issue for hazardous wastes, since it has banned mixing certain hazardous waste streams intentionally, unless certain conditions are met, and has prohibited mixing hazardous waste with soil to create contamination soil, which can be managed in accordance with less stringent EPA requirements.

3.8 Consistency with Policies of International Organizations and Other Countries

International organizations with roles in radioactive waste management (i.e., ICRP, IAEA) have addressed dilution in guidance documents they have issued. Generally, these guidance documents discourage dilution of solid materials to meet waste management goals, although they also contain suggestions that if dilution is allowed, that the responsible regulatory agency should approve its application. Additionally, some countries have addressed dilution in their "National Reports for the First Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management." These discussions generally discourage dilution to meet waste management goals, particularly with respect to "Clearance." An allowance for intentional mixing to meet LTR clearance criteria could easily be perceived as contrary to the preferences of the international community on how to best manage radioactive waste.

3.9 Public Acceptance

Implementation of a policy to allow mixing of contaminated soil at a decommissioning site is likely to meet with resistance from the public, particularly if other solutions are perceived to be available. There are two subissues that the staff has identified, which involvement of stakeholders will probably revolve around:

3.9.1 Creation of a Disposal Site

The reaction to the use of rubblization discussed earlier illustrates that a perception exists that a disposal site is being created when a solution at a remediation site is to leave contaminated material onsite, where an alternative that could be selected involves exhuming material and disposing of it offsite. At the very least, the public strongly prefers the removal of contamination from nuclear facilities being decommissioned, rather than leaving any of it onsite. If intentional mixing were allowed at a decommissioning site to meet release criteria where an alternative is considered to ship offsite, this potential negative reaction would probably surface. Staff believes that the current practice of the NRC expressed several times in correspondence discussed earlier could partially address this stakeholder concern, and should continue. That practice is to consider mixing in the context of an overall approach to the site cleanup, which includes the application of the ALARA principal and considers only those cases where it can be demonstrated that removal of the soil would not be reasonably achievable. A site where there is a severe shortfall of funding to complete cleanup may be a case where it is unreasonable to remove the soil and where an alternative using mixing could provide a solution to meet the LTR release criteria.

The approach used at Superfund sites could also be useful in combating this perception, since leaving contamination onsite is quite common for the chosen remedies at Superfund sites. In the principles mandated by Congress, and the decision criteria that are used in selecting the preferred remedy for a Superfund cleanup, there are strong preferences for treatment of wastes and contamination, so as to create a safer condition. Many remedies that are chosen and

agreed on by the impacted stakeholders include treatment steps, followed by disposal onsite, many times returning the media right back where they were excavated. This is done when the treatment renders the media clean, and also when the treatment performs a function that reduces the mobility, such as stabilization or solidification, but does not necessarily render the media clean. The preference for treatment in the Superfund remedy selection process seems to lead to easier final disposition decisions, and a similar emphasis (i.e., preference for treatment followed by disposal) may be beneficial for LTR sites, especially "legacy" sites, where a long-term commitment of the resource is necessary.

3.9.2 Mixing as Treatment

Since it is a step leading to disposal, intentional mixing could be perceived as serving a function that is basically analogous to waste treatment. However, it will not meet the intention of waste treatment to either reduce the toxicity or mobility of the hazardous constituents. It could also be arguable, depending on how the blending was achieved, whether it is reducing the volume or amount of contamination requiring containment. In short, the only obvious intention of mixing of contaminated soil is to result in meeting criteria for release of the facility from the license (although this intention is focused on the overarching criterion that demonstrates public health and safety and the environment are adequately protected).

In order to address the concerns posed by these two subissues, possibly (a) performing an additional step of treatment (stabilization or solidification) for blended contaminated media that will be disposed of onsite, or (b) having additional controls (e.g., only allowing intentional mixing for restricted release or requiring institutional controls of some kind for unrestricted release where mixing takes place), or (c) setting limitations (e.g., disposal area containing mixture has thicker cap as an additional safeguard), could be considered.

3.10 Conclusions

Intentional mixing was not addressed in the GEIS that supports the LTR rulemaking. Generic or site-specific NEPA analysis must be completed to allow intentional mixing of contaminated soils. There are many issues concerning the Commission's work on "Clearance" and "Unimportant Quantities of Source Material," and allowing intentional mixing of contaminated soils to meet LTR release criteria might complicate or confuse those efforts. There are specific environmental and health impacts of different ways that intentional mixing could be applied that should be considered in deciding whether to approve intentional mixing and how to implement allowing intentional mixing if it is approved. However, it appears that intentional mixing of contaminated soil would be consistent with the protection of public health and safety, as the result would mean the dose criteria of the LTR were being met.

