POLICY ISSUE
(Notation Vote)

April 7, 2010 SECY-10-0043

FOR: The Commissioners

FROM: R. W. Borchardt
Executive Director for Operations

SUBJECT: BLENDING OF LOW-LEVEL RADIOACTIVE WASTE

PURPOSE:

To provide the Commission with the results of the staff's analysis of issues associated with the blending of low-level radioactive waste (LLRW), as directed in Chairman Jaczko's October 8, 2009, memorandum to the staff. The closure of the Barnwell waste disposal facility to most U.S. generators of Class B and C LLRW has caused industry to examine methods for reducing the amount of these wastes, including the blending of some types of Class B and C waste with similar Class A wastes to produce a Class A mixture that can be disposed of at a currently licensed facility. This paper identifies policy, safety, and regulatory issues associated with LLRW blending, provides options for a U. S. Nuclear Regulatory Commission (NRC) blending position, and makes a recommendation for a future blending policy. This paper does not address any new commitments.

SUMMARY:

In this paper, the staff examines the blending or mixing of LLRW with higher concentrations of radionuclides with LLRW with lower concentrations of radionuclides to form a final homogeneous mixture. While recognizing that some mixing of waste is unavoidable, and may even be necessary and appropriate for efficiency or dose reduction purposes, NRC has historically discouraged mixing LLRW to lower the classification of waste in other circumstances.

CONTACTS: James E. Kennedy, FSME/DWMEP
(301) 415-6668

A. Christianne Ridge, FSME/DWMEP
(301) 415-5673

With the closure of the Barnwell LLRW disposal facility on June 30, 2008, to most U.S. generators of Class B and C wastes, licensees and industry are exploring blending higher concentration wastes with lower concentration wastes to produce a final mixture of Class A waste. Such mixing could promote the goal of disposal of waste, rather than its storage onsite, since Class A waste can be disposed of at a currently operating disposal facility. The agency's previous policies and positions on blending of LLRW are evaluated in this paper in light of these new circumstances, and options for new agency positions on blending are provided for Commission consideration. The assumption that blending is *a priori* undesirable is examined in light of risk-informed, performance-based regulation that focuses on the safety hazard of blending and the blended materials. Other alternatives for a blending position are also considered, including several that would impose additional constraints. The Enclosure is a detailed analysis of blending of LLRW. Section 4.0 of the Enclosure addresses the specific topics contained in the Chairman's October 9, 2009, memorandum.

The staff believes that the current LLRW blending guidance would be improved if it were risk-informed and performance-based, consistent with NRC's overall policy for regulation. This change could be accomplished in part through revisions to two guidance documents, the Branch Technical Position on Concentration Averaging and Encapsulation[1] (CA BTP) and the Commission's Policy Statement on Low-Level Waste Volume Reduction (Policy Statement).[2] In addition, the staff would clarify that large quantities of blended waste are considered a unique waste stream and included in NRC's ongoing rulemaking on this topic. These changes would ensure continued safety by requiring that disposal of large-scale blended waste is subjected to a site-specific intruder analysis as part of the overall performance assessment of a disposal facility. The changes would also improve NRC openness and effectiveness by clarifying the agency's LLRW blending policy and its bases.

<u>BACKGROUND</u>:

On June 30, 2008, the Barnwell disposal facility closed to most LLRW generators in the U.S. Now, only generators in the Atlantic Compact — the States of South Carolina, Connecticut, and New Jersey — can dispose of their LLRW at that facility. Although the Energy*Solutions* disposal facility in Clive, Utah remains available for Class A waste disposal by the generators that lost access to Barnwell, these generators have no disposal option for their Class B and C waste.

Licensees and industry are considering the blending of certain types of LLRW to help mitigate the impact of Barnwell's closure. One type of waste being considered for blending is ion exchange resins from nuclear power plants, which can be blended into a relatively uniform mixture. These resins account for about half of the volume of Class B and C waste generated each year. Resins are also the focus of a waste processor's expanded LLRW blending at its facility in the State of Tennessee. The waste processor has received approval for testing from its Agreement State regulator, and is continuing to develop a process for large-scale blending. Because disposal options were available for all classes of LLRW in the recent past, the agency's positions on blending were not challenged and required no further clarification.

---

[1] Final Branch Technical Position on Concentration Averaging and Encapsulation, January 17, 1995.

[2] Policy Statement on Low-Level Waste Volume Reduction, 46 FR 51100, October 16, 1981.

However, the proposal to perform large-scale off-site blending has generated significant interest in the subject of blending and NRC's position on this practice. Objectives of this paper include the identification of specific safety, policy, and regulatory considerations that underlie the positions in the staff blending guidance to better inform potential revisions, as well as to identify and address concerns raised by stakeholders on blending.

Blending, as the staff uses the term in this paper, is the mixing of LLRW with different concentrations of radionuclides, which results in a relatively homogeneous mixture that may be appropriate for disposal in a licensed facility. The concentration of the resulting mixture is the total radioactivity in the mixture divided by its volume or weight. The types of waste may include those that are physically and chemically similar (such as ion-exchange resins from nuclear power plant systems), but could also include different waste types that can be made into a relatively homogeneous final mixture, such as soil and ash. Blending, as used in this paper, does not include placement of discrete wastes of varying concentrations into a disposal container, or the averaging of concentrations of radioactivity of a discrete component over its volume. Blending, as discussed in this paper, is confined to waste types that have physical properties that result in a homogeneous final waste form (the degree of homogeneity of the final waste form would be considered as part of the staff's analysis of this issue).

In the past, NRC has discouraged the blending or dilution of radioactive waste, without distinguishing between the two practices. Among the reasons given are not increasing "the burden on society" by increasing waste volume, and therefore the number of waste shipments for disposal. However, mixing or blending of waste with Class B or C concentrations with Class A would not increase the volume of waste.

This paper does not use the term "blending" in the sense of dilution (i.e., the intentional mixing of waste with clean or uncontaminated material to lower its waste classification or to release it into the general environment). The release of waste to the general environment could cause members of the public to be exposed to a hazard, however small. The use of dilution to facilitate disposal at a lower waste class would increase waste volumes, which has historically been considered undesirable. The staff notes that the terms "blending" and "dilution" are frequently used synonymously. The staff differentiates these terms as defined above.

The terms "mixing," "blending," and "dilution" are neither defined nor used in the Commission's regulations that relate to reducing a potential waste classification, or to disposal requirements for waste. Blending, including blending that lowers the waste classification, is neither prohibited nor explicitly addressed in NRC regulations.

NRC staff's guidance on LLRW blending is contained in the CA BTP. The CA BTP provides guidance to licensees on blending of LLRW, and on methods of radionuclide concentration averaging, such as encapsulation of sealed sources and the mixing of components with different waste concentrations in containers. With respect to the blending of wastes into a homogeneous final waste form, the staff in the CA BTP recommends restrictions on blending by applying a "factor of 10" provision, whereby the concentrations of batches of LLRW to be mixed should be within a factor of 10 of the average concentration of the final mixture. This limits the amount of blending that should be performed. Applying a risk-informed, performance-based approach would define the uniformity of concentration in the waste after mixing, rather than the CA BTP's approach of placing concentration limits on the wastes before they are mixed. By placing limits on the amount of mixing, however, the "factor of 10 rule" furthers the position that mixing should not be used solely to reduce waste classification. The staff in the CA BTP recommends exceptions to the "factor of 10 rule" when operational efficiency or worker dose reductions can be demonstrated. The staff's positions are based on a combination of: (1) practical considerations in the operation of a facility, whereby wastes are routinely combined or mixed for operational efficiency; (2) NRC's general policy that discourages mixing for the purposes of reducing the waste class; and (3) safety considerations mainly associated with protection of an individual who inadvertently intrudes into a disposal facility 100 years or more after its closure. The CA BTP attempts to balance these objectives.

Part 61 of 10 CFR establishes the procedures, criteria, and terms and conditions for the issuance of licenses for the disposal of LLRW. Four performance objectives, including protection of an inadvertent intruder into the waste disposal site, define the overall level of safety to be achieved by disposal.[3] Intruder protection is provided in part by the waste classification concentration limits in 10 CFR § 61.55, which are designed to ensure that an inadvertent intruder is not exposed to unsafe levels of radiation. Any blended LLRW must be classified in accordance with the waste classification tables in 10 CFR § 61.55. If batches of waste were not blended into a relatively homogeneous[4] final mixture, hot spots above the concentration limits for a particular waste class might expose an inadvertent intruder to unsafe levels of radiation. Concentrations of radionuclides that are used to determine the waste classification may be averaged over the volume or weight of the waste, in accordance with 10 CFR § 61.55(a)(8), and the staff has published guidance that defines acceptable approaches for such averaging. This guidance would have to be revised to address large-scale blending of waste. Blended waste, like any waste, must not affect a disposal facility's ability to meet any of the performance objectives in 10 CFR § Part 61.

DISCUSSION:

This section identifies a number of different options for addressing blending in NRC's LLRW regulatory framework. The options are designed to address the policy, technical (safety), and regulatory issues discussed in the Enclosure. The policy issues the staff evaluated include (a) NRC's past statements on blending to reduce waste class; (b) facilitation of waste disposal through blending; (c) the impact on the LLRW management program in the U.S.; (d) impacts of blending on disposal capacity; (e) impacts on volume reduction; (f) unintended consequences of changing the Commission's blending position; and (g) blending of greater-than-Class C LLRW. The safety issues evaluated include (a) protection of an offsite member of the public (10 CFR § 61.41); (b) protection of an inadvertent intruder into a disposal facility after the institutional control period ends (10 CFR § 61.42); (c) waste characterization and homogeneity; and (d) stability of the waste form. Regulatory issues include (a) the method for issuing an NRC position on blending; (b) National Environmental Policy Act (NEPA) compliance; and (c) the applicability of NRC's guidance to waste processors.

[3] The others are protection of the general population from releases of radioactivity; protection of individuals during the operation of the facility (as opposed to after the facility is closed) and stability of the disposal site.

[4] Because hot spots are a concern primarily with respect to protection of an individual who may inadvertently intruder into the waste after the end of the institutional control of the site, the CA BTP defines a "homogeneous waste type" as one in which the radionuclide concentrations are likely to approach uniformity in the context of intruder scenarios.

Options

The staff has identified four options for regulatory actions that NRC could undertake regarding blending of different types and classes of LLRW. These range from maintaining the status quo, to constraining all blending, to a risk-informed, performance-based approach. Each option also includes a discussion of how the staff believes that option can be effectively implemented (i.e., whether by rulemaking or guidance). In developing these options, the staff's goal was to provide the Commission with a broad range of options for a policy on blending, and to identify an appropriate means to implement that policy.

Option 1: Maintain current NRC positions on blending of homogeneous waste streams (status quo).

Under this option, the Commission would not change its existing positions on the use of blending as discussed in the CA BTP. This guidance recommends constraints on blending through the use of the "factor of 10" provision, which limits mixing of homogeneous waste streams to batches of waste that are within a factor of 10 of the average concentration after mixing. But the current staff position also acknowledges that blending is appropriate without the constraints of the CA BTP if it results in operational efficiencies or worker dose reductions.

NRC staff responses to three letters from industry representatives in late 2009 provide additional clarification on blending, and these clarifications are also part of the status quo.[5] These letters include the following clarifications: (a) blending is neither prohibited nor explicitly addressed in NRC regulations; (b) while the staff has stated that wastes should not be mixed *solely* to lower the waste classification, NRC guidance acknowledges that blending, including some blending that may lower the waste classification, may be appropriate under certain circumstances; (c) waste classification is related to the safety of the disposed waste, and NRC regulations do not require waste to be classified prior to its shipment for disposal, including when it is shipped to waste processors; and (d) NRC's blending guidance applies to all NRC licensees, including waste processors.

This option would be implemented by updating the CA BTP and issuing a Regulatory Issue Summary that documents staff positions in recent letters to industry. For the CA BTP, the staff would simply clarify terms, and better describe the bases for its positions. Among the advantages of this option are that licensees and Agreement States are familiar with the current averaging provisions in the CA BTP and use them extensively, and issuing guidance uses fewer resources to update the agency policy than the other options. Among the disadvantages are that this option could lead to inconsistent treatment of LLRW that could vary according to where the waste is generated, processed, and/or disposed, because guidance lacks the potential compatibility requirements of a rule. Nearly all waste processors and disposal facilities are regulated by Agreement States that are not required to follow NRC guidance. Waste blended and classified in accordance with the requirements of the State in which the generator or processor is located may not be accepted for disposal at a site in another State that has adopted different waste classification and blending criteria. Another disadvantage is that the

[5] August 27, 2009, letter from Larry Camper to Thomas Magette, EnergySolutions. (ML092170561); October 30, 2009, letter from Larry Camper to Joseph DiCamillo, Studsvik, Inc.. (ML092930251); October 30, 2009, letter from Larry Camper to Scott Kirk, Waste Control Specialists. (ML092920426).

existing positions are not risk-informed and performance-based. Finally, there is a potential safety concern for an inadvertent intruder involving disposal of large-scale blended waste that would need to be evaluated on a case-by-case basis. While the need to protect an inadvertent intruder is specified in 10 CFR Part 61, there is some confusion concerning the requirement to conduct an analysis to ensure protection of an inadvertent intruder that may not be clarified if the status quo is maintained. The safety of an inadvertent intruder is typically ensured by the waste classification system and the disposal requirements imposed for each class of waste, and not necessarily or typically by a site-specific analysis.

Option 2: Revise blending positions to be risk-informed and performance-based.

Under this option, the agency's position on blending of waste streams would become risk-informed, performance-based, rather than, for example, relying on the "factor of 10" provision in the current guidance. The principal consideration would be whether a final blended waste form could be safely disposed of. Among the changes and clarifications that would be made to the existing blending positions are the following: (a) clarify that a site-specific intruder analysis must be performed to determine whether an intruder could be protected, or the conditions necessary for such protection; (b) develop criteria defining acceptable homogeneity and sampling considerations; and (c) eliminate the "factor of 10 rule" for mixing of wastes that can be blended into a homogeneous mixture, because the concentration of final mixture will be relatively uniform in the context of a site-specific intruder scenario.

This option would be consistent with the Commission's policy on risk-informed, performance-based regulation. In 1997, the Commission addressed risk-informed performance-based regulation as one of the 20 direction setting issues in its overall Strategic Assessment of the agency's programs at that time, deciding that NRC ". . . will have a regulatory focus on those licensee activities that pose the greatest risk to the public." In the last decade, increased use of risk-informed performance-based regulation has been a continuing agency policy and is one of the safety strategies in the NRC Strategic Plan[6] that guides work in all NRC programs.

This option would be implemented through a combination of rulemaking and issuance of guidance. The requirement for a site-specific intruder analysis, which is a risk-informed, performance-based approach to addressing blending, would be mandated in the rulemaking for unique waste streams, which the Commission directed the staff to start in its March 18, 2009, staff requirements memorandum for SECY-08-0147. The rulemaking would explicitly require a site-specific analysis for an inadvertent intruder. Under this approach, disposal of large amounts of blended waste would have to be evaluated for intruder protection on a site-specific basis. As part of the NEPA analysis for this rulemaking, disposal of blended ion exchange resins from a central processing facility would be compared to direct disposal of the resins, onsite storage of certain wastes when disposal is not possible and further volume reduction of the Class B and C concentration resins. The regulatory basis document for this rulemaking is scheduled to be completed in September 2010, and the staff would begin work on the proposed rule at that time. The staff does not believe that the addition of blended waste to the regulatory basis will require significant resources or time to complete. Nevertheless, if the Commission decision on this paper occurs late in Fiscal Year (FY) 2010 or in FY 2011, the regulatory basis document or proposed rulemaking schedules may have to be revised somewhat to

[6] "Strategic Plan, Fiscal Years 2009-2013. NUREG-1614, Volume 4. February 2008.

accommodate the addition of blended waste to the rulemaking. The staff will take steps to mitigate any impacts in the meantime. There would be no impact on the schedule for the unique waste streams rulemaking if the Commission chooses any of the other options.

Two documents would be updated as part of this option — the Volume Reduction Policy Statement and the CA BTP. The Policy Statement, published in 1981, encourages licensees to take steps to reduce the amount of waste generated and to reduce its volume once generated. That position was issued when disposal space was scarce since two of the three operating LLRW disposal sites had threatened to close at that time, and one had recently reduced the annual amount authorized for disposal by half. Further, volume reduction techniques were not yet in widespread use and NRC's Policy Statement was meant to encourage the use of such techniques. Although the Policy Statement does not address blending directly, some stakeholders have argued that blending is contrary to the policy and to the goal of achieving reduced waste volumes. Notwithstanding NRC's policy, volume reduction is widely practiced today, in large part because disposal costs have risen significantly in the last 30 years and it is economical to reduce disposal volumes. The staff believes that the Policy Statement could be updated to recognize the progress that has been achieved, and to acknowledge that other factors may be used by licensees in determining how best to manage their LLRW. Specifically, the Policy Statement could be revised to acknowledge that volume reduction continues to be important, but that risk-informed, performance-based approaches to managing waste are also appropriate in managing LLRW safely and that volume reduction should be evaluated in this light. For the CA BTP, risk-informed, performance-based blending guidance would be specified and existing guidance that is not consistent with such approaches, such as the "factor of 10 rule," would be removed.

