December 5, 2005

MEMORANDUM TO: Michael T. Lesar, Chief
Rules and Directives Branch
Division of Administrative Services
Office of Administration

FROM: Ryan Whited, Chief /**RA**/
Low-Level Waste Section
Environmental and Performance Assessment Directorate
Division of Waste Management and Environmental Protection
Office of Nuclear Material Safety and Safeguards

SUBJECT: PUBLICATION OF INTERIM CONCENTRATION AVERAGING GUIDANCE, FOR PUBLIC COMMENT

Attached please find an original signed copy of a *Federal Register* notice releasing draft interim concentration averaging guidance, for public comment. Five copies of the notice and a diskette containing an electronic version of the notice are also attached. Please transmit the *Federal Register* notice to the Office of the Federal Register for publication.

Attachments:
1. Signed original FRN
2. 5 copies of FRN
3. Diskette

Docket No. PROJ0734, PROJ0735, PROJ073, POOM-32

CONTACT: Anna Bradford, NMSS/DWMEP
(301) 415-5228

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[7590-01-P]

NUCLEAR REGULATORY COMMISSION
[Docket No. PROJ0734, PROJ0735, PROJ0736, POOM-32]

Draft Interim Concentration Averaging Guidance for Waste Determinations

AGENCY: Nuclear Regulatory Commission.

ACTION: Issuance of Draft Interim Guidance.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is issuing draft interim guidance on concentration averaging for public comment. The NRC is currently in the process of preparing a Standard Review Plan (SRP) to provide guidance to NRC staff regarding reviews of waste determinations submitted by the U.S. Department of Energy (DOE). The NRC staff held a public scoping meeting on the draft SRP on November 10, 2005, to obtain stakeholder input on the contents of the SRP. The draft SRP is expected to be released for public comment in 2006 and will include, among other things, guidance on evaluating concentration averaging in those cases that are specific to the types of waste and situations typically evaluated in waste determinations. Because several stakeholders are interested in obtaining NRC guidance on concentration averaging as soon as practicable, the NRC is issuing this draft interim guidance prior to completion and public release of the entire draft SRP. This draft interim guidance is applicable only to waste determinations at DOE sites. This guidance will eventually be incorporated into the draft SRP and any comments received on this guidance will be evaluated at the same time as other public comments that are received following the release of the draft SRP.

DATES: The public comment period on the draft interim guidance begins with publication of this notice and continues until January 31, 2006. Written comments should be submitted as described in the ADDRESSES section of this notice. Comments submitted by mail should be postmarked by that date to ensure consideration. Comments received or postmarked after that date will be considered to the extent practical. Note that a subsequent public comment period will also be held after publication of the draft SRP in 2006.

ADDRESSES: Members of the public are invited and encouraged to submit comments to the Chief, Rules Review and Directives Branch, Mail Stop T6-D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Please note Docket Nos. PROJ0734, PROJ0735, PROJ0736, and POOM-32 when submitting comments. Comments will also be accepted by e-mail at NRCREP@nrc.gov or by facsimile to (301) 415-5397, Attention: Anna Bradford.

FOR FURTHER INFORMATION CONTACT: Ms. Anna Bradford, Senior Project Manager, Environmental and Performance Assessment Directorate, Division of Waste Management and Environmental Protection, Office of Nuclear Materials Safety and Safeguards, U.S. Nuclear Regulatory Commission, Rockville, MD, 20852. Telephone: (301) 415-5228; fax number: (301) 415-5397; e-mail: AHB1@nrc.gov.

SUPPLEMENTARY INFORMATION:

I. Background

The Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) provides criteria for determining whether certain waste resulting from the reprocessing of spent nuclear fuel is not high-level waste (HLW). Criteria 3(A) and 3(B) of Section 3116(a) of the NDAA require that the waste be disposed of in compliance with the performance objectives contained in NRC regulations at 10 CFR 61, Subpart C. The applicability of either 3(A) or 3(B) is dependent upon whether the waste exceeds Class C concentration limits, thus the classification of waste residuals must be determined in order to apply the NDAA criteria.