Allowing intentional mixing could be viewed as contrary: (a) to existing NRC policies and positions; (b) to the positions and policies of other US agencies that have a role in management of radioactive waste; (c) to the guidance of international bodies involved in radioactive waste management; and (d) even to the policies of certain countries towards their management of

radioactive waste. Stakeholder involvement would be necessary from an early stage of implementation of allowing intentional mixing to address these views. Stakeholder involvement would be necessary also to address concerns the public might have that a disposal site is being created or that the real intent of performing mixing is to meet regulatory criteria that would not otherwise be met if this approach to meeting the LTR criteria were allowed. The NRC should continue the current practice it has expressed several times that mixing and/or dilution should only be used in the context of an overall approach to site cleanup, which includes the application of the ALARA principle and considers only cases where it can be demonstrated that removal of the soil would not be reasonably achievable.

4. EVALUATIONS OF OTHER CONSIDERATIONS

4.1 Relationship to NRC's Four Performance Goals

Attachment 12 of SECY-03-0069 provided an analysis of the "Major Outcomes of License Termination Rule Recommendations with Respect to NRC's Four Performance Goals." The following paragraphs address the contributions to those outcomes if intentional mixing at some sites undergoing license termination were allowed:

4.1.1 Maintain Safety, Protection of the Environment, and the Common Defense and Security.

Could contribute to achieving the restricted release/alternate criteria provisions of the LTR (if an approach is chosen that permits this in implementation) that, combined with other recommended changes to the LTR in SECY-03-0069. May also reduce the risk from these sites by reducing the dose levels as a result of mixing.

Could improve the risk-informed implementation of the LTR.

Will only allow mixing where it can be shown to be safe [or at acceptable levels (i.e., 0.25 mSv/y (25 mrem/y) < dose < 1 mSv/y (100mrem/y) for restricted release or dose < 0.25 mSv/y (25 mrem/y) for unrestricted release]

4.1.2 Make NRC Activities and Decisions More Effective, Efficient, and Realistic.

Could Increase NRC flexibility by providing an option for potential solutions to complex decommissioning sites that have limited resources.

Could provide an option to more efficiently use available funds from licensees with limited financial resources, and could reduce the expenditure of large amounts of

Federal government funds to finish cleanup of these sites when the licensee resources are expended.

4.1.3 Reduce Unnecessary Burden on Stakeholders.

Since recommended option would allow blending to meet unrestricted release and to otherwise facilitate license termination, it would reduce the regulatory burden on licensees during decommissioning.

4.1.4 Increase Public Confidence.

Could result in a decrease in public confidence in NRC regulatory decisionmaking. This decrease could be reduced somewhat if stakeholders perceived that NRC cleanup decisions were being made more consistently like CERCLA Superfund site cleanup decisions (See the next section).

4.2 Framework for Remedy Selection under CERCLA

The framework and the criteria used for Superfund remedy selection under CERCLA are compared to the framework and elements of NRC decisions on releasing sites under the LTR, in Table 4.1. As can be seen, the decision-making criteria used under CERCLA by EPA and the States is very similar to that used by NRC in releasing sites under the LTR. The ultimate goal is the same, that of cleaning up a site and returning it for productive use, if possible.

The two threshold criteria of the Superfund framework are essentially embodied in NRC's

Table 4.1 - Comparison of Superfund Remedy Selection and NRC LTR Release Decision Frameworks

Superfund Framework	NRC LTR Framework
Threshold Criteria	Dose Requirements
Overall Protection of Health and Environment	Release Criteria of LTR
Compliance with ARARs	Unrestricted Release
	Restricted Release
Balancing Criteria	Alternate Criteria
Long-term Effectiveness and Permanence	Other Requirements
Short-term Effectiveness	ALARA/Cost
Reduction of Toxicity, Mobility, or Volume thru Treatment	Stakeholder Advice
Implementability	Institutional Controls
Cost	Financial Assurances
	Specific Commission Approval (For Alternate Criteria)
Modifying Criteria	
State Acceptance	
Community Acceptance	

Notes: NRC - U.S. Nuclear Regulatory Commission; LTR - License Termination Rule; ARARs - Applicable or Relevant and Appropriate Requirements; ALARA - As Low As Is Reasonably Achievable.

release criteria in the LTR. As shown, some of the primary balancing and modifying criteria are also included in the NRC framework for determining the acceptability of the approach for releasing a site under the LTR.

The CERCLA framework for decision-making allows for the flexibility of evaluating and approving several approaches to meeting the cleanup goals at a site, including innovative approaches, as long as the threshold criteria are met. It could be argued that it is possible under the similar NRC framework and criteria, to also evaluate and approve several approaches, including innovative approaches, as long as the release criteria are met. One approach could be allowing intentional mixing of contaminated soil.

4.3 Impact on Operating Facilities

Implementation of a policy to allow mixing of contaminated soil at a decommissioning site under the LTR will not necessarily afford a similar alternative to operating facilities, such as intentional mixing of different waste streams that could lead to a change in the waste characteristics or classification (e.g., mixing waste streams that result in a change in its 10 CFR Part 61 classification) , and a concomitant cost savings associated with the change. Policies on waste characterization and classification for operating facilities would remain the same, consistent with international guidance on providing a different approach toward cleaning up contamination from the past versus appropriate waste management of currently generated waste streams, to prevent the same problems that are being addressed at cleanup sites. Implementation of a policy to allow mixing of contaminated soil at a decommissioning site must be adequately justified, especially in terms of the potential cost and exposure savings that could result, and the fact that these savings are not being afforded to an operating licensee if a similar policy existed.