The staff would also issue interim guidance to Agreement States on how to evaluate proposed disposal of large quantities of blended waste until the rulemaking is completed. The guidance would recommend a case-by-case evaluation of blended waste for each site that plans to accept this type of waste for disposal. Factors such as intruder protection, the need for mitigative measures, and homogeneity would need to be evaluated by the appropriate regulator. The staff's preliminary independent analysis indicates that current practices at existing disposal facilities may safely accommodate an increase in the amount of disposed waste at or just below the Class A limits.

Among the advantages of this option are: (a) use of risk-informed, performance-based criteria, which would be consistent with NRC's overall policy of risk-informed regulation; and (b) use of fewer staff resources than options 3 and 4 by piggybacking onto a rulemaking that is already underway. Among the disadvantages are that existing licensee and applicable Agreement State regulations and guidance may have to be changed, and some stakeholders may perceive this new blending policy as a reduction in protection of public health and safety.

<u>Option 3</u>: Revise agency blending policy to further constrain blending.

Under this option, the Commission would develop a policy and promulgate a rule that would require that the in-process concentrations of waste determine waste classification, rather than the waste being classified when it is ready for disposal, the current requirement. The rulemaking would initially propose that radioactive material that has been blended as a result of stabilization, mixing, or treatment, or for any other reason, would be subject to the disposal regulations it would have been subject to prior to blending. This rule would require classification at points prior to the preparation of waste for disposal. A Regulatory Issue Summary would be published soon after the Commission decision to inform licensees that a revised blending policy was under development. Among the advantages of this option are (a) it would eliminate some stakeholder concerns over blending to reduce waste classification; (b) it would eliminate any ambiguity about blending for purposes of lowering the waste classification — any blending under this option could not lower the waste classification; (c) it would provide for more measures to isolate and contain waste than the current requirements in 10 CFR Part 61, since the classification of some wastes under this approach would be higher than current practice (a corresponding "con" is that measures unnecessary for adequate protection of public health and the environment would be required in some cases). Among the disadvantages are: (a) it may result in larger occupational exposures because of the need to sample and characterize waste more frequently; (b) it would not be risk-informed and performance-based, since classification of waste would be based on the as-generated waste, not of the concentrations of waste at the time of disposal; and (c) it would require more LLRW storage by creating more Class B and C waste.

Option 4: Prohibit large-scale blending at off-site processor.

NRC could prohibit large-scale blending that lowers the waste classification at a waste processor[7] because it is tantamount to intentional mixing to lower the waste classification. This option would be implemented through a rulemaking. A Regulatory Issue Summary would also be issued after a Commission decision, but before the rulemaking was completed, to notify licensees of the planned change. An important part of the rulemaking would be differentiating between the routine blending that currently occurs at waste processors, and large-scale blending to lower the waste classification, such as has been proposed for ion-exchange resins from nuclear power plants. Among the advantages of this option are: (a) it would address concerns raised by stakeholders opposed to blending in general and potentially increase public confidence that their health and safety are being protected; and (b) it would continue to allow for individual waste generators to blend waste as part of normal operations. Among the disadvantages are that (a) it is not a risk-informed, performance-based position; (b) there is no clear health and safety basis for discouraging this type of blending; and (c) generators could still produce resin waste similar to blended waste by removing resins from service before Class B concentrations are reached, which would increase LLRW volumes by requiring more resin to accomplish the same task.

STAKEHOLDER INPUT

The staff solicited stakeholder input in developing this paper. On November 30, 2009, the staff issued a *Federal Register* notice requesting public comments on LLRW blending. Fourteen organizations and individuals provided comments. In December 2009, the staff met individually with three companies that had written to NRC expressing their views on LLRW blending. The meetings were open to the public, and opportunities for public comment were provided. On January 14, 2010, the staff held an all day public meeting in Rockville, Maryland, to provide the public with an opportunity to comment on LLRW blending. Stakeholders commenting at the meeting included representatives from States and Compacts, advocacy groups, the waste processing industry, waste generators, and DOE. The staff reviewed and considered all of the comments received in developing this paper.

---

[7] Included in the scope of this prohibition would be waste processors that are designated as LLRW generators through waste attribution. See Section 3.1.3 of the Enclosure for a discussion of attribution.

Stakeholders hold a wide variety of views on blending, and there was significant controversy about the appropriate policy for blending in the public meetings. Appendix B of the Enclosure lists the organizations that commented on the November 30, 2009, *Federal Register* Notice soliciting public comments, the Adams accession number for the letters received in response to the notice, the presentations given in the four public meetings, as well as a transcript of the January 14, 2010, public meeting. Most of the issues addressed in this paper were identified and discussed in the public meetings. They include the potential safety impacts of large-scale blending, the impact of blending on LLRW volume reduction, how NRC's blending position should be documented (i.e., whether in guidance or rulemaking), and the potential unintended consequences of a new NRC blending position. The staff intends to prepare and implement a communication plan after the Commission decides on an option to help ensure that NRC's position, its bases, and the process for policy development are understood.

AGREEMENT STATE VIEWS

In preparing this paper, the staff consulted with Agreement States that are significantly involved in the regulation of waste processing and disposal facilities. The staff reviewed the contents of the paper with the Agreement States of Washington, South Carolina, Texas, Utah, Tennessee, and Pennsylvania. States were generally satisfied with the issues addressed and the options presented for Commission consideration. One State official was concerned that joining the site-specific intruder assessment requirement for blending with the unique waste streams rulemaking would delay that effort. Another noted that assuring homogeneity is more important for large-scale blended waste than for smaller amounts from individual generators, because it will be closer to the limits for Class A waste. Some States, but not all, argued for flexibility in implementing any new regulations on blending. Texas in particular has a regulation that addresses waste dilution and believes that any NRC regulation on blending should allow their existing regulation to remain in place. A related issue for this State is its concern about ensuring that out-of-State generators that might dispose of waste in the State disposal facility comply with their dilution regulation. The staff will have further discussions with Texas on this issue.

Two of the above States also commented formally on blending in response to the staff's *Federal Register* Notice of November 30, 2009. Utah, among other comments, is opposed to blending if the intent is to alter the waste classification for the purposes of disposal site access. For allowable blending, the State believes that requirements should be contained in performance-based regulations addressing sampling and radiological characterization standards. The Pennsylvania Department of Environmental Protection also provided comments in a January 28, 2010, submittal. The Department would not oppose intentional blending of LLRW if it results in a change of classification of waste to a lower classification and only for access to a LLRW disposal facility and not for release to the environment. The Department also recommended that NRC clearly define blending (and to prohibit dilution). The State also believes that the original generator of blended waste should be maintained in records, and that an evaluation of the potential benefits and risks associated with blending be conducted.

In the January 14, 2010, public meeting, a representative from the Tennessee Department of Environment and Conservation had no technical opinion on blending. The representative noted that if large-scale blending was determined to be commercially viable, their responsibility is to license a blending operation if protection of public health and safety and the environment are demonstrated.

The Utah and Pennsylvania comments can be found in ADAMS under the accession numbers identified in Appendix B of the Enclosure. The Tennessee comments are contained in the transcript for the January 14, 2010, meeting, which is also listed in Appendix B.

RECOMMENDATIONS:

The staff believes that the current blending positions would be improved if they were risk-informed and performance based, and were specified in regulation and further clarified in guidance. The staff recommends the Commission approve:

Option 2 — to adopt a risk-informed, performance-based LLRW blending policy.

RESOURCES:

Option 1 - (Status Quo) would require 0.6 Full Time Equivalent (FTE) and $50,000 to complete, with 0.40 FTE and $25,000 in FY 2011.

Option 2 - (Risk-Informed, Performance-Based) will require 1.0 FTE and $50K for tasks unique to blending. Blended waste is also considered a unique waste stream under this option. The unique waste streams rulemaking has already been approved by the Commission in the Staff Requirements Memorandum for SECY-08-0147. The total resources, both for tasks unique to blending and for the unique waste streams rulemaking, would be 7.3 FTE and $1,550K, with 4.2 FTE and $775K for FY 2011.

Option 3 - (Further constrain blending) will require 3.5 FTE and $250,000 to complete with 0.2 FTE in FY 2011.

Option 4 - (Prohibit large scale blending) will require 3.3 FTE and $250,000 to complete with 0.2 FTE in FY 2011.

FY 2011 resources are available in the rulemaking product line within the Decomm/LLRW business line for the preferred Option #2. If the Commission determines one of the other options should be implemented (numbers 1, 3 or 4), the staff will need to redirect resources from the Oversight product line to the rulemaking product line. Resources for FY 2012 and beyond will be addressed through the Planning, Budgeting, and Performance Management process.

COORDINATION:

The Office of the General Counsel has no legal objection concerning this paper. The Office of the Chief Financial Officer has reviewed this paper for resource implications and has no objections.

/RA by Martin Virgilio for/

R. W. Borchardt
Executive Director
for Operations

Enclosure:
Analysis of Blending of Homogeneous
Low-Level Radioactive Waste

ANALYSIS OF BLENDING OF LOW-LEVEL RADIOACTIVE WASTE

1. Introduction

In this paper, the U. S. Nuclear Regulatory Commission (NRC) staff examines blending or mixing low-level radioactive waste (LLRW) that has higher radionuclide concentrations with LLRW that has lower radionuclide concentrations, particularly blending that lowers the classification of waste. Such mixing may be done for a variety of reasons: 1) to consolidate wastes from a number of different sources within a plant for reasons of operational efficiency; 2) to reduce radiation exposures to workers; and 3) to lower the classification of some of the waste by averaging its concentration over a larger volume. While recognizing that some mixing is unavoidable and even desirable for efficiency or dose reduction, NRC has historically discouraged mixing to lower the waste classification. The maxim "dilution is not the solution to pollution" appears to have been a factor in developing agency positions that discourage and constrain, but do not prohibit, the mixing of wastes. Dilution can increase the amount of waste by mixing clean and contaminated materials together, and may enable the mixture to be released to the general environment where members of the public will be exposed to the hazard, however small. The term "blending" as used in this paper, however, involves the mixing of higher and lower concentrations of contaminated materials, not clean materials, and disposal in a licensed disposal site, not release to the general environment. Thus, the undesirable characteristics of dilution are not present in this kind of blending, while safety and efficiency may be improved by selection of appropriate criteria to be applied to such blending. Although NRC's LLRW regulations neither prohibit nor explicitly address blending, staff guidance recommends constraints on the use of blending, while recognizing that it is appropriate in some circumstances. The constraints do not always have a clear safety basis.

With the June 30, 2008, closure of the Barnwell LLRW disposal facility to most U. S. generators of Class B and C wastes, licensees and industry are exploring the blending of LLRW that would otherwise be Class B and C into a homogeneous Class A mixture that could be disposed of as Class A waste. Such blending would eliminate the need for indefinite onsite storage of at least some of these wastes, while furthering the goal of permanent disposal. Not all LLRW can be blended into a homogeneous mixture suitable for disposal as Class A waste: irradiated reactor components, reactor pressure vessels, and other types of solid waste are not amenable to blending. Other reactor waste streams, particularly ion exchange resins, which account for about half of the volume of Class B and C waste generated each year, can be blended into a homogeneous mixture with a relatively uniform concentration of radioactivity, and some of these Class B and C resins could be blended with resins that have radioactivity concentrations well below the Class A limits to produce a final Class A mixture.

Some stakeholders, however, have raised concerns with such large-scale blending and have asked NRC to clarify its position on blending and what is acceptable under the regulations and guidance, especially with respect to blending that results in a change in the classification of the waste under 10 CFR § 61.55. Noting that policy issues were associated with blending of

LLRW, Chairman Jaczko, in an October 8, 2009, memorandum to the NRC staff, requested a vote paper that discusses the following topics:

- Issues related to intentional changes in waste classification due to blending, including safety, security, and policy considerations
- Protection of the public, the intruder, and the environment
- Mathematical concentration averaging and homogeneous physical mixing
- Practical considerations in operating a waste treatment facility, disposal facility, or other facilities, including the appropriate point at which waste should be classified
- Recommendations for revisions, if necessary, to existing regulations, requirements, guidance, or oversight related to blending of LLRW

The agency's previous policies and positions on blending of LLRW are evaluated in this paper to respond to this request and to other issues raised by stakeholders. Options for new agency positions on blending are provided for Commission consideration. The position that blending is *a priori* undesirable is examined in light of risk-informed, performance-based regulation that focuses on the safety hazard of the blended materials. This paper insofar as possible addresses the blending issue generically and without consideration of the specific business models or licensing actions for waste processing and disposal. However, in a few cases, references to specific facilities are necessary.

This paper is organized into the following sections:

- Background on waste blending, including definitions, how and why it is performed, and NRC regulations and guidance on the use of blending in general and for LLRW in particular
- Analysis of policy, safety and environmental, and regulatory issues
- Analysis of issues in the Chairman's tasking memo
- Stakeholder views
- Agreement State views
- International guidance and practice
- Options for NRC policy on blending
- Conclusions and recommendations

2. <u>Background</u>

This section first defines the term "blending" for the purposes of this paper, since the blending considered is narrow in scope. It then describes NRC regulations, guidance, and other positions applicable to blended LLRW. Industry initiatives that propose to expand the use of blending of LLRW and that have caused this re-examination of the NRC's guidance are then identified and described.

2.1 <u>Definition of "Blending"</u>

Blending, as the staff uses the term in this paper, is the mixing of LLRW having different concentrations of radionuclides to form a relatively homogeneous mixture that may be appropriate for disposal in a licensed facility. The concentration of each radionuclide in the resulting mixture is the radioactivity of each radionuclide in the mixture divided by the mixture's volume or weight. The types of waste that are blended may include those that are physically and chemically similar (such as ion-exchange resins from nuclear power plant systems), but could also include different waste types that can be made into a relatively homogeneous final mixture, such as soil, ash, and shredded trash. Blending, as used here, does not include the placement of discrete wastes of varying concentrations into a disposal container, or the averaging of concentrations of radioactivity of a discrete component over its volume. It also does not cover encapsulation of certain wastes in a non-radioactive matrix, as described in the Branch Technical Position on Concentration Averaging and Encapsulation (CA BTP) (NRC, 1995, Section 3.7). Such encapsulation may be used to meet the stability requirements for Class B and C LLRW. Blending, as discussed in this paper, is confined to waste types that have physical properties that enable mixing into a relatively homogeneous final waste form. The term "blending" as used in this paper, involves the mixing of higher and lower concentrations of contaminated materials, not clean materials, and disposal in a licensed disposal site, not release to the general environment. Blending is not "dilution," as the staff defines the term for this paper, which is the mixing of clean and contaminated materials.

2.2 Regulations and Guidance on Waste Blending

2.2.1 Regulations addressing waste classification, protection of an inadvertent intruder, and blending

Blending of LLRW that lowers waste concentrations from Class B or C levels to Class A is the primary focus of this paper. This section therefore addresses the requirements for waste classification, protection of an individual who inadvertently intrudes into a waste facility (the primary reason for classifying waste), and blending.

The terms "mixing," "blending," and "dilution," are not used in the regulations in 10 CFR that relate to reducing the potential waste class or disposal requirements for wastes. Thus blending, including blending that lowers the waste class, is neither prohibited nor explicitly addressed in NRC regulations.

The waste classification system is an important component in the regulations that provides for protection of an inadvertent intruder into a waste disposal facility. Protection of an inadvertent intruder is one of the four performance objectives for a LLRW disposal facility in 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste." Specific requirements were included in 10 CFR Part 61 that would prevent an intruder from receiving an unsafe exposure to radioactivity.[1] Among these requirements are the waste classification system contained in 10 CFR 61.55. Under this system, three classes of waste are defined for near-surface disposal, based on the radioactivity concentration of certain critical radionuclides. Greater controls are required as the waste classes increase in hazard. Class A waste poses the least hazard, and requires the fewest controls, while Class C is the most hazardous and requires, for example, either deeper disposal or an engineered barrier that will prevent human intrusion for 500 years, among other measures. A fourth class, greater than Class C (GTCC), is also defined, but wastes in this category are generally not suitable for near surface disposal because of the hazard they present. The allowable concentration of radioactivity in a waste class is directly related to the radiation exposure that an inadvertent intruder would receive

[1] As the Advisory Committee for Nuclear Waste and Materials (ACNW&M) noted in its April 30, 2008, letter to the Commission (ACNW&M, 2008), Resource Conservation and Recovery Act regulations for hazardous waste disposal facilities do not postulate an inadvertent intruder into the sites. Thus, the intruder protection provision in NRC regulations is conservative. Intruder protection is not always examined in managing risks associated with disposal of other waste types.

using the assumptions in the technical basis for 10 CFR Part 61. Appendix A to this paper contains a more complete explanation of the bases for the waste classification system in 10 CFR Part 61. As noted later in this paper, the technical basis for 10 CFR Part 61 contained in the draft environmental impact statement (DEIS) for 10 CFR Part 61 (NRC, 1981) and the final environmental impact statement (EIS) (NRC, 1982), considered the waste streams that were being generated at the time the rulemaking was being developed. These waste streams did not include large-scale blending of ion-exchange resins, an issue that is addressed in more detail in Section 3.2 of this paper.

In addition to 10 CFR Part 61, NRC also has provisions in its regulations that address waste classification in 10 CFR Part 20 Appendix G. These requirements, among other things, address the disposal of waste after its generation and processing. Such processing could include blending. Part 20 of 10 CFR, Appendix G describes the requirements for transferring LLRW for disposal and completing manifests for shipments of waste. The primary objective of this regulation is to ensure that the properties of waste that is being sent for disposal are identified and characterized for the disposal facility operator. The disposal facility operator needs to know this information in order to be able to determine that the site will perform safely when that waste is disposed. Some of the most important pieces of information are the radionuclides and their amounts, so that the inventory of disposed waste at the site is known and can be used in performance assessments to determine if the site can safely isolate these wastes.