NRC's regulation, "Licensing Requirements for Land Disposal of Radioactive Waste," 10 CFR Part 61, provides waste classification tables (Tables 1 and 2 of 10 CFR 61.55) to ensure suitability of radioactive waste for near-surface disposal. The waste classification system (along with other provisions such as waste segregation and intruder barriers) was developed in part to provide protection to individuals from inadvertent intrusion into the waste after disposal. To determine waste classification, 10 CFR Part 61 allows for the averaging of the concentration of radionuclides in waste over the volume or weight of the waste, depending on the units used to express the limits for the radionuclides. The guidance provided in NRC's Branch Technical Position (BTP) on Concentration Averaging and Encapsulation (January 17,1995) represents acceptable methods by which specific waste streams or mixtures of these waste streams may be compared to the tabulated concentration values in Tables 1 and 2 of 10 CFR 61.55. The concentration averaging BTP was written to address a subset of acceptable classification or encapsulation practices and was not intended to address all cases. For example, the concentration averaging BTP was not written to address residual contamination of large underground or buried structures or systems.

Waste classification was developed to ensure that waste concentrations would not exceed the values provided in Tables 1 and 2 of 10 CFR 61.55, without special authorization, to provide protection of individuals from inadvertent intrusion into the waste. The waste classification tables were developed from performance assessment calculations for a variety of intruder scenarios considering the types of waste and disposal technologies that would likely be utilized for near-surface commercial disposal of low-level waste. The term "near-surface disposal" indicates disposal in the uppermost portion, or approximately the top 30 meters, of the earth's surface. Waste that would decay to acceptable levels within 100 years was defined as Class A or B waste, and institutional controls were believed to be effective at limiting inadvertent intruder risk from these classes of waste. Waste that would decay to acceptable levels for an inadvertent intruder within 500 years was defined as Class C waste. Class C waste was envisioned to be segregated from other classes of waste, to be protected with 100 years of institutional control, to be disposed of deeper than Class A and B wastes, and to be disposed of with an intruder barrier that would prevent contact with the waste for 500 years. It was also recognized that waste exceeding Class C limits for which form and disposal methods must be different, and in general more stringent, than those specified for Class C waste would not generally be suitable for near-surface disposal. However, it was recognized that there may be instances where waste with concentrations greater than permitted for Class C would be acceptable for near-surface disposal with special processing or design. These would be evaluated on a case-by-case basis.

Guidance on acceptable methods for performing concentration averaging to determine waste classification is presented in this draft interim guidance. Interpretation and examples of implementation of the BTP on concentration averaging and encapsulation as it applies to the types of waste and situations typically evaluated in waste determinations are provided. This guidance is only applicable to waste determinations at DOE sites; other uses may be authorized with permission of the NRC.

II. Proposed Concentration Averaging Guidance

The guidance contained herein does not replace the guidance contained in the BTP on concentration averaging and encapsulation for the purposes of waste classification for the commercial disposal of low-level waste. The guidance is not intended to address all unique situations at DOE sites. However, the guidance contained herein is generally applicable to the following scenarios:

(1) Underground waste storage tanks including heels, cooling coils, and residuals adhering to walls and other surfaces,

(2) Infrastructure used to support underground waste storage tanks such as transfer lines, transfer pumps, and diversion boxes,

(3) Waste removed from tanks that is processed or treated for disposal in a near surface disposal facility, and

(4) Other scenarios relating to waste determinations proposed by the DOE and accepted by the NRC.

Although the concentration averaging BTP was not written to address residual contamination of underground or buried structures or systems, the fundamental principles contained within the BTP are applicable to these systems. This guidance clarifies the fundamental principles presented in the BTP and provides specific examples that may be pertinent to DOE waste determinations. The acceptable methods for concentration averaging for the purposes of waste classification for waste determinations are based on the following fundamental principles introduced in the BTP:

(5) Measures are not to be undertaken to average extreme quantities of uncontaminated materials with residual waste solely for the purpose of waste classification.

(6) Mixtures of residual waste and materials can use a volume or mass-based average concentration if it can be demonstrated that the mixture is reasonably well-mixed.

(7) Credit can be taken for stabilizing materials added for the purpose of immobilizing the waste (not for stabilizing the contaminated structure) even if it can not be demonstrated that the waste and stabilizing materials are reasonably well-mixed, when the radionuclide concentrations are likely to approach uniformity in the context of applicable intruder scenarios.

(8) Other provisions for the classification of residual waste may be acceptable if, after evaluation of the specific characteristics of the waste, disposal site and method of disposal, conformance of waste disposal with the performance objectives in Subpart C of 10 CFR Part 61 can be demonstrated with reasonable assurance.