4.4 EPA ANPR on Low-Activity Low-Level Radioactive Waste

On November 18, 2003, EPA published an ANPR in the Federal Register, entitled, “40 CFR Chapter 1, Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste: Request for Comment; Proposed Rule” (68 FR 65120). The ANPR requests comments on a variety of issues and questions about a proposal to allow hazardous waste disposal facilities permitted under RCRA Subtitle C to accept certain low-activity radioactive wastes for disposal. The ANPR states that the easiest way EPA envisions this occurring at this point is to establish concentration limits for radionuclides below which mixed low-level waste and some other low-activity radioactive wastes could be disposed of in the Subtitle C facility. The ANPR anticipates that both EPA and NRC would have to perform some regulatory actions to allow this disposal option to occur. The ANPR suggests that if all the disposal options for low-activity radioactive waste were allowed under the new proposals, that as many as 20 subtitle C hazardous waste disposal facilities might be available for radioactive waste disposal, compared to the three low-level waste disposal facilities operating now. Furthermore, increased availability could reduce the cost of low-activity disposal making offsite disposal available for more decommissioning sites.

Staff is in the process of commenting on the ANPR. Staff is concerned that, since concentration limits are the bases favored by the EPA, in the ANPR, for allowing low-activity

radioactive waste into Subtitle C disposal facilities, that any policy actions on allowing intentional mixing under the LTR is confusing with respect to the ANPR, and may affect the efforts of NRC and EPA related to the proposals in the ANPR. This is particularly true if mixing were allowed to meet the waste acceptance criteria of a disposal facility, as has been approved by NRC in the past.

4.5 Conclusions

Allowing intentional mixing of contaminated soil at sites terminating licenses would increase NRC's flexibility in determining compliance with the LTR release criteria and possibly make the restricted release and alternative criteria provisions of the LTR more viable. This flexibility could be further justified because the NRC decision-making framework for releasing sites under the LTR is very similar to the framework used under CERCLA to determine remedy selection. Intentional mixing of waste streams to meet other waste management criteria (e.g., the classification system of Part 61), is not being evaluated. If approved, the reasoning for allowing intentional mixing to meet LTR release criteria must discuss the difference between allowing mixing of contaminated soils at a decommissioning site to facilitate meeting the LTR and not allowing mixing of waste streams at an operating facility to meet other waste management goals. The staff must solicit comments and information, from EPA, concerning the ANPR on management of low-activity radioactive waste disposal at RCRA subtitle C sites, and the implication of allowing intentional mixing of contaminated soil, particularly the application of using intentional mixing to meet waste acceptance criteria of a disposal site.

APPENDIX

ABBREVIATIONS AND ACRONYMS

AAR	AAR Manufacturing Group, Inc. site, MI
AEA	Atomic Energy Act
ALARA	As Low as is Reasonably Achievable
ANPR	Advance Notice of Proposed Rulemaking
ANSI	American National Standards Institute
AOC	EPA Administrative Order of Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ATK	Alliant Integrated Defense Company, LLC
Bq/kg	Becquerels per kilogram
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CRCPD	Conference of Radiation Control Program Directors
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FR	**Federal Register**
FUSRAP	Formerly Utilized Sites Remedial Action Program
GEIS	Generic Environmental Impact Statement
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
LACOB	L-Area Oil and Chemical Basin (at DOE Savannah River Site, SC)
LDRs	Land Disposal Restrictions
LLW	Low-Level Waste
LSA	low-specific activity
LTR	License Termination Rule
m^3	cubic meters
mrem	millirem
mrem/y	millirem per year
mSv	millisievert
mSv/y	millisievert per year
NARM	Naturally-Occurring and Accelerator-Produced Radioactive Materials
NEI	Nuclear Energy Institute

NEPA	National Environmental Policy Act
NMSS	Office of Nuclear Material Safety and Safeguards, NRC
NORM	Naturally-Occurring Radioactive Materials
NPL	National Priority List (Superfund sites)
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site Department of Energy Disposal Facility, NV
OGC	Office of General Counsel, NRC
OSP	Office of State and Tribal Programs, NRC
PADEP	Pennsylvania Department of Environmental Protection
PCBs	Polychlorinated Biphenyls
pCi	picocuries
pCi/g	picocuries per gram
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RIS	Regulatory Information Summary
ROD	Record of Decision
SLC	Safety Light Corporation site, PA
SMC	Shieldalloy Metalurgical Company site, NJ
SRM	Staff Requirements Memorandum
SRS	Savannah River Site, SC
TAC	Texas Administrative Code
TDH	Texas Department of Health
TENORM	Technologically-Enhanced Naturally-Occurring Radioactive Material
TRU	Transuranic Waste
US	United States
USACE	U.S. Army Corps of Engineers
VOCs	Volatile Organic Compounds
WAC	Waste Acceptance Criteria
WCS	Waste Control Specialists, TX
WDEQ	Wyoming Department of Environmental Quality
yd^3	cubic yards