In addition to the inventory, the manifest provisions in Appendix G of Part 20 also require that the classification of the waste (i.e., Class A, B, or C) be identified *when the waste is being shipped for disposal.* Waste is not required to be classified when it is shipped from a generator to a processor for subsequent disposal. NRC's land disposal regulations in 10 CFR Part 61 define the disposal requirements, including the classification of waste in 10 CFR § 61.55. Like Appendix G of Part 20, the 10 CFR Part 61 regulations do not require that waste being shipped for processing for subsequent disposal be classified. The reason for this is that waste is classified for the purposes of ensuring its safe disposal, primarily to protect an inadvertent intruder into a waste disposal site. Waste is not required to be classified at intermediate points between its generation and disposal, such as processing and storage, because the characteristics of the waste at these intermediate points do not directly affect its safe disposal. Once waste is ready for disposal, it must be classified.

Class A waste has the lowest radionuclide concentrations and requires fewer controls during disposal than Class B or C. Similarly, the disposal requirements for Class B waste are somewhat less demanding than those for Class C waste. Notwithstanding this requirement to classify waste at the time of disposal, it is not uncommon for generators and processors to classify waste before that point. Licensees may "classify" waste while it is being processed to ensure that it falls within the desired final waste class. For example, a licensee may want to avoid concentrating waste to greater than Class C concentrations, for which there is no disposal option, and could avoid that by knowing its "classification" and concentration while it is undergoing processing. In addition, the concentration and implied classification may change from the time a waste is generated until it is shipped for disposal, as a part of the routine handling and processing that occurs. It is not possible to avoid changes in the concentration, and in some cases, changing the classification of waste. Such changes are not significant in terms of protecting an intruder into a waste disposal site, since it is the characteristics of the waste at the time of disposal that affect an inadvertent intruder.

Although blending of LLRW is not addressed in the regulations, and blending that “lowers the waste classification” is, from an NRC regulatory perspective, not possible since waste is not required by NRC regulations to be classified until it is ready for disposal, NRC guidance has discouraged blending that reduces the concentrations of radionuclides in waste from Class B and C levels to Class A levels, as discussed in the next section.

2.2.2 NRC Guidance on Blending of LLRW

For blending of LLRW, the staff has developed guidance that describes how licensees may meet the concentration averaging provision in 10 CFR § 61.55(a)(8).[2] The CA BTP addresses three broad types of averaging, including blending, as summarized below:

- Blending — includes the mixing of homogeneous[3] wastes (i.e., the actual practice of blending different batches or types of waste), and the constraints that should be applied to such mixing. The CA BTP limitations on blending do not apply to 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.” No further guidance on the use of these exceptions is provided. Any constraints or conditions needed in these instances must be addressed on a case-specific basis.

  If the exceptions for occupational efficiency or worker dose reduction are not used, the CA BTP states that homogeneous waste types can be mixed if either a) the classification of the mixture is based on the highest nuclide concentrations in any of the individual waste types of the mixture, or b) the average nuclide concentrations of individual waste type contributors are within a factor of 10 of their average concentrations in the final mixture (the so-called “factor of 10 rule”). In addition, other alternative mixing schemes can be authorized if specific regulatory approval is obtained under 10 CFR 61.58.[4] This provision enables the Commission to approve on its own initiative or in response to a specific request, alternative classification or characteristics of LLRW for disposal in a Part 61 facility. It is rarely used by NRC or Agreement States. For homogeneous wastes, the CA BTP does not explain why LLRW that is capable of being mixed into a homogeneous final waste form (such as soil, resins, and ash) is subject to the factor of 10 constraint on the radionuclide concentrations in the waste before mixing. A performance-based approach would define the required uniformity of radionuclide concentrations in the waste after mixing, rather than using the CA BTP’s approach of placing concentration limits on wastes before they are mixed.

- Concentration averaging — is concerned with either: a) the mathematical averaging of waste concentrations, based on the size, geometry, and type of radioactive emission, or b) the combining of radioactive components in a single container and how their radioactivity may be averaged over the volume of the container. An example of the former type of

[2] 10 CFR 61.55(a)(8) states that “the concentration of a radionuclide [in waste] may be averaged over the volume of the waste, or the weight of the waste if the units [for the values tabulated in the concentration tables in 10 CFR 61.55] are expressed as nanocuries per gram.”

[3] The CA BTP defines a “homogeneous waste type” as one in which the radionuclide concentrations are likely to approach uniformity in the context of intruder scenarios used to establish the concentrations for the waste classification system. Although the definition of “homogeneous waste type” is based on the waste characteristics after mixing, the CA BTP addresses this waste type before mixing by imposing the “factor of 10” rule.

[4] 10 CFR 61.58, Alternative requirements for waste classification and characteristics states “The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a specific basis, if, after evaluation of the specific characteristics of the waste, disposal site, and method of disposal, it finds reasonable assurance of compliance with the performance objectives in subpart C of this part [61].”

averaging is irradiated hardware from a nuclear power reactor, which often has different radioactivity concentrations from one portion of a component to another. The CA BTP describes how and when these concentrations may be averaged to determine the waste classification of the component, based on the projected dose to an inadvertent intruder into a disposal facility.

- Encapsulation — is the surrounding of a radioactive source or component with a non-radioactive material, and using the entire volume or mass for the purposes of determining the waste concentration and class. Unlike blending, which often involves the mixing of relatively homogeneous, flowable materials of different radionuclide concentrations and may result in a final uniform mixture, encapsulation involves a radioactive core surrounded by a non-radioactive matrix. The CA BTP describes the constraints on the use of the non-radioactive matrix for concentration averaging, based on safety analyses of the radiation exposure to an inadvertent intruder into a disposal facility.

These three main sections of the CA BTP address and differentiate between mathematical concentration averaging and homogeneous physical mixing. Mathematical averaging, in the context of waste classification, is the summation of radionuclide activity measurements for a discrete package, component or volume of LLRW divided by the volume or weight of the entire package or component when the radioactivity concentrations of the components themselves cannot be altered by mixing. The mathematical average concentrations are used to determine the waste classification in accordance with concentrations defined in 10 CFR 61.55. For example, a container of waste destined for a LLRW disposal site may be filled with pieces of hardware that vary in radioactivity concentration, and the CA BTP identifies considerations and defines approaches for acceptable averaging.

In the case of wastes of varying concentrations that can be physically mixed into a homogeneous mixture, in theory, no mathematical averaging would be required, since the final mixture would have a single concentration of each radionuclide. In practice, mixtures will not be entirely uniform and some specification of the degree of homogeneity (i.e., the range of acceptable radionuclide concentrations) needs to be in place. Because releases of radioactivity from a hot spot would be mixed in the environment before reaching an off-site member of the public, hot spots are of most concern with respect to protection of a potential inadvertent intruder. Thus, the primary purpose of homogeneity requirements would be to ensure that any hot spots do not expose an inadvertent intruder to an unacceptable dose. A sampling program also needs to be in place to ensure that the homogeneity requirements are met.

Because mathematical averaging could be applied to the final blended mixture, it seems appropriate for any homogeneity requirements to be consistent with the mathematical averaging guidance. For example, it may not be risk-informed or performance-based to require smaller variations of radionuclide concentrations in a container of blended waste than NRC would allow in a container of waste to which the CA BTP mathematical averaging guidance is applied. Risk-informed requirements for blended waste would require homogeneity in the context of an intruder scenario. That is, radionuclide concentrations would not be required to be homogeneous on a physical scale smaller than the amount of waste the intruder would mix by intrusion. Alternately, homogeneity requirements stricter than mathematical averaging requirements may be justified in terms of "as low as is reasonably achievable" (ALARA) requirements, because the NRC staff expects that blended waste can be mixed to relatively homogeneous concentrations whereas discrete components to which mathematical averaging typically is applied cannot.

As noted earlier, the CA BTP positions are based on a combination of 1) practical considerations in the operation of a facility, whereby wastes are routinely combined or mixed for operational efficiency reasons, 2) NRC's general policy that discourages mixing for the

purposes of reducing the waste class, and 3) safety considerations. These three objectives are not fully compatible, but the CA BTP attempts to provide positions that balance them. For example, blended homogeneous wastes are constrained by the "factor of 10 rule" mentioned earlier, unless operational efficiency or worker dose reductions occur (in which case, the CA BTP limitations on blending are not applicable, and case-specific constraints must be developed). The CA BTP addresses waste class reduction in only two places. In a section addressing mixing of "dissimilar waste streams," one of eight different sections in the CA BTP, it states that it is acceptable to mix these streams if the classification of the mixture is not lower than the highest waste classification of any individual components in the mixture. In addition, an appendix to the CA BTP entitled, "Analysis of and Response to Comments on Concentration Averaging and Encapsulation Technical Position," contains statements that discourage waste class reduction. It states: ". . . it has been clarified [in the final version of the CA BTP] that the record of analyses which documents the licensee's use of concentration averaging and encapsulation practices defined in this technical position, should generally be sufficient, in and of itself, to show that *the averaging of concentrations was not undertaken solely to lower the classification of any specific waste in a disposal container*" [emphasis added].[5] The CA BTP is not entirely consistent in its positions on waste class reduction, since some waste blended according to the "factor of 10 rule" could undergo waste class reduction. Further, the above statement regarding waste class reduction appears only in a comment resolution appendix, not the guidance itself.

In response to letters from stakeholders, NRC staff addressed specific questions and comments on NRC's blending position in three letters published in late 2009 (NRC, 2009a, b, c). Among the comments NRC staff received was the statement that NRC policy prohibits the blending or dilution of radioactive material for the purpose of changing its waste classification. The staff noted in its responses that this statement was not correct. Nothing in NRC's regulations prohibits blending, and while staff guidance discourages blending in some circumstances, it also recognizes that there may be circumstances where blending that results in a lower waste classification is appropriate. These letters explain the guidance on selected issues and correct certain misinterpretations.

2.2.3 NRC Guidance on Blending in Other Waste Programs

Notwithstanding that blending is not addressed in the regulations and that waste classification is not required until waste is ready to be disposed of, NRC has recommended constraints, in addition to those in the CA BTP, on the blending or dilution of waste, without distinguishing between the two practices. SECY-04-0035 (NRC, 2004a, Attachment 2, p 5) summarizes a 1987 memorandum from the NRC Executive Director for Operations to one of the NRC Commissioners which provides an example of the agency's position on intentional dilution.[6] The

[5] The staff presented this more conservative position on blending in the CA BTP in a recent letter to Alaron, a waste processor (NRC 2006b). The CA BTP is arguably ambiguous on whether blending may be done solely to reduce waste class.
[6] Although the memorandum uses the term "dilution," it addresses "blending" of wastes, as defined in this paper (i.e., the mixing of wastes with higher and lower radionuclide concentrations and disposal of the mixture in a licensed facility.)

memorandum responded to a question raised by the Commissioner regarding whether an approach contemplated in an Advance Notice of Proposed Rulemaking (ANPR) would allow blending of high-level waste so that it could be classified as low-level waste. The memorandum makes clear that the ANPR neither allows nor specifically prohibits dilution of radioactive wastes but also contains the following statement:

> "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 the waste, is unacceptable."

The memorandum goes on to state that "while dilution might reduce the risk to an individual potentially affected by the wastes, in many cases dilution would increase the overall burden to society by making the wastes more 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 . . . 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."

NRC staff prepared a comprehensive analysis of the intentional mixing of contaminated soil in the decommissioning of nuclear facilities in SECY-04-0035 (NRC, 2004a). In evaluating options for addressing intentional mixing associated with the decommissioning of sites, the Commission chose an option (NRC, 2004b) that allowed for certain limited mixing of contaminated soil onsite, as well as the mixing of soil for offsite disposal to meet the waste acceptance criteria (WAC) for a waste disposal facility. The staff guidance that was developed to implement the Commission decision (NRC, 2006a) also states that mixing of soil for offsite disposal is permissible ". . .as long as the classification of the waste, as determined by the requirements of 10 CFR 61.55 [the waste classification tables in Part 61], is not altered." The analysis of the blending issue in this Commission paper (SECY-04-0035) did not address in detail the lowering of waste class through mixing, since all or nearly all contaminated soils associated with decommissioning are Class A waste. Although the decommissioning guidance constrains waste class reduction from intentional mixing of soil in decommissioning of nuclear facilities, this paper addresses a much broader range of waste types and classifications where waste class reduction already is allowed, and may have certain benefits if expanded, namely reducing the amounts of LLRW in storage. Little, if any, soil from decommissioning would be Class B or C waste.

NRC similarly discourages blending that lowers the waste class in its program to review U. S. Department of Energy waste determinations for residual high-level waste. NUREG-1854, "NRC Staff Guidance for Activities Related to U. S. Department of Energy Waste Determinations," (NRC, 2007a) states that "Extreme measures [should not be taken and] may include . . . deliberate blending of lower concentration waste streams with high activity waste streams *solely* to achieve waste classification objectives*, although blending may be needed for waste management purposes"* [emphasis added].

2.2.4 NRC Policy Statement on Low-Level Waste Volume Reduction

Another document related to blending is NRC's Policy Statement (PS) on Low-Level Waste Volume Reduction (NRC, 1981b). The PS encourages licensees to take steps to reduce the amount of waste generated and to reduce its volume once generated. That position was issued when disposal space was scarce since two of the three operating LLRW disposal sites had threatened to close at that time, and one had recently reduced the annual amount authorized for disposal by half. Further, volume reduction techniques were not yet in widespread use and NRC's PS was meant to encourage the use of such techniques. NRC issued the PS was in response to a General Accounting Office (now U.S. Government Accountability Office (GAO))

report that recommended that NRC take this step to help preserve disposal facility space (GAO, 1980). This PS is discussed in more detail in Section 3.1.5 of this paper.

Although the PS does not address blending directly, some stakeholders have argued that blending is contrary to the policy and to the goal of achieving reduced waste volumes. Large-scale blending of ion-exchange resins could be performed in lieu of waste processing that would achieve further volume reduction. In addition, one stakeholder commented that the goal of the Volume Reduction Policy Statement — to extend the operational lifetime of existing commercial disposal sites — is best served by prohibiting large-scale blending of LLRW.

2.3 Practical considerations

NRC waste guidance, while discouraging blending that lowers waste classification in some situations, also recognizes that such blending may be appropriate in others. Practical considerations require this flexibility. Licensees mix different contaminated waste materials, such as clothing, paper, and floor sweepings, for operational efficiency and because there is no reason to keep them separate, as they are generally all bulk Class A materials that can be handled similarly. Such blending is a routine part of operating a facility, processing waste, or decommissioning a facility and is often incidental to the purpose of the facility — to produce electricity, to dismantle and dispose of buildings no longer used, or to process a variety of waste streams by sorting, compacting, incinerating, packaging, and stabilizing. One example that often involves blending of higher and lower activity waste is the mixing of ion exchange resins generated in various locations in a nuclear power plant. It is more efficient to combine these wastes into one or several tanks in such a facility, rather than keep them separate after they are removed from service. Blending may also be performed to keep radiation exposures to workers as low as reasonably achievable, since the doses from a mixture of two or more streams of LLRW with different radiation levels may result in a combined mixture that has lower radiation levels. Third, waste disposal may also be facilitated by blending. For example, two batches of waste blended together may meet the waste acceptance criteria for a specific disposal facility, although the higher concentration batch by itself would not.

The Chairman's October 9, 2009, tasking memo directed that this paper address the appropriate point at which waste should be classified. As noted in Section 2.2.1, NRC regulations do not require that waste be classified until it is ready for disposal, since waste classification per 10 CFR § 61.55 is designed to protect an inadvertent intruder into a disposal site, and the "classification" at points prior to final disposal are not relevant to this objective. During handling and processing, waste concentrations may increase or decrease (and the implied "classification" may also change as a result). For example, compaction and evaporation will increase concentrations of waste. A nuclear power plant may consolidate resins in a central tank in the facility, so that some of the resins are increased in concentration, while others are reduced. A generator may want to know the concentration and the implied classification prior to undertaking these operations so that a higher waste class is not inadvertently produced.

Even though NRC regulations do not require classification of waste until it is ready for shipment to a disposal facility, NRC guidance addresses waste "classification" at points prior to shipment for disposal. NRC guidance goes beyond the regulations by implying that waste will be classified at intermediate points during collection or processing. In fact, such intermediate classification is unnecessary and thus any recommended constraint on blending through

guidance is unenforceable. These recommended constraints appear to have been designed to address the maxim, “dilution is not the solution to pollution,” even if that reason is not explicitly stated in the guidance. At the extremes, using clean material to reduce large quantities of B, C or GTCC waste to a lower class would be undesirable and discouraged. In any case, NRC guidance that discourages waste class reduction before waste is required to be classified has not been a significant issue until the recent proposals to blend resins for their disposal as Class A waste.

On balance, the staff does not believe that new requirements to classify waste prior to shipment are needed. Licensees may continue to classify waste on their own in order to manage it effectively. Of course, if the Commission wishes to restrict mixing of waste classes, classification of waste at intermediate points during collection or processing would be required. Absent such a decision, the staff does not believe that requirements to classify waste prior to shipment are needed.