(9) Regardless of the averaging that is performed for waste classification purposes, the performance assessment or other approach used to demonstrate compliance with the performance objectives of 10 CFR Part 61, Subpart C, must consider the actual distribution of residual contamination in the system when estimating release rates to the environment and exposure rates to inadvertent intruders. Conservative assumptions regarding the distribution of contamination are appropriate.

The purpose of these principles is to prevent arbitrary or incorrect classification of materials that may result in near-surface disposal of materials that are not suitable for near-surface disposal. Appropriate concentration averaging may indicate that waste exceeds Class C concentration limits. Waste that exceeds Class C concentration limits may be suitable for near-surface disposal, but the evaluation of the suitability must involve independent analyses such as would be performed by the NRC under 10 CFR 61.58. The methods that follow can be used to determine the waste classification of waste residuals. As indicated by the first principle above, extreme measures should not be taken when performing concentration averaging to determine waste classification. Extreme measures include: 1) deliberate blending of lower concentration waste streams with high activity waste streams to achieve waste classification objectives, or 2) averaging over stabilizing material volume or masses that are not needed to stabilize the waste per the 10 CFR 61.56 stability requirement or are not homogeneous from the context of the intruder scenarios. This guidance presents three categories of calculations of the concentrations of radionuclides in waste. The first pertains to cases in which the waste can be mixed and is fairly homogeneous. The second pertains to cases in which the waste cannot be removed or well mixed, and is stabilized in place to satisfy the requirements of 10 CFR 61.56. The third pertains to the concentrations used in performance assessment calculations to determine the suitability of near-surface disposal according to 10 CFR 61.58 and does not pertain to the determination of whether a waste is Class A, Class B, Class C, or greater than Class C as defined in 10 CFR 61.55.

Category 1. Physical Homogeneity

In general, waste will have been processed to the maximum extent practical and will have been stabilized so that there is reasonable assurance that the performance objectives of 10 CFR 61, Subpart C, can be achieved. The concentrations of radionuclides in the waste for waste classification can be based on the average concentration calculated from the total volume or mass of the waste and processing or stabilizing materials if the materials are reasonably well-mixed. For Category 1, the weight or volume of the container should not be included in the calculation of average concentrations. The primary consideration is whether the distribution of radionuclides within the final wasteform is reasonably homogeneous. Technical basis should be provided (e.g., sampling results, engineering experience, operational constraints) to demonstrate that the waste is reasonably well-mixed. The preferred method to demonstrate homogeneity would be to provide a statistical measure of the variability of concentration within the waste, although it is recognized that this may not always be practical. For homogeneous mixtures, the classification of waste residuals may be based on the total volume or mass of the final wasteform. If additional averaging (e.g., as in the examples in

Category 2) is not applied, waste with radionuclide concentrations after mixing that are greater than the values provided in Tables 1 and 2 of 10 CFR 61.55 would be considered to be greater than Class C waste.

Mixing within waste or of waste with stabilizing materials may be needed for a variety of reasons. Mixing of waste and stabilizing materials may be advantageous to reduce release rates in order to achieve the performance objectives. As defined with respect to the principles of the BTP, mixing with excessive amounts of stabilizing materials solely to reduce the waste concentrations to alter waste classification should not be performed. In most cases, the ratio of the unstabilized to stabilized radionuclide concentrations would not be significantly greater than a factor of 10 for waste classification purposes. For unstabilized waste that can not be selectively treated or removed, mixing (within waste, not between waste streams) to facilitate homogenization of radionuclide concentrations is appropriate. For example, mixing may be used to reduce the variability in concentrations within a layer of tank waste that can not be removed for further treatment.

Example 1-1 - Liquid waste is removed from a tank and additional fluids are added in order to adjust the chemistry for processing. Cement and fly ash are mixed with the resultant liquid in an industrial mixer to form a grout that is placed in disposal containers. The concentration of radionuclides for determining waste classification is based on the total volume or mass of the final wasteform.

Example 1-2 - Reducing grout is added to stabilize a tank heel. The waste residuals in the tank are flocculated solids suspended in a liquid phase that can be mobilized with the tank transfer equipment. However, the solids can not be removed with the existing equipment. The *reducing grout has a relatively high viscosity, such that the flocculated solid residuals and remaining waste liquids can be mixed with the grout prior to setting with the transfer equipment. The concentration of radionuclides for waste classification is based on the total volume or mass of the waste and the reducing grout in which the waste is mixed. Additional reducing grout into which little or no waste is mixed should not be included in the total mass or volume used for concentration averaging.*

<u>Category 2. Stabilization to Satisfy 10 CFR 61.56</u>

Stabilization is a factor in limiting exposure to an inadvertent intruder because it provides a recognizable and non-dispersible waste. For solidified liquids and solids, Section 3.2 of the BTP provides for the concentration of the radionuclides to be determined based on the volume or weight of the solidified mass, which is defined here to be the amount of material needed to stabilize the liquids or dispersible solids to satisfy 10 CFR 61.56. Liquid waste must be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid (10 CFR 61.56). However, the stabilizing material is not to be interpreted as bulk material added to fill void space. Stabilization is determined with respect to the waste and not the entire disposal system or unit. While stabilization of the entire disposal unit (e.g., a tank) may be necessary to meet the performance objectives, it generally would not be needed to make the residual waste recognizable and non-dispersible.

Waste concentrations are calculated based on the volume or mass of material needed to be added to liquids or dispersible solids in order to solidify or encapsulate them. The concentration of the stabilized waste (waste plus stabilizing material) should generally be within a factor of 10 of the concentration on either a mass or volume basis in the unstabilized waste.

The factor of 10 is derived from consideration that most stabilization techniques commonly envisioned use cementitious materials, and most cementitious wasteforms can readily achieve a ten mass percent waste loading. Additional stabilizing materials would in general not be needed for waste stabilization but may be needed for stabilization of the system or structures.

For thin layers of contamination on surfaces, especially vertical surfaces, the average concentration may be based on the volume or mass of the structure in direct contact with the contamination plus a layer of stabilizing material that would be needed to stabilize the waste, as discussed above. This is not to be interpreted that averaging can be performed over all materials added to fill void space in the structure or over the portions of the structure that are essentially uncontaminated. This approach is justified because the concentrations would be expected to approach homogeneity with respect to the intruder scenarios, and the main justification for the classification system is to provide protection to the inadvertent intruder. The concentration values found in Tables 1 and 2 of 10 CFR 61.55 were derived assuming the total volume of waste exhumed by the intruder is at those concentrations, therefore a thin layer of more concentrated material averaged over the same exhumed volume would achieve a similar level of protection. Specific averaging volumes are not provided in this guidance because of the site-specific nature of the waste and site-specific considerations for intruder scenarios.

Example 2-1 - A tank contains a heel that is 2.5 cm thick, and is composed of liquids and dispersible solids. A 20 cm thick layer of reducing grout is needed to stabilize the waste, and an additional 300 cm of high-strength grout is added to fill void space and to provide an intruder barrier. The concentration of radionuclides would be calculated by averaging over the 20 cm thick layer of reducing grout. Use of a 20 cm layer of reducing grout in the concentration calculation is based on the amount of grout that would be needed to stabilize the waste if it *could be removed from the tank and made into a stable wasteform. The concentration of the stabilized waste (waste plus stabilizing material) would generally be within a factor of 10 of the concentration in the unstabilized waste on either a mass or volume basis.*

Example 2-2 - The walls of a waste storage tank have a thin layer (0.1 cm) of residual contamination that is not easily removed. The tank walls are 1 cm thick and the tank is contained within a 0.5 m thick vault. The contamination is distributed on the lower 5 m of the vertical surface. The contamination is not easily dispersed into the environment and is located underground. Closure of the storage tank will involve filling the tank and all void space with grout. The concentration of the waste for waste classification is calculated based on the thickness of the tank wall over the lower 5 m of the tank, the thickness of the contamination, and a 1 cm thick layer of stabilizing grout. Use of a 1 cm layer of grout in the concentration calculation is based on the assumption that formation of a stable waste form is accomplished by incorporating the 0.1 cm layer of residual waste into a cementitious waste form at a mass loading of approximately 10%. The concentrations of the thin layer would be reduced by a factor of 20 for estimating waste classification if a volume basis were used.