2.4 Initiatives to Expand LLRW Blending

On June 30, 2008, the Barnwell disposal facility closed to most LLRW generators in the U. S. Now, only generators in the Atlantic Compact — the States of South Carolina, Connecticut, and New Jersey — are able to dispose of their waste at that facility. Although the EnergySolutions’ disposal facility in Clive, Utah, remains available for Class A waste disposal by the generators that lost access to Barnwell, these generators have no disposal option for Class B and C waste. Thus, 90 of the 104 operating reactors have to store these wastes. In addition, 18,694 of the 22,357 materials licensees are located in the 36 States[7] that lost access to Barnwell. While many of these materials licensees do not produce LLRW at all,[8] and many of those that do generate LLRW generate Class A only, some of these licensees generate Class B and C waste, particularly sealed sources.

Licensees and industry representatives are considering mixing certain LLRW to help to mitigate the impact of Barnwell’s closure. A waste processor in Tennessee is exploring the blending of ion exchange resins from nuclear power plants, which can be blended into a relatively uniform mixture. These resins, which are the focus of this company’s proposed expansion of LLRW blending, account for about half of the volume of Class B and C waste generated each year in the U.S.[9] This blending would enable some materials that would otherwise have been disposed of as Class B or C waste to be mixed with Class A waste to create a Class A mixture. A recent article by the Electric Power Research Institute (EPRI) on their LLRW classification studies (Tran, 2008) reports that Class B and C resins account for approximately 12,000 ft^3 of LLRW disposed annually, whereas Class A resins account for about 75,000 ft^3 disposed annually.[10] The article states that if resin blending was practiced, the volume of Class A resin would increase by approximately 8,000 ft^3/yr to a total of 83,000 ft^3/yr. This would leave about 4,000

[7] The 197 licensees in the District of Columbia, Guam, Virgin Islands, and Puerto Rico also do not have access.
[8] Licensees use decay-in-storage or recycle sealed sources, or both, in lieu of LLRW generation.
[9] Based on 12,000 ft^3/yr of Class B and C resins, as reported in “EPRI Takes on Low-Level Waste Disposal Issues,” *Radwaste Solutions,* May/June 2008, Vol. 15, No. 3, pp 14-21. Irradiated hardware accounts for much of the rest of Class B/C waste. Resin data covers 2003-2007. (Tran, 2008).
[10] The Barnwell disposal facility was accepting out-of-compact waste at the time these data were collected.

ft^3 of Class B/C resin to be stored (see Table 1 below). Table 2 contains the total LLRW disposed of in a year, by volume, activity, and waste class.

Waste Class	Resin Volume, ft^3/yr (unblended)	Blended Resin, ft^3/yr
A	75,000	83,000
B/C	12,000	4,000
Total:	87,000	87,000

Table 1. Disposal of blended (projected) and unblended ion-exchange resin volumes by waste class[11]

Waste Class	Volume, ft^3	Activity, Curies
A	2,640,741	8,543
B	9,152	36,057
C	14,532	1,283,321

Table 2. Total LLRW disposed in one year[12]

2.5 Revisions to Concentration Averaging CA BTP in the LLRW Strategic Assessment

In SECY-07-0180, "Strategic Assessment of Low-Level Waste Regulatory Program," (NRC 2007b), the staff identified revisions to the Concentration Averaging CA BTP as one of seven high priority tasks. As described in that paper, the staff would "[u]pdate the CA BTP guidance by, for example, revisiting the 'factor of 10 rule,' allowing some blending of waste to lower the waste class, and providing needed clarification of complex sections in the CA BTP, as well as articulating the bases/rationales for the positions in these sections." The staff noted that ". . . there is general agreement that many statements in the CA BTP are difficult to interpret and that the underlying rationales for many, if not most, are not self-evident." The potential revisions identified in this paper are one part of the overall revisions contemplated for the CA BTP in the Strategic Assessment. This paper focuses on the blending of homogeneous waste streams, such as ion exchange resins, into a reasonably homogeneous waste form. The CA BTP also addresses mathematically averaging the concentration of radionuclides in irradiated hardware and components placed in a package, as well as encapsulation of sealed sources. The staff intends to revise and update these other areas of the CA BTP, such as encapsulation of sealed sources and mathematical averaging of irradiated hardware, after it receives direction from the Commission on blending of LLRW. No policy issues have been identified for Commission consideration at this time in these other areas of the CA BTP. Any proposed revisions to the technical positions in the CA BTP will be made available for stakeholder review and comment. If in the course of considering these other revisions any policy issues are identified, the staff will inform the Commission.

2.6 Recent Interest in Clarification of NRC Position on Blending

The staff believes that because disposal options were available for all classes of LLRW in the recent past, the agency's positions on blending were not challenged or identified as requiring

[11] Based on an analysis by EPRI (Tran, 2008).
[12] Waste volumes reported are from July 1, 2007, to June 30, 2008. Data obtained from the U. S. Department of Energy Manifest Information Management System (MIMS), http://mims.apps.em.doe.gov/.

clarification. With the closure of Barnwell, industry and licensees have begun to explore mixing of homogeneous waste streams to facilitate waste disposal, and previous staff positions that may not be based solely on risk and protection of the inadvertent intruder have come under scrutiny. In the next section, the staff identifies specific safety, policy, and regulatory issues associated with blending.

3.0 Discussion

This section identifies and discusses policy, technical (safety, security, and environment) and regulatory issues associated with blending of homogeneous wastes.

3.1 Policy Issues

How and whether NRC decides to revise its position that discourages blending of LLRW raises several policy issues, each of which is addressed in this section.

3.1.1 Past Agency Positions on Reducing Waste Class

NRC has previously taken positions that discourage and constrain the mixing of waste to reduce its waste classification. These positions are not confined to mixing with clean materials, but also include mixing of contaminated materials together, as examined in this paper. Recently revised guidance for decommissioning in NUREG-1757 (NRC 2006a) that implements the Commission decision on intentional mixing of soil in decommissioning states that mixing is permissible provided it is approved by NRC and does not alter the 10 CFR § 61.55 waste classification.

Although the CA BTP already allows for waste class reduction, which is inherently part of the mathematical averaging of waste concentrations that is currently permitted by 10 CFR § 61.55, the CA BTP does not explicitly acknowledge that such waste class reductions occur. In fact, as noted earlier, an Appendix to the CA BTP states that "the record of analyses which documents the licensee's use of concentration averaging and encapsulation practices defined in this technical position, should generally be sufficient in and of itself, to show that the averaging of concentrations *was not undertaken solely to lower the classification* [emphasis added] of any specific waste in a disposal container." This statement appears to be an artifact of earlier drafts of the CA BTP, since the statement does not appear in the CA BTP itself, and is contrary to positions in the CA BTP that in effect allow for waste class reduction. Since mathematical averaging is usually undertaken to lower the classification of discrete portions of waste, consistent with the intent of 10 CFR § 61.55(a)(8), this statement would be deleted in a future revision to the CA BTP. Nevertheless, whatever increased blending might be permitted in the future (e.g., by eliminating the "factor of 10" provision), needs to be considered in light of past NRC statements that while not prohibiting waste class reduction, at least discourage it.[13]

3.1.2 Facilitation of Disposal of Waste

[13] In a related matter, the NEI/EPRI "Guidelines for Operating an Interim On-site Low-Level Radioactive Waste Storage Facility" (NEI, 2008) notes that power reactor licensees could convert Class B and C waste to GTCC waste through volume reduction. Staff understands there are no imminent industry plans for doing so, however. Staff has not developed a position on conversion of B and C waste to GTCC but will discuss the issue with NEI and DOE. If it appears that it would be used in practice, staff would notify the Commission with a possible request for policy guidance.

A second policy issue is that increased blending would facilitate the disposal of some LLRW, rather than its indefinite, onsite storage. Some waste, such as ion exchange resins from nuclear power plants, if not blended prior to disposal would be at Class B or C concentrations, and therefore would have no disposal option if generated in one of the 36 States that lost access to the Barnwell disposal facility on June 30, 2008. Intentional blending of this waste to concentrations below the Class A limits would enable it to be disposed of at the facility that accepts Class A waste. Although LLRW can be managed safely and securely both in storage and through disposal, permanent disposal is the preferred approach.[14] Permanent disposal also eliminates the need for monitoring of the waste in storage and the associated exposures to radiation by workers in performing this monitoring.

It should be noted that reactor licensees currently remove some ion exchange resins from service before Class B and C concentrations are reached. This practice enables the continued disposal of resins as Class A, but with an increase in volume of waste. Although this practice could be viewed as contrary to the Commission's PS of Volume Reduction (NRC, 1981b), it cannot not be prohibited since a PS is not enforceable. In addition, as the staff notes in Section 3.1.5 on Volume Reduction, factors other than volume reduction affect licensees' decisions on how best to manage LLRW. Blending of higher concentration waste with lower concentrations, as discussed in this paper, would enable current practices for resin removal to continue, without an increase in waste volumes.

Large-scale blending has the potential to facilitate disposal of some ion-exchange resins in an available Class A disposal facility. At least one commenter believes that such blending would, in the long-term, exacerbate challenges to disposal of all Class B and C LLRW, as discussed below.

3.1.3 Impact on Existing LLRW Management Program

Several stakeholders have indicated that a significant reduction in Class B and C waste disposal volumes caused by expanded blending could have adverse impacts on some existing and planned waste facility operations. Forecasts of waste streams for disposal are used for determination of disposal fees, for example, and a significant reduction in Class B and C waste will potentially affect the economic viability of a planned facility, according to some commenters. These same commenters stated that reducing the Class B/C waste stream amounts through blending could make disposal of the remaining Class B/C waste more difficult. At a minimum, disposal costs would increase for this waste, since the amount of B/C waste would be smaller. In the worst case, there would be no new disposal facility for Class B/C waste because a new facility would not be economically viable after a reduction in the potential Class B/C waste stream volume. The staff notes that these arguments rely on speculation about the future. Currently, there is a new facility under development and expected to be in operation in approximately a year. The operator of the facility is authorized to accept waste from two States within its LLRW Compact. Although the operator is pursuing approval of out-of-compact waste (including large quantities of class B and C waste), whether that occurs is speculative at this time. The staff did not independently analyze the economics of the facility and the potential effect of smaller Class B/C waste stream volumes, since NRC's responsibilities as a regulatory agency are limited to ensuring protection of the public health and safety and the environment

[14] For example, Staff Requirements Memorandum for SECY-93-323, "Withdrawal of Proposed Rulemaking to Establish Procedures and Criteria for On-Site Storage of Low-Level Radioactive Waste After January 1, 1996," February 1, 1994, states, "the Commission continues to favor disposal of low-level radioactive waste over storage . . ."

and promoting the common defense and security.

Waste blending is not the only initiative being explored in an effort to establish new disposal options, or the only initiative that could potentially affect the existing LLRW disposal situation in the U.S. A recent report, “Sealed Source Disposal and National Security — Problem Statement and Solution Set” (DSFG, 2009), explores potential solutions for disposal, including use of U. S. Department of Energy (DOE) disposal facilities. The Radiation Source and Protection and Security Task Force Report (RSSPTF, 2006), mandated by the Energy Policy Act of 2005, also recommends exploration of new options for disposal of LLRW.

Another potential issue raised by State officials is the effect of increased mixing on “attribution” of waste. Attribution is the identification of the waste generator. Current practice in waste processing in some cases results in wastes being “attributed” to a waste processor (i.e., the processor is considered to be the waste generator), when, for example, distinct batches attributable to individual generators cannot easily be separated during processing. Depending upon the circumstances, blending could result in the attribution of more waste to processors, and the loss of identity of the original waste generator. Attribution is important to some LLRW Compacts that regulate the import and export of waste from the Compact borders, and require generator identification for fee determinations and exercise of their other authorities to regulate LLRW. A waste processor located within a Compact that has a regional disposal facility could conceivably accept out-of-compact waste that would then become eligible, through attribution to the processor, for disposal within the Compact. With regard to the current blending proposal by industry, the staff understands that even after the blending of wastes, the wastes will be attributed to the original generators.

NRC regulations in 10 CFR Part 20, Appendix G, address manifesting of LLRW for shipment. Waste attribution is addressed in these regulations and the Statement of Considerations for the final rule (NRC, 1995b). Agreement States are currently provided flexibility in making attribution determinations. Some States and compacts believe that NRC should establish a national attribution policy that ensures that the identity of the original generator (not the waste processor) is maintained through disposal.

3.1.4 Disposal Capacity

One stakeholder also commented that blended ion exchange resins would quickly use up existing capacity at the Class A facility that is currently operating. The stakeholder made assumptions about the amount of waste that would be blended, and compared the resulting volumes and associated number of shipments with the volumes and shipments of the same waste having been processed and volume reduced at the stakeholder’s facility. The disposal facility operator, however, provided its own estimates for remaining capacity, which were significantly different from the first stakeholder’s estimates and ranged up to many years of remaining capacity, depending upon the assumptions. The staff did not independently analyze these estimates. Capacity is affected by assumptions about future business obtained, licensing of additional disposal cells, future waste generation rates, and other factors and any conclusions about future disposal capacity by the staff would be speculative. As noted in Section 3.1.3, several initiatives are currently underway to explore expanding disposal capacity, and could result in increased capacity. Other initiatives may be started as well. For example, on February 8, 2010, a private company announced plans for a new Class A disposal facility in Utah.

3.1.5 Volume Reduction

As noted earlier, some stakeholders have argued that blending is contrary to NRC's 1981 PS on Low-Level Waste Volume Reduction. They argue that Class B/C waste that would otherwise be volume reduced through waste processing would not be volume reduced if blended with Class A waste. Among other things, they argue that the remaining disposal capacity in the U.S. would be adversely impacted. Disposal capacity is discussed in the previous section.

For this paper, the staff examined whether and how much waste volumes might be affected through increased blending of LLRW. Blending, as defined in Section 2.1, is the mixing of waste streams with higher and lower radionuclide concentrations. Thus, certain wastes such as ion exchange resins from nuclear power plants that would otherwise be Class B or C waste may be blended to Class A waste. Such blending would not result in any increase in waste volumes, since the volume of the mixture would be the sum of the volume of the parts that were mixed. However, blending waste that has Class B or C radionuclide concentrations with lower activity waste to create Class A waste could be performed instead of using some available volume reduction techniques that may otherwise have been applied to the higher activity waste. Class B and C waste may undergo volume reduction as part of the required stabilization process for these two waste classes, if a generator chooses to use an available processing option. Class A waste, because of its lower hazard, is not required to be stabilized. One commenter noted that if resins with Class B or C concentrations from U.S. nuclear plants were not mixed and were instead stabilized and volume reduced, a fivefold volume reduction could result (Studsvik, 2009). Using annual resin volumes reported by EPRI (Tran, 2008),[15] the volume increase caused by not stabilizing resins with Class B and C concentrations would be 9600 ft^3/year (274 m^3/yr), or approximately 0.36 percent of the total LLRW volume disposed of each year. If all B/C resins were to be volume reduced (contrary to current practice, by which only some of the resins are volume reduced), the 12,000 ft^3 of B/C resins would be reduced to approximately 2400 ft^3.

Notwithstanding NRC's volume reduction policy, volume reduction is widely practiced today, in large part because disposal costs have risen significantly in the last 30 years and it is economical to reduce disposal volumes. Pressurized water nuclear power plants, for example, have reduced the annual volume of LLRW disposed each year by a factor of 25 from 1980 to 2000.[16] In addition, the Volume Reduction PS is appropriately guidance, not a requirement. Licensees consider other factors, such as cost and worker exposures, in determining the optimum approach for waste management.

Given the reasons stated above, the staff believes that the PS could be updated to acknowledge that other factors in determining how waste is to be managed are appropriately considered by licensees, and to put volume reduction in context. These other factors would include cost, worker exposures, and reducing the amount of waste that would need to be stored. A revision would also acknowledge that NRC's regulatory program is risk-informed and performance-based and that NRC would consider volume reduction in that context.

3.1.6 Unintended Consequences

[15] EPRI states that 12,000 ft^3 (340 m^3) of Class B and C resins are generated each year (Tran, 2008).
[16] Source: INPO-01-003 and 96-02, "WANO Performance Indicators for U. S. Nuclear Utility Industry".

In the public comment process, one stakeholder, representing a number of different materials licensees, cautioned NRC that unintended consequences may result if a new position is taken that further restricts blending of waste. The stakeholder noted that there are materials facilities that are blending now and that could be adversely affected by a new position. Similarly, the stakeholder noted that when new facilities for molybdenum-99 are developed in the U.S., they will produce Class B/C resins that could potentially be blended. Another commenter noted that waste processor operations and numerous other licensed operations could be significantly impacted by a rigid rule that prohibits blending.

3.1.7 Greater-Than-Class C (GTCC) Waste

Several stakeholders were concerned that a new blending position would enable GTCC LLRW to be blended to a lower waste class. A specific concern is that disposal of GTCC waste is a federal responsibility, while disposal of Class A, B, and C LLRW is the responsibility of the States.

DOE is the Federal agency that is developing disposal capacity for GTCC waste. On July 23 and 31, 2007, DOE published a Notice of Intent to prepare an EIS for the disposal of GTCC LLRW (DOE, 2007a, b). In it, DOE provides an estimated inventory of GTCC for disposal through the year 2035, divided into three categories: activated metals, sealed sources, and other types of GTCC, such as equipment, debris, trash, and decontamination and decommissioning waste. The majority of GTCC wastes falls in the first two categories, activated metals and sealed sources. Waste capable of being blended would only be included in the "other" category, and would be a subset of all of the wastes in that category. The estimated total amount of waste in this category is 0.007 percent of the total curies of GTCC waste, and 2.9 percent of the volume. The total volume of this waste (i.e., not activated metals or sealed sources) through 2035 is about 10 percent of the *annual* Class B/C LLRW volume. One of the options provided in this paper would not allow for reducing the waste class of GTCC waste, or any other class of waste. In the other options, no distinction is made between GTCC and other types of waste, in part because the amount of GTCC waste that can be blended is small in comparison to both the total amount of all classes of LLRW and to other types of GTCC.

3.2 Technical (Safety, Security, and Environmental) Issues

Technical issues are those that have a potential effect on the protection of public health and safety, security, and/or environmental protection, and that are associated with the existing CA BTP positions or potential revisions to those positions. National Environmental Policy Act (NEPA) reviews are addressed in the Regulatory Issues section (3.3). Blended waste would be subject to existing security requirements and no unique issues have been identified. Although LLRW can be safely and securely stored, blending waste for disposal would reduce the amount of LLRW in storage and thereby eliminate any safety or security risk from storage of this waste.

3.2.1 Protection of an Offsite Member of the Public

Large-scale waste blending is expected to increase the amount of radioactivity disposed of at Class A disposal facilities, but not the total volume or activity of LLRW, by increasing the volume and radioactivity of waste disposed as Class A waste. Given this expected increase, the licensee and applicable regulator must address whether the performance objectives of 10 CFR Part 61 would continue to be met. The first performance objective of 10 CFR Part 61, protection of the general population from releases of radioactivity, has historically been and would continue to be demonstrated with a site-specific performance assessment. Thus any impacts of the expected increase in the amount of radioactivity disposed of at a Class A facility to an off-site member of the public would be addressed in a site-specific analysis.

3.2.2 Intruder Protection

The second performance objective in 10 CFR 61 is protection of individuals from inadvertent intrusion. Unlike the performance objective for protection of the general population from releases of radioactivity, discussed in the previous section, protection of an inadvertent intruder is not necessarily typically demonstrated with a site-specific analysis. Instead, the safety of an inadvertent intruder is typically ensured by the waste classification system and the disposal requirements imposed for each class of waste. Some waste streams different from those analyzed in the technical basis for 10 CFR Part 61 would need to be considered in the technical analyses required under § 61.13, including a site-specific evaluation for intruder protection.

The connection between the waste classification system and protection of an inadvertent intruder originated in the development of the waste classification tables in 10 CFR 61.55(a). In the DEIS for Part 61, when it was initially developed, analyses were done for several "generic" waste sites with different characteristics to evaluate the impacts of waste disposal on an off-site member of the public and an inadvertent intruder. The case that most limited the radionuclide concentrations in waste, rather than the total amount of radioactivity that could be disposed, was protection of an inadvertent intruder. Thus the concentration-based waste classification tables in 10 CFR 61.55 were ultimately designed to protect an inadvertent intruder.

Consistent with the development of the waste classification system, the technical analysis requirements in 10 CFR 61.13(b) specify that analyses of the protection of individuals from inadvertent intrusion must include a demonstration that there is reasonable assurance the waste classification and segregation requirements will be met and that adequate barriers to inadvertent intrusion will be provided. Unlike the requirements of 10 CFR 61.13(a) and § 61.41, which address protection of the general population from releases of radioactivity, no specific dose limit is set in the performance objective or technical requirements for protection of an inadvertent intruder. Whereas the safety of the off-site member of the public is addressed in a site-specific performance assessment demonstrating specific dose limits will be met, the safety of the inadvertent intruder is typically expected to be ensured by the waste classification system and the disposal requirements imposed for each class of waste. Thus, any inconsistency between waste disposal practices and the assumptions underlying the development of the waste classification tables in 10 CFR 61.55(a) are of greater concern regarding protection of an inadvertent intruder than they are with respect to protection of the general population from releases of radioactivity. Protection of the general population is ensured through a site-specific assessment and does not rely directly on the waste classification system.

Blended waste was not considered during the original development of the NRC waste classification system. Furthermore, there are some important differences between blended wastes and the waste streams addressed in the Part 61 DEIS analyses. One major consideration is that, in the original analysis supporting the waste classification system, NRC assumed that not all of the waste encountered by an inadvertent intruder would be present at the classification limits. That is, the staff assumed that any waste at the concentration limits would be mixed with a significant amount of waste with radionuclide concentrations far below the class limits. Thus, a waste stream that is blended so that a significant fraction of the waste that an inadvertent intruder could encounter is near or at the Class A limit is different from what NRC considered in the original analysis.

One commenter raised the concern that because a waste stream consisting primarily of waste at or just below the Class A limit was not evaluated in the Part 61 DEIS analysis supporting the waste classification system, it would be inappropriate to assume that the current waste classification system is protective of an intruder encountering a significant volume of waste blended to the Class A limit. The commenter submitted an analysis estimating the dose to an inadvertent intruder who encountered waste blended to the Class A limit, unmixed with lower concentration waste. The commenter assumed the intruder encountered the waste in an “intruder-agriculture” scenario as described in NRC staff’s “Update of Part 61 Impacts Analysis Methodology,” NUREG/CR-4370 (NRC, 1986). Specifically, the commenter assumed that 100 years after site closure, institutional controls have ceased to be effective and a residence is constructed on the waste site. To construct the house, 600 m^3 (21,200 ft^3) of material, including 200 m^3 (7060 ft^3) of waste and 400 m^3 (14,100 ft^3) of a clean cover, is assumed to be excavated and spread within 25 m (82 ft) of the house. The analysis assumes that all 200 m^3 (7060 ft^3) of waste exhumed is at the Class A limit (on a sum-of-fractions basis) and is dominated by Cesium-137 (Cs-137). Actual blending proposals may involve quantities of waste at the Class A limit less than the 200 m^3 (7060 ft^3) used in this conservative analysis. The analysis also implicitly assumes that at 100 years after waste site closure, the blended waste is unrecognizable and presumed to be soil. The commenter’s analysis indicates that, based on these assumptions, which are not consistent with the more protective disposal methods used to dispose of waste near the Class A limits at the operating LLRW sites, an intruder living in the house and consuming food from an on-site garden would receive a dose significantly greater than 5 mSv/yr (500 mrem/yr).

Independent analyses performed by NRC staff, also based on the “intruder-agriculture” scenario described above and in NUREG/CR-4370, indicate that, in the unlikely case that a house is constructed on a disposal site such that all of the waste exhumed (200 m^3 [7060 $ft^{3]}$) is at the Class A limit, an intruder living in the house around which the waste is spread could receive an elevated dose. In this hypothetical case, which is not representative of the manner in which waste at the upper limit of Class A concentrations is actually disposed at the operating LLRW sites, the disposal would not meet the 10 CFR § 61.42 performance objective for protection of individuals from inadvertent intrusion. However, because the requirement to conduct a site-specific inadvertent intruder analysis is not specifically identified in 10 CFR Part 61 and may not be well understood, there is a concern that applicants or licensees could misinterpret the regulations to only require compliance with the concentration limits in the waste classification tables for ensuring protection of the intruder, as required by 10 CFR § 61.42. As a result, there is a concern that disposal of a significant amount of waste at the Class A disposal limit under the minimal disposal requirements for Class A waste imposed by 10 CFR 61 could cause an unacceptable dose to an inadvertent intruder.

Currently, LLRW disposal facility licensees meet additional requirements, beyond the minimum disposal requirements of 10 CFR 61, (e.g., requirements addressing waste stabilization, disposal depth, or engineered barriers) that ensure that an inadvertent intruder is protected from waste at or just below the Class A limits. For example, an operating facility in Utah plans to dispose of waste near the Class A limit at more than 5 m (16 ft) depth, which would significantly limit the amount of waste an intruder would be expected to encounter, because 5 m (16 ft) is deeper than typical residential construction depths. This facility also plans to dispose of waste near the Class A limit in containers, rather than as bulk waste, which would help to maintain a recognizable waste form, thereby limiting the expected intruder exposure. A new facility in Texas disposes of all commercial LLRW, including Class A waste, as containerized, rather than bulk waste. The facility is required by Texas regulation (30 TAC §336.730(b)(3)) to dispose of all containerized waste more than 5 m (16 ft) below the top surface of the cover or with intruder barriers that are designed to protect against an inadvertent intrusion for at least 500 years. As previously discussed, disposal at greater than 5 m (16 ft) is expected to significantly reduce exposure of an inadvertent intruder. Similarly, an intruder barrier lasting 500 years would protect an intruder by allowing radioactive decay of short-lived radionuclides, which are expected to dominate the ion-exchange resins that represent the majority of Class B/C waste amenable to blending. The staff's preliminary independent analysis indicates that current practice at these, and possibly other, disposal facilities may safely accommodate an increase in the amount of disposed waste at or just below the Class A limits. Site-specific intruder analyses could be used to confirm protection of individuals from inadvertent intrusion at these sites.

Blended wastes are not unique in their potential to have radionuclide concentrations at or just below the Class A disposal limits. For example, it is possible that resins in an operating nuclear power plant could be removed when they get close to the Class A limits for waste disposal rather than remaining in service longer and reaching Class B or C concentrations. Such resins could be similar to blended wastes in that both would be different from the DEIS assumptions for waste streams, and both could be near the Class A limits. However, the specific concern with proposals for large-scale blending is that significant fractions of waste in one area in a disposal facility, corresponding to a large shipment of blended waste, could have radionuclides at or just below the Class A disposal limits. This configuration would pose a greater risk to an inadvertent intruder than smaller batches of waste with the same radionuclide concentrations because the intruder would be more likely to exhume a significant volume of waste near the Class A limit unmixed with lower concentration waste. While other waste streams, such as ion exchange resins kept in service until they reach concentrations near the Class A limit, could have similar radionuclide concentrations, they are less likely to pose the same risk to an inadvertent intruder because they are expected to be disposed in smaller quantities in physical proximity to other, lower-concentration wastes, and to be mixed with those wastes if exhumed by an intruder.

In addition to the potential for blended wastes, there have been other changes in waste streams and disposal practices in the last 30 years as well. For example, as previously discussed, LLRW disposal facility licensees currently meet disposal requirements that are more stringent than the minimal disposal requirements assumed in the Part 61 DEIS or NRC staff's "Update of Part 61 Impacts Analysis Methodology" (NUREG/CRR-4370). In addition, the original analysis in the DEIS that supported the development of the waste classification tables in 10 CFR 61.55(a) used ICRP 2 dose methodology, while a new analysis would use a more modern dose methodology. A requirement for a site-specific intruder analysis would ensure that the inadvertent intruder continues to be protected, independent of inconsistencies with the assumptions underlying the waste classification tables in 10 CFR § 61.55(a).

3.2.3 Waste Characterization and Homogeneity

Blended waste would need to be sufficiently uniform in concentration after blending so that any "hot spots" or inhomogeneities would not affect protection of an inadvertent intruder. Some averaging of radionuclide concentrations is permitted in accordance with 10 CFR 61.55(a)(8), which states that the concentration of radionuclides may be averaged over the volume or weight of the waste. The CA BTP, which was developed to provide guidance on the implementation of

10 CFR 61.55(a)(8), states that the classification of a mixture 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. While the "highest nuclide concentrations" provision is clearly conservative and relatively easy to apply (and thus requires no further explanation or rationalization), it is not often used.

The rationale for the "factor of 10" provision, which is often used by industry, is not given in the CA BTP. However, it appears to accomplish two goals. First, because the difference in allowable concentrations of long-lived radionuclides (as given in Table I of 10 CFR 61.55(a)) for Class A and Class C waste is also a factor of 10, the guidance in the CA BTP on mixing of homogeneous wastes, in effect, places a limit on the extent to which Class C waste can be blended with Class A material. While this accomplishes the goal of placing limits on mixing, it has no direct relationship to protection of public health and safety. Second, the factor of 10 in effect provides limits on the heterogeneity of the final waste form. The CA BTP does not specifically identify criteria for the homogeneity of the final form, except to define a "homogeneous waste type" as one in which the radionuclide concentrations are likely to approach uniformity in the context of intruder scenarios used to establish the concentrations for the waste classification system. The factor of 10 criterion provides assurance that the concentration variation in the final waste form will be within certain limits. In this respect, it is notable that the staff's Technical Position on Radioactive Waste Classification (NRC, 1983) states that a factor of 10 is "…a reasonable target for determining measured or inferred [radionuclide] concentrations…" in the waste, given physical limitations in the waste and resultant ". . . difficulties in obtaining and measuring representative samples at reasonable costs and acceptable occupational exposures."

By limiting heterogeneity, the "factor of 10" criterion helps to provide for protection of an inadvertent intruder into a disposal site for materials that cannot be blended or mixed into a final homogenous mass. Solid materials of varying concentrations are frequently "mixed" or packaged in a container for disposal. For wastes that can be mixed or blended into a relatively homogeneous mixture, the "factor of 10 rule" could be replaced with a performance-based criterion for final homogeneity of the waste form. In fact, a "factor of 10 rule" might be appropriate, as a performance-based approach, if applied to the final mixture rather than being applied to component wastes before they are mixed. Such an approach would enable mixtures with radionuclide concentrations that vary by more than a factor of 10 to be mixed, would be consistent with performance-based regulation, and would still provide for protection of an inadvertent intruder into a disposal facility.

Several stakeholders commented on this issue during the public meetings. The concerns are that it would be difficult to mix the waste so that it would be homogeneous enough that all of the waste was actually below the Class A limits, and it would take far more radiological characterization than is currently typically performed to show that the waste really meets all the applicable radionuclide limits. This raises a potential concern for an inadvertent intruder, who may hit "hotspots" of waste that is insufficiently blended and disposed of as Class A waste without the additional protections required of Class B and C waste. Some commenters expressed concern that, because of the need for more thorough waste characterization, there may be an increase in cumulative worker dose. An opposing argument was posited suggesting that there would be no significant increase in worker dose because a blending facility would be specially designed for blending and characterization activities and would be able to achieve worker doses lower than doses to workers characterizing waste in plants, where the same protections may not be in place. In either case, the 10 CFR Part 20 provisions for worker protection and keeping radiation exposures as low as is reasonably achievable would apply and would ensure safety.

With respect to ensuring appropriate homogeneity, as discussed in Section 2.2.2, it may be appropriate to ensure that requirements for homogeneity are consistent with allowances for

mathematical averaging, as permitted by 10 CFR 61.55(a)(8). For example, it may not be risk-informed to require that blended wastes have variations of no more than 2 or 3 in final radionuclide concentrations if mathematically averaged wastes could have radionuclide concentrations varying by a factor of 10. To impose homogeneity requirements stricter than variations allowed by mathematical averaging would be essentially equivalent to prohibiting mathematical averaging from being applied to the final blended wastes. As discussed in Section 2.2.2, it may be appropriate to prohibit mathematical averaging from being applied to blended waste based on the need to keep doses as low as reasonably achievable, because it is expected that blended wastes could be blended to a greater homogeneity whereas discrete wastes to which mathematical averaging typically is applied cannot.

In either case, risk-informed requirements for homogeneity would require that wastes be reasonably homogeneous in the context of an intruder scenario, in which a certain amount of mixing is assumed to occur. For example, if the minimum amount of mixing that could reasonably be assumed to occur during intrusion would occur if an intruder contacts waste by drilling a well and spreading drill cuttings on the land, there is no need to impose requirements that waste be homogenous on a smaller scale than the drill cutting volume, because an intruder will not encounter a “hotspot” smaller than the drill cutting volume.

Irrespective of whether NRC allows mathematical averaging to be applied to physically blended waste, the effect of mathematical averaging on waste classification will naturally be limited in a waste stream in which the radionuclide concentrations in the bulk of the waste are near the limits for a waste class. For example, in a waste stream predominantly near the Class A limits, very few sub-sections of waste could be present measurably above the Class A limits before the average radionuclide concentrations would be greater than the Class A limits on a sum-of-fractions basis. Compared to a lower-concentration waste stream in which more variation could be tolerated before the average concentration exceeded the limits, more thorough characterization of blended waste may be necessary to have reasonable assurance that smaller sub-sections of the waste did not elevate the average concentration above the Class A limits. Thus, it appears that it would be more challenging for licensees to determine that wastes close to the concentration limits for Class A waste are compliant with those limits than it is to show that typical Class A waste, which is further below the Class A limits, meets the requirements. Additional guidance may be appropriate.

3.2.4 Stability

For a 10 CFR Part 61 disposal facility, “stability,” or the ability of the site and the waste to retain its physical form and to not erode, is one of the four performance objectives (10 CFR 61.44). A stable waste form provides additional protection to an intruder, because stabilized, non-dispersible waste forms are more likely to be recognized by an inadvertent intruder, thus limiting intruder contact with the waste and thereby limiting radiation exposures. In addition, a stable waste form may also contribute to the overall stability of the waste disposal site. A problem encountered in early radioactive waste disposal facilities was slumping, or the "bathtub effect" whereby buried unstable wastes collapsed, causing voids and hollows in the disposal facility cover that collected rainwater and increased infiltration of water into the disposal trenches. 10 CFR Part 61 addresses this potential problem by requiring that Class B and C waste be stabilized. Class A is not required to be stabilized (nor is it prohibited from being stabilized) because of its lower concentration. Stabilization can be beneficial in limiting contact of the waste with water that might be present and that could increase the dissolution of radionuclides.