Category 3. Other Provisions

10 CFR Part 61.58 allows the Commission to authorize other provisions for the classifications and characteristics of waste, 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. Demonstration that the performance objectives can be satisfied would involve a site-specific analysis (e.g., performance assessment). 10 CFR Part 61.58 was intended to allow the NRC to establish alternate waste classification schemes

when justified by site-specific conditions, and does not affect the generic waste classifications established in 10 CFR 61.55. Thus, if the results of concentration calculations performed in a manner consistent with the principles and examples described previously in this document indicate that radionuclide concentrations in the waste exceed Class C limits, then the waste is greater than Class C waste for waste classification purposes. If it can be demonstrated that the performance objectives of 10 CFR Part 61.58 can be satisfied, then the waste would be suitable for near surface disposal.

For the performance assessment calculations, the waste should be represented as it is physically expected to be present, and not averaged over the stabilizing and encapsulating materials unless the estimated doses to the public and inadvertent intruders were conservative as a result of averaging. Otherwise, every attempt should be made to represent the expected distribution of activity within the disposal system. If the 10 CFR 61 Subpart C performance objectives can be met with reasonable assurance, then the waste is considered to be acceptable for near surface disposal.

When performing the intruder calculations, it is not appropriate to calculate an average dose factoring in the likelihood of the occurrence of the scenario. The likelihood of the intruder scenario occurring is already represented in the higher limit (e.g., 500 mrem/yr) applied for inadvertent intruder regulatory analysis.

Example 3-1 - A waste heel remains in a HLW tank. Reducing grout is added to the heel, displacing some material to the center of the tank, while a fraction of the waste remains on the tank surfaces encapsulated by the reducing grout. A high strength grout is placed over the reducing grout as an intruder barrier and to limit water contact. The top of the waste *residuals are 10 meters below the ground surface.*

An intruder scenario is evaluated in which a well-driller places a well through the disposal system. In this case, the intruder is exposed to drill cuttings (waste). The average concentration of the waste used in the performance assessment calculations should be calculated by assuming mixing over the volume of well cuttings exhumed because the cuttings are expected to be well-mixed when spread on the land surface. This average concentration is applicable only to the performance assessment and not to the determination of waste classification.

Because the rate of erosion at the site is relatively high, a second intruder scenario is evaluated in which most of the cover is eroded over the analysis time period. Some cover is expected to remain. The intruder constructs a home in the area over the tank. Because the direct exposure pathway is the only major contributing pathway for this scenario, the actual waste distribution can be used in the performance assessment. Alternatively, the average concentration of waste over the stabilizing materials can be used in the performance assessment because there would be less shielding for this calculation and the doses would likely be conservative.

The doses to a public receptor who is offsite when institutional controls are in place and at the edge of a buffer zone near the closed tanks after institutional controls end is evaluated with an all-pathways performance assessment. The performance assessment represents expected degradation of the system over time. The modeling of the source term represents the waste as two zones, one zone of higher hydraulic conductivity and reducing conditions that persist for 500 years and one zone of lower hydraulic conductivity and reducing conditions that *persist for the entire analysis period (10,000 years). The first zone represents waste between the tank surface and the added grout which may be exposed to increased moisture flow/oxidation because of shrinkage effects or degradation of the grout itself over time from various attack mechanisms. The second zone represents waste that was immobilized in the center of the reducing grout by the pour sequence of the tank closure operations. The concentrations of radionuclides in both zones should be represented in the performance assessment by the expected distribution of contamination within the zones, or distributions that can be demonstrated to be conservative with respect to release and exposure modeling. The potential pathways of water to the waste may depend on the discrete features of the system (e.g., cooling coils, shrinkage effects, fractures).*

III. Further Information

Documents related to NRC's reviews of waste determinations are available electronically at the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/adams.html. From this site, you can access the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents. Recent documents related to reviews of NRC waste determinations can be found under Dockets Numbers PROJ0734, PROJ0735, PROJ0736, and POOM-32. If you do not have access to ADAMS or if there are problems in accessing the documents located in ADAMS, contact the NRC Public Document Room (PDR) Reference staff at 1-800-397-4209, 301-415-4737 or by email to pdr@nrc.gov.

Documents may also be viewed electronically on the public computers located at the NRC's Public Document Room (PDR), O 1 F21, One White Flint North, 11555 Rockville Pike, Rockville, MD 20852. The PDR reproduction contractor will copy documents for a fee.

Dated at Rockville, MD this 5th day of December, 2005.

For the Nuclear Regulatory Commission.

/**RA**/

Scott Flanders, Deputy Director
Environmental and Performance Assessment Directorate,
Division of Waste Management and Environmental Protection,
Office of Nuclear Materials Safety and Safeguards