Blending could reduce the amount of stabilized waste disposed at a LLRW facility that accepts A, B, and C waste because some waste that would otherwise be stabilized Class B or C waste could be disposed of as unstabilized Class A waste. A disposal facility licensee would need to verify that the performance of the facility receiving less stabilized waste continued to meet the 10 CFR Part 61 performance objectives, particularly the 10 CFR 61.41 objective that limits offsite releases of radioactivity, since stability may contribute to immobilization of the waste. Such verification is routinely performed to ensure that a disposal facility can safely isolate the actual types and amounts of waste received. In addition, Agreement State regulatory agencies typically require existing disposal sites to provide engineered barriers, even for Class A waste, that will help provide stability not required by 10 CFR Part 61 for Class A waste.

3.3 Regulatory Issues

3.3.1 Method of Issuing NRC Position on Blending

If NRC were to revise its position on blending, the new position could be promulgated in a rulemaking, guidance, or a combination of the two. Revisions to the guidance can be accomplished more quickly and with fewer resources than a rulemaking. A rule, however, is enforceable and could, with the appropriate compatibility designation for Agreement States (such as Category B), provide for a uniform approach to blending in the U.S. Most U.S. licensees, including waste processors that are likely to perform blending, as well as disposal facility operators, are located in Agreement States. A compatibility category of B means that the States will have to adopt essentially the same provisions as NRC because of significant direct trans-boundary implications. Currently, the existing provisions in 10 CFR Part 61 relating to waste classification, including concentration averaging, are compatibility category B. Such a designation would help to ensure consistency between processors and disposal facilities. A final determination on compatibility for any new requirements would be made as part of the rulemaking process.

One State already has a regulation that is different from existing NRC guidance on blending and concentration averaging. The staff understands that this State provision is based on a hazardous waste provision in the State's regulations. The regulation states the following:

> "No person shall reduce the concentration of radioactive constituents by dilution to meet exemption levels . . . or change the waste's classification or disposal requirements. Radioactive material that has been diluted as a result of stabilization, mixing, or treatment, including, but not limited to, Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDR) treatment, or for any other reason, *shall be subject to the disposal regulations it would have been subject to prior to dilution*." [emphasis added].

The blending provisions contained in a rulemaking would vary depending upon the option chosen by the Commission (see Section 8.0 for a discussion of the options). With respect to guidance, three different types were discussed in meetings with stakeholders, and have been considered by the staff. Several stakeholders recommended that NRC issue a Regulatory Issue Summary (RIS) that describes and references NRC blending positions. The RIS would include references to the CA BTP and to the three letters sent by NRC staff to industry stakeholders in late 2009 to clarify positions in the CA BTP. A RIS may be used, among other things, to announce staff technical or policy positions not previously communicated to industry or not broadly understood. A RIS does not have to be noticed for public comment.

The Commission's 1981 Volume Reduction PS could also be revised to address issues that have arisen in public meetings on blending. Section 2.2.4 of this paper describes the origin of this PS. Since the PS was issued, nuclear power plant licensees have significantly reduced the amount of LLRW generated and disposed of. From 1980 to 2000, pressurized water reactor licensees in the U.S. reduced the volume of LLRW by a factor of 25.[17] In addition to the PS's endorsement of volume reduction, the cost of disposal has been an incentive to reduce volumes. Given the success in volume reduction by industry, the staff believes that the PS could be updated to recognize the progress that has been achieved, and to acknowledge that other factors may be used by licensees in determining how best to manage their LLRW. Although volume reduction has never been the sole consideration of licensees in managing waste, comments by stakeholders on the blending issue did not always recognize that other factors affect licensee's decisionmaking. This point could be documented in a revision to the PS. Specifically, the PS could be revised to acknowledge that volume reduction continues to be important, but that risk-informed, performance-based approaches to managing waste are also appropriate in managing LLRW safely and that volume reduction should be evaluated in this light. The PS could also acknowledge that licensees may consider cost and operational efficiency in their decisionmaking on waste management. Dated material would also be removed, such as references to an increase in the applications to implement waste processing systems.

A third guidance document that addresses blending is the CA BTP. Section 2.2.2 describes the scope of the document, and its guidance on LLRW blending. Although this guidance has been used successfully by licensees for many years, the staff plans to update it to, at a minimum, clarify terms, and better describe the bases for its positions. In addition, the staff may have to make other changes to the CA BTP to conform to whatever option the Commission chooses for a blending position. For example, a risk-informed, performance-based blending policy would eliminate the constraints on blending in the CA BTP, such as the "factor of 10 rule."

3.3.2 National Environmental Policy Act

In public meetings and formal written comments, several stakeholders recommended that NRC undertake a NEPA analysis to evaluate the impacts of large-scale blending at a LLRW processing facility. Specifically, one commenter argued that the radiation exposure impacts of large-scale blending in comparison with other alternatives needed to be evaluated, and the approach with the lowest dose to the public should be chosen.

In developing the disposal regulations in 10 CFR Part 61, NRC prepared an EIS. As noted in the final EIS (NRC, 1982), NRC had a two-fold purpose in preparing the final EIS. The first

[17] Source: INPO-01-003 and 96-02, "WANO Performance Indicators for U.S. Nuclear Utility Industry.

purpose was to fulfill NRC's responsibility under the NEPA Act of 1969 (i.e., to prepare an EIS for a major Federal action). Second, NRC prepared the final EIS to document the decision processes applied in the development of Part 61. NRC analyzed alternative courses of action and requirements were selected with consideration of costs, environmental impacts, and health and safety effects to current and future generations. These alternatives were based on LLRW practices at the time, some of which have changed since then. The final EIS noted that it was a generic EIS in that it did not analyze all of the issues involved in the disposal of LLRW. Rather, the final EIS provided the decision analysis for requirements in Part 61 that were developed at that time.

A NEPA evaluation would be required if NRC were to promulgate a rulemaking on blending. Either an EIS or environmental assessment (EA) would be developed, depending upon the scope of the rulemaking. An EIS would be required if there were a major NRC action significantly affecting the quality of the human environment. Issuance of a PS or other guidance document would not constitute a major Federal action and no NEPA reviews would be needed. In this paper, three of the options are rulemakings and would require a NEPA analysis. Changes in practice resulting from specific licensing actions in Agreement States do not require that NRC perform a NEPA analysis.

3.3.3 Applicability to Waste Processors

As a result of industry's consideration of large-scale, offsite blending, several stakeholders raised questions about the applicability of the staff guidance in the CA BTP to waste processors. Waste processors are not specifically discussed in the CA BTP, which is addressed to "all NRC licensees." The text of the CA BTP also uses the term "licensees," which would include waste processors. In its three letters to industry in late 2009 the staff affirmed that that the CA BTP applies to waste processors, in addition to licensees that generate waste, such as nuclear power plant operators. The CA BTP also contains positions that are useful to and needed by processors in averaging and blending of LLRW.

Large-scale blending of waste that has Class B or C concentrations of radionculides with lower activity waste to result in Class A waste at a waste processor could be viewed as tantamount to blending for the purpose of lowering the waste classification, if not solely for this reason, then at least primarily. NRC guidance for other programs has discouraged blending for the sole purpose of reducing the waste classification. While the staff has clarified in its recent letters that the current guidance for LLRW blending in the CA BTP applies to waste processors, this paper contains an option that would prohibit large-scale blending at waste processing facilities if the Commission wishes to revise the current blending position.

4.0 Analysis of Issues in Chairman's Tasking Memo

Chairman Jaczko, in an October 8, 2009, memorandum to the NRC staff, requested a vote paper that discusses five different topical areas. These are identified below, along with the sections of this paper that address each.

4.1 Issues related to intentional changes in waste classification due to blending, including safety, security, and policy considerations.

Policy and safety and security issues are addressed in Sections 3.1 and 3.2 respectively.

4.2 Protection of the public, the intruder, and the environment.

These issues are addressed in Section 3.2 and in the options presented in Section 8.0.

4.3 Mathematical concentration averaging and homogeneous physical mixing.

This topic is addressed in Section 2.2.2.

4.4 Practical considerations in operating a waste treatment facility, disposal facility, or other facilities, including the appropriate point at which waste should be classified.

This topic is addressed in Section 2.2.1, “Regulations addressing waste classification, protection of an inadvertent intruder, and blending,” Section 2.2.2, “NRC Guidance on blending of LLRW,” and Section 2.3, “Practical considerations.” The staff believes that waste should continue to be classified when it is ready for disposal, consistent with purpose of waste classification, which is to help to provide for the safety of an inadvertent intruder at a disposal facility. The staff has also provided an option, however, (Option 3) that requires classification to be based on the concentration before any dilution or blending.

4.5 Recommendations for revisions, if necessary, to existing regulations, requirements, guidance, or oversight related to blending of LLRW.

These topics are addressed in Section 9, “Conclusions and Recommendations,” and Section 8.0, “Options.” With respect to oversight, the staff has recommended that until a rulemaking or revisions to guidance are completed that the applicable regulators authorize disposal of blended waste from large-scale waste processing using case-specific approvals for individual sites. NRC staff is publishing interim guidance on how site specific intruder performance assessments may be done. The staff believes that existing licensing and inspection programs of NRC and Agreement State regulators will be adequate to oversee any blending operations. In addition, NRC staff will continue to implement the Integrated Materials Performance Evaluation Program to review Regional and Agreement State programs.

5.0 Stakeholder Views

The staff solicited stakeholder input in developing this paper. On November 30, 2009, the staff issued a *Federal Register* notice requesting public comments on LLRW blending. Fourteen organizations and individuals provided comments. In December 2009, the staff met individually with three companies that had written to NRC expressing their views on LLRW blending. The meetings were open to the public, and opportunities for public comment were provided. On January 14, 2010, the staff held an all day public meeting in Rockville, Maryland, to provide the public with an opportunity to comment on LLRW blending. Stakeholders commenting at the meeting included representatives from States and compacts, advocacy groups, the waste processing industry, waste generators, and DOE. The staff reviewed and considered all of the comments received in developing this paper.

Stakeholders hold a wide variety of views on blending, and there was significant controversy about the appropriate policy for blending in the public meetings. Appendix B lists the organizations that commented on the November 30, 2009, *Federal Register* Notice soliciting public comments, the accession number for the letters received in response to the notice, the presentations given in the four public meetings, as well as a transcript of the January 14, 2010, public meeting. Most of the issues addressed in this paper were identified and discussed in the public meetings. They include the potential safety impacts of large-scale blending, the impact of blending on LLRW volume reduction, how NRC's blending position should be documented (i.e., whether in guidance or rulemaking), and the potential unintended consequences of a new NRC blending position. In a related matter, bills were recently introduced into the Senate and House of the Tennessee General Assembly that would require waste processors to classify waste after processing as the highest classification that any of the radioactive materials would have had if such radioactive materials had been classified prior to processing (Tennessee, 2010).

The staff intends to prepare and implement a communication plan after the Commission decides on an option to help ensure that NRC's position, its bases, and the process for policy development are understood.

6.0 Agreement State Views

In preparing this paper, the staff consulted with Agreement States that are significantly involved in the regulation of waste processing and disposal facilities. The staff reviewed the contents of the paper with the Agreement States of Washington, South Carolina, Texas, Utah, Tennessee, and Pennsylvania. States were generally satisfied with the issues addressed and the options presented for Commission consideration. One State official was concerned that joining the need for a site-specific intruder assessment with the unique waste streams rulemaking would delay that effort. Another noted that assuring homogeneity is more important for large-scale blended waste than for smaller amounts from individual generators, because it will be closer to the limits for Class A waste. Some States, but not all, argued for flexibility in implementing any new regulations on blending. Texas in particular has a regulation that addresses waste dilution and believes that any NRC regulation on blending should allow their existing regulation to remain in place. A related issue for this State is its concern about ensuring that out-of-State generators that might dispose of waste in the State disposal facility comply with their dilution regulation. The staff will have further discussions with Texas on this issue.

Two of the above States also commented formally on blending in response to the staff's *Federal Register* Notice of November 30, 2009. Utah (Finerfrock, 2010), among other comments, is opposed to blending if the intent is to alter the waste classification for the purposes of disposal site access. For allowable blending, the State believes that requirements should be contained in performance-based regulations addressing sampling and radiological characterization standards. The Pennsylvania Department of Environmental Protection (Janati, 2010) also provided comments in a January 28, 2010, submittal. The Department would not oppose intentional blending of LLRW if it results in a change of classification of waste to a lower classification and only for access to a LLRW disposal facility and not for release to the environment. The Department also recommended that NRC clearly define blending (and to prohibit dilution). The State also believes that the original generator of blended waste should be maintained in records, and that an evaluation of the potential benefits and risks associated with blending be conducted.

In the January 14, 2010, public meeting, a representative from the Tennessee Department of Environment and Conservation had no technical opinion on blending. The representative noted that if large-scale blending was determined to be commercially viable, their responsibility is to license a blending operation if protection of public health and safety and the environment are demonstrated.

The Utah and Pennsylvania comments can be found in ADAMS under the accession numbers identified in Appendix B of the Enclosure. The Tennessee comments are contained in the transcript for the January 14, 2010, meeting, which is also listed in Appendix B.

7.0 <u>International Guidance and Practice</u>

The International Atomic Energy Agency (IAEA) has issued statements in its publications that address dilution of waste. IAEA does not explicitly address the blending of already contaminated materials into a homogeneous form for disposal in a licensed facility, the topic of this paper.

- An IAEA Safety Series publication (IAEA, 1995) states that "[s]afe radioactive waste management includes keeping the releases from the various waste management steps to the minimum practicable. The preferred approach to radioactive waste management is concentration and containment of radionuclides rather than dilution and dispersion in the environment." This provision recognizes that dilution is appropriate at times (i.e., there is no prohibition on it). It also addresses release to the general environment, rather than disposal of blended (or even diluted) materials in a licensed facility, and does not address whether both clean and contaminated materials are covered.

- The IAEA Safety Standard addressing exemption and clearance of radioactive materials (IAEA, 2004) states:

  "Deliberate dilution of material, as opposed to the dilution that takes place in normal operations when radioactivity is not a consideration, to meet the values of activity concentration given in Section 4 [the release limits], should not be permitted without the prior approval of the regulatory body." This provision applies to the release of materials to the general environment, not disposal in a licensed facility, and appears to allow the mixing of clean material with contaminated materials. The document does not define the term, "dilution" but the context suggests clean materials are not excluded.

- IAEA's Safety Guide No. GS-G-3.3, "The Management System for the Processing, Handling, and Storage of Radioactive Waste" (IAEA, 2008), states that "[l]imits may need to be established on the distribution of activity within a container to control surface dose rates and to prevent criticalities. Where required, these limits should be derived from the safety and EA of the disposal facility. They should reflect the need to reduce the dilution and dispersion elements of radioactive waste management, which is justifiable on environmental and economic grounds. The waste form should not be artificially manipulated by dilution, or by insertion of concentrated sources into a non-radioactive matrix, for the express purpose of compliance with activity limits alone." The guide appears to use the term "dilution" to refer to mixing of uncontaminated materials and "dispersion" to a practice that increases the volume of the contaminated materials. Thus, it is not directly applicable to blending as defined in this paper. Its acknowledgement of safety, environment, and economics as factors in decisionmaking is conceptually similar to NRC's current guidance that recommends constraints on blending, while at the same time stating that "operational efficiencies" may justify it.

A review of statements made by some Member States in their National Reports prepared under the terms of the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" (IAEA, 1997) indicates that a few of the Member States with mature nuclear programs have expressed national policies consistent with the IAEA guidance noted above. For example, the German National Report to the 2nd Review Meeting of the Joint Convention (FRG, 2005, p 80) states, “Deliberate mixing or dilution of the materials in order to achieve clearance is not permitted.” Likewise, the French National Report (ASN, 2005, p 101) states “Introduction of this restrictive criterion [regarding total quantities and concentrations of radionuclides] is meant to avoid the risk of dilution of radioactive material in order to fall below the exemption threshold.” In both of these cases, the dilution restriction focuses on preventing the dilution of waste for the purpose of achieving exemption or clearance levels of radionuclides. The staff was unable to identify any Member States’ National Report that addresses the subject of blending of radioactive waste materials as described in this report (i.e., the mixing of wastes with higher and lower radionuclide concentrations).

8.0 Options for Blending Policy

This section discusses options concerning regulatory actions that NRC could undertake regarding blending of different types and classes of LLRW. They range from maintaining the status quo, to constraining all blending to eliminate any reductions in waste classification, to a risk-informed, performance-based approach. Each option also includes a discussion of how it can be effectively implemented, in the staff’s view (i.e., whether by rulemaking or guidance). In developing these options, the staff’s goal was to provide the Commission with a broad range of options for a policy on blending, and to identify an appropriate means to implement the policy.

The staff considered whether an option to specifically address blending and the conditions under which it may be performed in a rulemaking should be presented, as several stakeholders had suggested. Option 1 is to maintain the status quo of using only guidance for addressing blending. Option 3 (Further Constrain Blending) is a rulemaking that in effect prohibits blending, or at least any benefits to a licensee from blending. Option 4 is a rulemaking that would prohibit large-scale offsite blending. Option 2 (risk-inform, performance-based blending) would be implemented through a combination of rulemaking and guidance. Only one aspect of blending would be addressed in the rule itself, the need for a site-specific intruder analysis for blended waste. Other blending issues, such as homogeneity of the blended waste, would be addressed in the guidance. An advantage of Option 2 is that the “unique waste streams” rulemaking is already underway and it addresses the need for a site-specific intruder performance assessment. If some additional blending criteria not included in the ongoing unique waste streams rulemaking, such as homogeneity, were determined to be best addressed in a rulemaking, rather than guidance they could be addressed in the rulemaking to risk-inform the waste classification system in 10 CFR 61.55. That rulemaking was initiated by the Commission in the Staff Requirements Memorandum for SECY-08-0147 (NRC, 2008b).

In evaluating the options, the primary criterion used by the staff was whether the option ensures safety, security, and protection of the environment. In addition, the Organizational Excellence objectives of openness and effectiveness in the NRC Strategic Plan (NRC, 2008a) were also considered. Openness means that NRC appropriately informs and involves stakeholders in the regulatory process. Effectiveness means that NRC actions are high quality, efficient, timely, and realistic, to enable the safe and beneficial use of radioactive materials. Among the strategies for achieving these objectives that are relevant to LLRW blending are the use of risk-informed, performance-based regulatory approaches, giving consideration to the burden on Agreement State programs, and ensuring that NRC guidance is up-to-date.

Option 1: Maintain current NRC positions on blending of homogeneous waste streams (status quo).

Under this option, the Commission would not change its existing positions on the use of blending as discussed in the CA BTP. This policy places constraints on blending through the use of the "factor of 10 rule," which limits mixing of homogeneous waste streams to batches of waste that are within a factor of 10 of the average concentration after mixing. But the staff position also acknowledges that blending is appropriate without the constraints of the CA BTP if it results in operational efficiencies or worker dose reductions. Figure 8.1 is a logic diagram for the current CA BTP provisions relating to the blending of homogeneous waste types that can be mixed into a uniform final mixture.

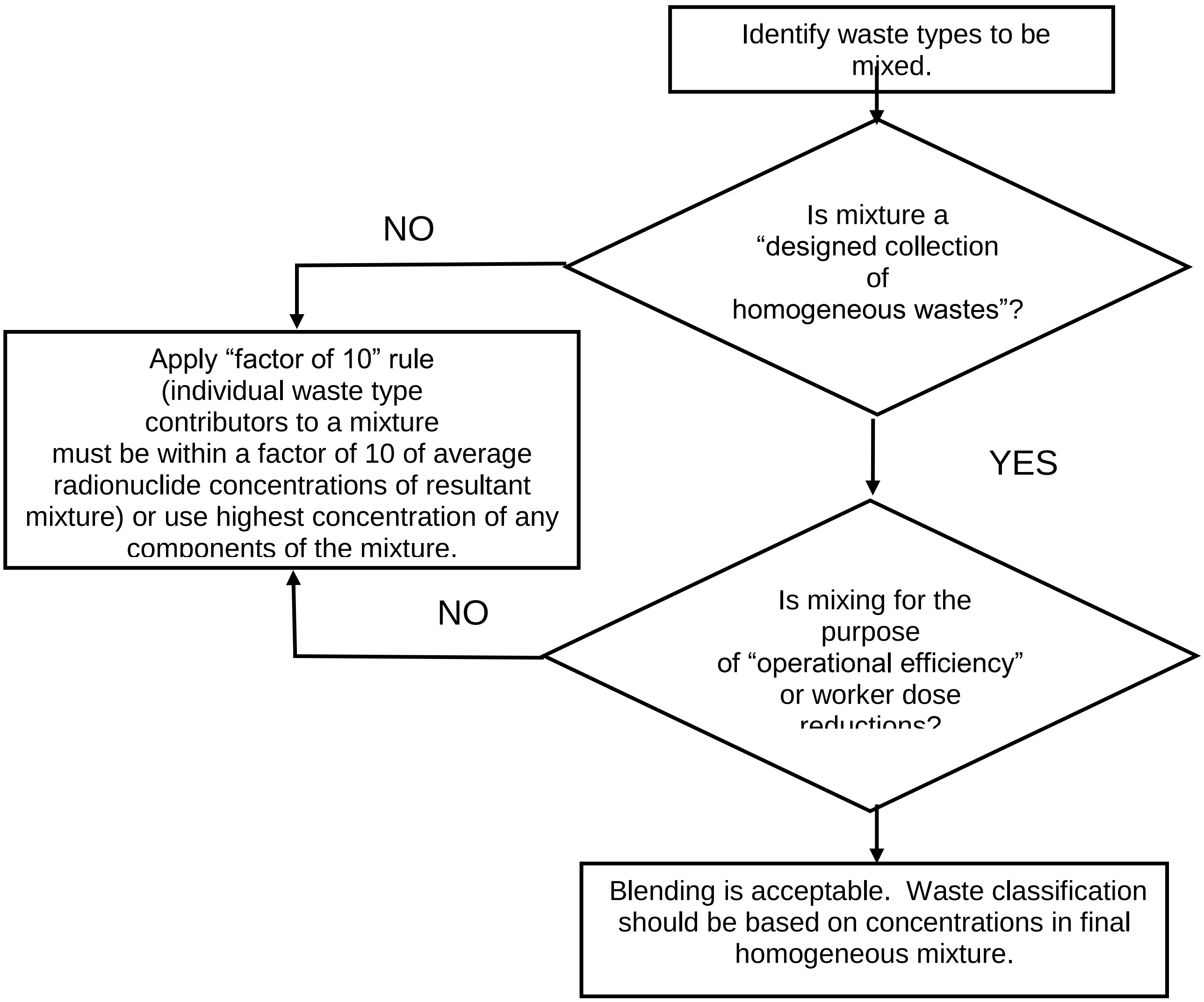

Figure 8.1 Logic diagram for current NRC blending position.

NRC staff's three letters to industry in late 2009 provide additional clarification on blending, and these clarifications are also part of the status quo. These letters include the following clarifications:

- Blending is not prohibited nor explicitly addressed in NRC regulations.

- While the staff has stated that wastes should not be mixed *solely* to lower the waste classification, NRC guidance acknowledges that blending, including some blending that may lower the waste classification, may be appropriate under certain circumstances.

- Waste classification is related to the safety of the disposed waste, and NRC regulations do not require waste to be classified prior to its shipment for disposal.

- NRC's blending positions apply to all NRC licensees, including waste processors.

This option would be implemented by clarifying the CA BTP and issuing a RIS that documents staff positions in recent letters to industry. For the CA BTP, the staff would simply clarify terms, and better describe the bases for its positions.

Pros:

- Maintains status quo in regulatory framework. Licensees and Agreement States are familiar with the current averaging provisions in the CA BTP and use them extensively.

- Guidance will take significantly fewer resources to develop than a rulemaking.

- Guidance can be developed more quickly than a rulemaking (approximately a year less time).

- Guidance provides more flexibility for Agreement States (stakeholders disagree on whether this is a pro or con, however).

Cons:

- This option could lead to inconsistent treatment of LLRW that could vary according to where the waste is generated, processed and/or disposed. Waste blended and classified in accordance with the requirements of the State in which the generator is located may not be accepted for disposal at a site in another State that has adopted different waste classification and blending criteria.

- Guidance is not binding and cannot be used to enforce a Commission policy.

- Guidance would not trigger a NEPA review, an action some stakeholders believe is necessary.

- The existing positions are not risk-informed and performance-based.

- The rationales for positions are based on a combination of practicality, ALARA, policy, and safety. These sometimes conflicting goals create a position difficult to understand that results in diverse outcomes, ranging from no guidance being specified on blending criteria in the CA BTP (i.e., case-specific constraints would be needed) to non-performance based constraints, such as the "factor of 10 rule."

- There is a potential safety concern for an inadvertent intruder when disposing of large-scale blended waste, which should be evaluated on a case-by-case basis. The need to conduct an inadvertent intruder analysis is not specifically identified in Part 61 and may not be well understood if the status quo is maintained.

- While some stakeholders believe that the current guidance is clear and appropriate, others believe it is not and have misinterpreted the guidance.

This position could enable large-scale blending at a processor, provided a specific proposal was found to be acceptable and approved by the appropriate regulators after a review including

consideration of protection of members of the public and an inadvertent intruder at a disposal facility. The staff notes that, under the current NRC regulatory framework, protection of an intruder may be assumed to be ensured by the waste classification system and disposal requirements imposed on each class of waste, rather than being demonstrated with a site-specific analysis.

<u>Option 2</u>: Revise blending positions to be risk-informed and performance-based.

Under this option, the agency's position on blending of waste streams would be based solely on the protection of public health and safety, security, and the protection of the environment, and factors such as the "factor of 10 rule" would not be a consideration for blending. The principal performance measure would be whether a final blended waste form could be safely disposed of. The following changes and clarifications would be made to the existing blending positions.

- Clarify that a site-specific intruder analysis would need to be performed to determine whether an intruder could be protected, or the conditions necessary for such protection. The intruder protection performance objective is in 10 CFR 61.42.

- Clarify that blended wastes need to be evaluated in site-specific performance assessments for ensuring protection of an offsite member of the public (10 CFR 61.41).

- Develop criteria defining acceptable homogeneity and sampling considerations.

- Clarify that the position applies to all licensees, including waste processors.

- Clarify that homogeneous wastes may be mixed with one another when the resulting mixture is homogeneous in the context of a site-specific intruder scenario.

- Eliminate the "factor of 10 rule" for mixing of wastes that can be blended into a homogeneous mixture, since the concentration of final mixture will be relatively uniform. The factor of 10 rule could be retained for wastes that could not be blended into a uniform mixture.

Figure 8.2 is a logic diagram for this risk-informed, performance-based approach.

This option would be consistent with the Commission's policy on risk-informed, performance-based regulation. In 1997, the Commission addressed risk-informed performance based regulation as one of the 20 direction setting issues in its overall Strategic Assessment of the agency's programs at that time, deciding that NRC ". . . will have a regulatory focus on those licensee activities that pose the greatest risk to the public." In the last decade, risk-informed performance-based regulation has been a continuing agency policy and is one of the safety strategies in the NRC Strategic Plan (NRC, 2008a) that guides work in all NRC programs.

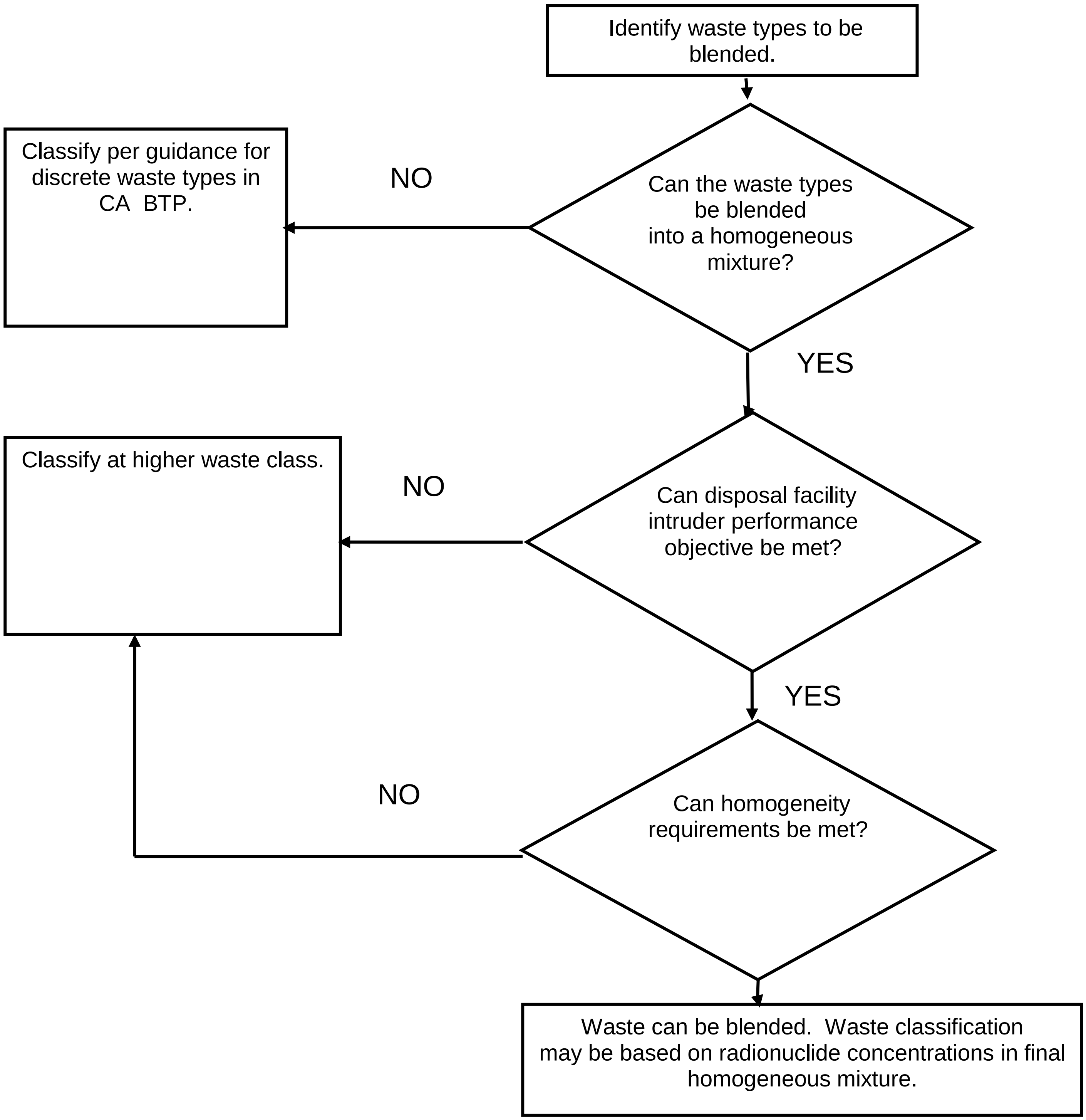

Figure 8.2 Logic diagram for risk-informed, performance-based approach to blending.

This option would be implemented through a combination of rulemaking and guidance. The requirement for site-specific intruder analysis, which is a risk-informed, performance-based approach to addressing blending, is being clarified in the rulemaking for large quantities of depleted uranium, as directed by the Commission in the March 18, 2009, staff requirements memorandum for SECY-08-0147 (NRC, 2008b). The rulemaking would explicitly require a site-specific analysis for an inadvertent intruder. Disposal of large amounts of blended waste would have to be evaluated for intruder protection on a site-specific basis. As part of the NEPA analysis for this rulemaking, disposal of blended ion exchange resins from a central processing facility would be compared to direct disposal of the resins, onsite storage of certain wastes when disposal is not possible, and further volume reduction of the class B/C concentration resins. The regulatory basis document for this rulemaking is scheduled to be completed in September 2010 and the staff would begin work on the proposed rule at that time. The staff does not believe that the addition of blended waste to the technical basis will require significant resources or time to complete. Nevertheless, if the Commission decision on this paper occurs late in FY 2010 or in FY 2011, the regulatory basis document or proposed rulemaking schedules may have to be revised somewhat to accommodate the addition of blended waste to the rulemaking. The staff will take steps to mitigate any impacts in the meantime. There would be no impact on the schedule for the unique waste streams rulemaking if the Commission chooses any of the other options.

Two documents would be updated as part of this option — the Volume Reduction PS and the CA BTP. As noted in Section 3.3.1, since the PS was issued, there have been significant reductions in waste volume. Given this success, the staff believes that the PS could be updated to recognize the progress that has been achieved, and to acknowledge that other factors may be used by licensees in determining how best to manage their LLRW. Specifically, the PS could be revised to acknowledge that volume reduction continues to be important, but that risk-informed, performance-based approaches to managing waste are also appropriate in managing LLRW safely and that volume reduction should be evaluated in this light. The second guidance document that addresses blending is the CA BTP. It would be revised to incorporate risk-informed, performance-based approaches. For example, a risk-informed, performance-based blending policy would eliminate certain constraints in the guidance, such as the "factor of 10 rule."

The staff would also issue interim guidance to Agreement States on how to evaluate disposal of large-scale blended waste until the rulemaking is completed. Blended waste would need to be evaluated on a case-by-case basis for the specific sites. Factors such as intruder protection, the need for mitigative measures, and homogeneity would need to be evaluated by the appropriate regulator. This interim guidance could be used until the Commission made a final decision on the depleted uranium rulemaking, including consideration of the NEPA analysis of alternatives to large-scale blended wastes. The staff's preliminary independent analysis indicates that current practice at LLRW disposal facilities may safely accommodate an increase in the amount of disposed waste at or just below the Class A limits.

Pros:

- Risk-informed, performance-based criteria would be consistent with NRC's overall policy of risk-informed regulation.

- Disposal of some wastes that would otherwise be Class B or C would be possible, reducing the need for indefinite storage of these wastes.

- Bases for positions would be clearer. Currently, the bases are a combination of safety considerations, practicality, and constraining the use of mixing or blending.

- By piggybacking onto a rulemaking already underway, fewer resources would be needed than for options 3 and 4.

- A rule requiring a site-specific performance assessment for an inadvertent intruder would be enforceable.

Cons:

- Existing licensee and Agreement State legislation and regulations may have to be changed,

- Some stakeholders may perceive this position as a reduction in protection of public health and safety.

<u>Option 3</u>: Revise agency blending policy to further constrain blending.

Under this option, the Commission would develop a policy and promulgate a rule that would require that the as-generated concentrations of waste or material determine waste classification, similar to the State rule discussed in Section 3.3.1. To ensure national uniformity, the staff believes that a "B" compatibility category (i.e., Agreement State regulations would have to be essentially identical to NRC regulations) would be beneficial. The final compatibility category would be determined during the rulemaking process. The rulemaking would specify that radioactive material that has been blended as a result of stabilization, mixing, or treatment, or for any other reason, would be subject to the disposal regulations it would have been subject to prior to blending. This rule, either implicitly or explicitly, would require classification at points prior to waste being ready for disposal. A RIS would be published soon after the Commission decision to inform licensees that a revised blending policy was under development. The existing guidance on blending in the CA BTP would be removed, as would other guidance on averaging (such as guidance on encapsulation of sealed sources).

Pros:

- Would eliminate some stakeholder concerns over blending to reduce waste classification.

- Would eliminate any ambiguity about blending for purposes of lowering the waste classification — waste could not be made a lower classification through blending.

- Would require more measures to isolate and contain waste than current requirements (a corresponding "con" is that measures unnecessary for adequate protection of public health and the environment would be required).

Cons:

- Would incur more radiation exposures to workers, because of the need to sample and characterize waste more frequently.

- Licensees and Agreement States that currently follow the CA BTP may have to modify their programs if a compatibility category B rulemaking were promulgated. If the guidance were revised, it is expected that at least some Agreement States would follow the new guidance.

- Would not be risk-informed and performance-based, since classification of waste would be based on the as-generated waste, not the disposed of waste. The hazard of the as-generated waste is not related to disposal safety.

- Would require more storage of LLRW by creating more Class B and C and Greater-Than-Class C waste. Would affect not only nuclear power plant licensees, but also some materials licensees, including those with sealed sources.

- Would encourage increased waste generation. For example, ion exchange resins would be changed out more often, before they reached Class B concentrations, so that they could be disposed of as Class A.

- Would be more costly for licensees to implement, since many specific items of waste (e.g., ion exchange columns) often do not have their concentrations measured at the time the waste is generated.

<u>Option 4</u>: Prohibit large scale blending at off-site processor.

NRC could prohibit large-scale blending that lowers the waste classification at a waste processor[18] because it is tantamount to intentional mixing to lower the waste classification. This option would be implemented through revisions to either 10 CFR Part 61, or 10 CFR Part 20, Appendix G, which currently addresses some waste processing activities. A RIS would also be issued after a Commission decision and before the rulemaking was completed, to notify licensees of the planned change. An important part of the rulemaking would be differentiating between the routine blending that currently occurs at waste processors, and large-scale blending to lower the waste classification, such as has been proposed for ion-exchange resins from nuclear power plants. The compatibility designation would be determined as part of the rulemaking process. The staff believes that a "B" designation would help to ensure national uniformity.

Pros

- Would address stakeholder concerns opposing blending in general and potentially increase public confidence.

[18] Included in the scope of this prohibition would be waste processors that are designated as LLRW generators through waste attribution. See Section 3.1.3 for a discussion of attribution.

- Would continue to allow for individual waste generators to blend waste as part of normal operations.

Cons

- Not risk-informed, performance-based.

- Not clear there is a safety basis for prohibiting this type of blending.

- Generators could still produce resin waste similar to blended waste by removing resins from service before Class B concentrations are reached, which would increase LLRW volumes.

- Would not address the possibility of larger-scale blending occurring at a generator's site.

9.0 Conclusions and Recommendations

The staff has examined the issue of blending of LLRW and the existing positions contained in staff guidance. The staff recommends that the agency position on blending of LLRW, as defined in this paper, be risk-informed and performance-based, consistent with NRC's overall policy for regulating, and as described in Option 2. These changes would improve NRC openness and effectiveness through clarification of the existing NRC blending position and its bases, and continue to ensure safety by clarifying that large-scale blended waste requires a site-specific intruder analysis. Until Option 2 was fully implemented, the staff would continue to use the current guidance in the CA BTP to respond to stakeholder requests. The CA BTP was subjected to public review and comment in the early 1990s and has been widely used since it was published in 1995. The staff plans to update the CA BTP later this year, as cited in its LLRW Strategic Assessment, but will delay that effort until it receives direction from the Commission on this paper. The staff would also clarify in interim guidance to Agreement States the need for a site-specific intruder analysis for disposal of blended wastes. Because of the significant stakeholder interest in this topic, the staff will prepare a communication plan to address implementation of the Commission's decision.

Appendix A -- Bases for 10 CFR Part 61 Waste Classification System

The classification system for near surface disposal of commercial (non-DOE) LLRW is in 10 CFR 61.55. The determination of the classification of LLRW involves consideration of the half-lives of the radionuclides present in the waste, among other factors. Thus, §61.55(a) contains separate tables for certain short-lived and long-lived radionuclides that provide a means for classifying LLRW as Class A, B, or C according to the concentrations of certain radionuclides in the waste. Part 61's classification system is intended to limit exposures of ionizing radiation to inadvertent intruders, in keeping with the performance objective in 10 CFR 61.42, which states that "design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site or contacting the waste at any time after active institutional controls over the disposal site are removed."

The potential impacts of human intrusion are addressed in detail in the EIS (NRC, 1981) for Part 61. Two concentration-limited scenarios, involving (1) excavation into the waste or construction of a house or building upon the disposal facility, and (2) persons living on the disposal facility, were considered, along with an "activity-limited" scenario involving the potential use of contaminated water from a well drilled onsite. The analyzed intruder scenarios contain a common assumption that the soil and waste mixture in which construction or agriculture takes place is more or less indistinguishable from ordinary (non-radioactive) dirt. In other words, the waste has decomposed to the point that the intruder does not realize they are contacting radioactive material. As stated in the DEIS (p.4-34), "this assumption is necessary since without it, the scenarios could not happen" (i.e., an intruder that recognized waste would not continue with an excavation or take up residence on the site).

Per 10 CFR § 61.7(b)(4), institutional control of access to the LLRW site is required for up to 100 years. Thus, the resultant radionuclide concentrations listed in the tables in §61.55(a) are established on the basis of calculations that showed that Class A and Class B waste could be disposed without special provisions for intrusion protection, because these classes of waste contain types and quantities of radioisotopes that will decay during the 100 year institutional control period (required by 10 CFR 61.59(b)) and do not present an unacceptable hazard to the intruder after the end of that period. Class C waste, however, will not decay to acceptable levels within 100 years, and either has to be buried at greater depth than the other classes so that subsequent surface activities by an intruder will not disturb the waste or, where site conditions prevent deeper disposal, requires the use of intruder barriers with an effective life of 500 years.

Although a numerical limit of 500 mrem whole body dose was proposed in the preliminary draft of Part 61 that was published in the *Federal Register* (45 FR 13104), the final rule's performance objective (10 CFR 61.42) for the intruder does not specify a numerical intruder dose limit. After receiving public comments on the draft rule, the 500 mrem dose limit was deleted, but it remains as the basis for the LLRW classification system, as indicated in the Statements of Consideration for Part 61 (NRC 1982).

The radionuclide concentrations in the waste classification tables imply that either the waste is uniform in concentration, or that the basis for classifying a waste batch uses the highest concentration within the batch. At the same time, Part 61 recognizes, in 10 CFR 61.55(a)(8) that it may be appropriate and safe to average wastes in certain circumstances. Although Part 61 itself places no constraints on blending, 61.55(a)(8) would apply to the resulting blended waste whose concentration for the purposes of waste classification would have to be an average of whatever variation occurred in the mixture.

REFERENCES

Autorité de sûreté nucléaire, “Second National Report on Implementation by France of Its Obligations Under the Convention,” September 2005.

Code of Federal Regulations (CFR), “Part 61 Licensing Requirements for Land Disposal of Radioactive Waste," Statements of Consideration, 47 FR 57446, December 27, 1982.

U. S. Department of Energy (DOE), “Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste,” *Federal Register* Vol. 72, No. 140, July 23, 2007.

DOE, “Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste,” *Federal Register* Vol. 72, No. 146, July 31, 2007.

Disused Source Focus Group of the Radioisotopes Sub-Council of the Nuclear Government and Sector Coordinating Councils, “Sealed Source Disposal and National Security — Problem Statement and Solution Set,” December 9, 2009.

Finerfrock, Dane, Utah Division of Radiation Control, January 26, 2010, submittal to NRC, (ML100341243).

Federal Republic of Germany, “Report of the Federal Republic of Germany for the Second Review Meeting in May 2006,” September 2005.

U. S. Government Accountability Office (formerly General Accounting Office), “The Problem of Disposing of Nuclear Low-Level Waste: Where Do We Go From Here?” GAO Report No. EMD-80-68, March 31, 1980.

International Atomic Energy Agency (IAEA), “Classification of Radioactive Waste,” Safety Series No. 111-G-1.1, 1994.

IAEA, “The Principles of Radioactive Waste Management,” Safety Series No. 111-F, 1995.

IAEA, “Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management,” INFCIRC/516, December 1997.

IAEA, “Application of the Concepts of Exclusion, Exemption, and Clearance,” Safety Guide No. RS-G-1.7, 2004.

IAEA, “The Management System for the Processing, Handling, and Storage of Radioactive Waste,” GS-G-3.3, 2008.

Nuclear Energy Institute/ Energy Power Research Institute (EPRI), “Guidelines for Operating an Interim On-Site Low-Level Radioactive Waste Storage Facility,” April 2008, (ML081580270).

Janati, Richard, Pennsylvania Bureau of Radiation Protection, January 29, 2010, submittal to NRC, (ML100341250).

NRC, “Policy Statement on Low-Level Waste Volume Reduction,” *Federal Register* Vol. 46, No. 200, October 16, 1981, (ML031210460).

NRC, "Draft Environmental Impact Statement on 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste," NUREG-0782, September 1981, (ML062210362).

NRC, “Final Environmental Impact Statement on 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste,” NUREG-0945, November 1982, (ML052590184, ML052920727, ML052590187).

NRC, “Technical Position on Radioactive Waste Classification,” May 11, 1983, (ML033630755).

NRC, “Update of Part 61 Impacts Analysis Methodology,” Volumes 1 and 2, 1986, ML100251399 and ML100250917.

NRC, “Branch Technical Position on Concentration Averaging and Encapsulation,” January 17, 1995, (ML033630732).

NRC, *Federal Register* notice, “Low-level Waste Shipment Manifest and Reporting,” Vol. 60, No. 58, March 27, 1995.

NRC, SECY-04-0035, “Results of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil,” March 1, 2004, Attachment 2, page 5, (ML040060667).

NRC, Staff Requirements Memorandum (SRM), SECY-04-0035, “Staff Requirements - SECY-04-0035 - Results of the License Termination Rule Analysis of the Use of Intentional Mixing of Contaminated Soil,” May 11, 2004. (ML041320165).

NRC, NUREG-1757, “Consolidated Decommissioning Guidance,” Volume 1, Rev. 2, pages 15-35, September 2006, (ML063000243).

NRC, October 16, 2006, letter from John Kinneman, NRC, to Joseph Harverson, Alaron, (ML062900166).

NRC, “NRC Staff Guidance for Activities Related to U. S. Department of Energy Waste Determinations,” NUREG-1854, August 2007, ML072360184.

NRC, SECY-07-0180, “Strategic Assessment of Low-Level Waste Regulatory Program,” October 17, 2007, (ML071350291).

NRC, “Strategic Plan: Fiscal Years 2008 – 2013 (NUREG-1614, Volume 4),” February 2008.

NRC, SECY-08-0147, “Response to Commission Order CLI-05-20 Regarding Depleted Uranium,” October 7, 2008, (ML081820814).

NRC, SRM, SECY-08-0147, “Response to Commission Order CLI-05-20 Regarding Depleted Uranium, March 18, 2009, (ML090770988).

NRC, August 27, 2009, letter from Larry Camper to Thomas Magette, EnergySolutions, (ML092170561).

NRC, October 30, 2009, letter from Larry Camper to Joseph DiCamillo, Studsvik, Inc., (ML092930251).

NRC, October 30, 2009, letter from Larry Camper to Scott Kirk, Waste Control Specialists, (ML092920426).

Radiation Source Protection and Security Task Force Report, August 2006.

Studsvik, "Comments on Blending of Low-Level Radioactive Waste," (NRC-2009-0520), ML093620111.

Tennessee General Assembly, Senate Bill 2735, House Bill 2826, March 2010.

Tran, P. and James, D., "EPRI Takes on Low-Level Waste Disposal Issues, Radwaste Solutions," EPRI, May/June 2008, pp 14-21, June 2008.

Appendix B – Public Comments

An important part of the development of this paper was public input on the issues associated with blending of low-level radioactive waste. The U. S. Nuclear Regulatory Commission (NRC) posted a request for formal written comments and notification of a public meeting in the *Federal Register* on November 30, 2009. Additionally, three public meetings with industry stakeholders were held at NRC Headquarters. This appendix contains information to locate the comments within ADAMS (**A**gencywide **D**ocuments **A**ccess and **M**anagement **S**ystem) which can be accessed via www.nrc.gov.

***Federal Register* Notice/Vol. 74, No. 228/11-30-2010 (NRC – 2009 – 0520): Notice of Public Meeting and Request for Comment on Blending of Low-Level Radioactive Waste**

Below is information regarding the formal written comments received from the *Federal Register* request for public comment:

Commenter	Date	ADAMS Number
Unknown Individual	12/12/2009	ML093500087
J. Scott Kirk on behalf of Waste Control Specialists, LLC	01/08/2010	ML100131012
Richard W. Borgmeier	01/25/2010	ML100350962
Dane Finerfrock on behalf of Utah Dept of Environmental Quality, Division of Radiation Control	01/28/2010	ML100341243
Bruce Thompson on behalf of South Carolina Electric & Gas	01/28/2010	ML100341244
Rich Janati on behalf of the State of PA, Department of Environmental Protection	01/28/2010	ML100341250
Michael H. Mobley on behalf of Southeast Compact Commission	01/29/2010	ML100341251
Mike Garner on behalf of Northwest Interstate Compact	01/29/2010	ML100341252
J. Scott Kirk on behalf of Waste Control Specialists, LLC	01/29/2010	ML100341257
Joseph DiCamillo on behalf of Studsvik, Inc.	01/29/2010	ML100341258
Thomas E. Magette on behalf of EnergySolutions	01/29/2010	ML100341190
John LePere on behalf of WMG, Inc.,	01/29/2010	ML100341245
Christopher Thomas on behalf of HEAL Utah	02/01/2010	ML100341246
Leonard R. Smith on behalf of the Council on Radionuclides and Radiopharmaceuticals, Inc.	02/26/2010	ML100700591

Appendix B – Public Comments (cont.)

Public Meeting and Request for Comment on Blending of Low-Level Radioactive Waste

DATE: January 14, 2010

PLACE: The Legacy Hotel & Meeting Centre
The Georgetown Room
1775 Rockville Pike
Rockville, MD 20852

Below is information regarding the meeting presentations and summary which can be found in ADAMS. Additionally, the transcript of the meeting is available. The transcript was reviewed by the NRC and all comments were evaluated for applicability.

Presentation Title	Presenter	ADAMS Number
Public Meeting on Blending of Low-Level Radioactive Waste	Larry Camper (NRC), Director - DWMEP	ML100120008
Safety, Security, and Environmental Protection	Christianne Ridge (NRC), Senior Project Manager – DWMEP/ERB	ML100120009
Practical Considerations	Brooke Traynham, Project Manager (NRC) – DWMEP/LLWB	ML100120010
Regulatory Infrastructure	Patrice M. Bubar (NRC), Deputy Director – DWMEP/EPAD	ML100120011
Regulatory Considerations	Maurice Heath (NRC), Project Manager – DWMEP/LLWB	ML100120015
Meeting Summary	**Author**	**ADAMS Number**
Summary of Public Meeting And Request For Comment On Blending Of Low-Level Radioactive Waste	Brooke Traynham, Project Manager (NRC) – DWMEP/LLWB	ML100320730
Official Meeting Transcript	**Author**	**ADAMS Number**
Public Meeting on Blending of Low-Level Radioactive Waste	Neal R. Gross - Court Reporters and Transcribers	ML100220019

Appendix B – Public Comments (cont.)

Public Meetings and Request for Comment on Blending of Low-Level Radioactive Waste

DATE: December 14 -15, 2009

PLACE: U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

Below is information regarding the presentations and summaries from the meetings which can be found in ADAMS.

Presentation Title	Presenter	ADAMS Number
Blending of Low-Level Radioactive Waste	Larry Camper (NRC), Director - DWMEP	ML093620117
Changing NRC Policy on Waste Dilution to Alter Waste Classification: Why Now?	J. Scott Kirk, VP Waste Control Specialists, LLC	ML093620115
Comments on Blending of Low-Level Radioactive Waste	Lewis Johnson, President – Studsvik Brad Mason, Chief Engineer - Studsvik	ML093620111
Blending of Low-Level Radioactive Waste	Thomas Magette – Senior VP, EnergySolutions	ML093620105
Meeting Summary	**Author**	**ADAMS Number**
Summary of Public Meeting Between the U.S. Nuclear Regulatory Commission and Waste Control Specialists on Low-Level Waste Blending	Maurice Heath (NRC), Project Manager – DWMEP/LLWB	ML093650064
Summary of Public Meeting Between the U.S. Nuclear Regulatory Commission and EnergySolutions On Low-Level Waste Blending	Maurice Heath (NRC), Project Manager – DWMEP/LLWB	ML100040113
Summary of Public Meeting Between the U.S. Nuclear Regulatory Commission and Studsvik on Low-Level Waste Blending	Maurice Heath (NRC), Project Manager – DWMEP/LLWB	ML093650201