ENVIRONMENTAL PROTECTION AGENCY

40 CFR Chapter 1

[FRL–7585–6]

RIN 2060–AL71

Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste: Request for Comment

AGENCY: Environmental Protection Agency (EPA).

ACTION: Advance notice of proposed rulemaking (ANPR).

SUMMARY: This Advance Notice of Proposed Rulemaking (ANPR) requests public comment regarding options to promote a more consistent framework for the disposal of radioactive waste with low concentrations of radioactivity (''low-activity''). Of immediate interest is low-activity mixed waste (LAMW). This waste is both chemically hazardous according to the Resource Conservation and Recovery Act (RCRA) and is radioactive with low radionuclide concentrations under the purview of the Atomic Energy Act of 1954 (AEA). Such waste is regulated and managed under both authorities but under certain conditions, one authority may be sufficient to provide public health and environmental protection. In particular, given appropriate limits on radionuclide concentrations in LAMW, disposal of LAMW in RCRA Subtitle C hazardous waste landfills, with their prescribed engineering design and associated RCRA requirements (*e.g.*, waste treatment, waste form), may provide protection of public health and the environment. This document focuses on effective use of the RCRA–C disposal technology for the disposal of LAMW. We (the Environmental Protection Agency) seek comment on standards that would codify this approach and provide greater flexibility for the safe disposal of LAMW.

Beyond LAMW, however, there is a wide variety of radioactive wastes with relatively low concentrations of radioactivity; these wastes are not considered mixed wastes because they are not regulated under both RCRA and the AEA. Examples of such low-activity waste include certain AEA radioactive wastes, certain wastes from the extraction of uranium or thorium (such as those generated by the Formerly Utilized Sites Remedial Action Program (FUSRAP)), a variety of wastes that fall into the technologically enhanced naturally occurring radioactive materials (TENORM) category, and certain decommissioning wastes. Some AEA wastes are deferred from regulation, such as ''unimportant quantities'' of source material with less than 0.05 percent uranium or thorium, and would be characterized as another form of low-activity radioactive waste (LARW, of which low-activity mixed waste would be a subset). Some radioactive wastes are regulated strictly down to the last atom while other low-activity wastes are regulated primarily for their chemically hazardous constituents. Some of these wastes may be unregulated or regulated under a framework lacking clarity and consistency. We seek comment on possible regulatory and non-regulatory options to provide a more coherent framework to manage LARW, and information to improve the scientific characterization of such wastes.

We envision that any standards promulgated to address the use of the RCRA–C disposal technology for LAMW (or, more broadly, LARW) would offer a new disposal option for these wastes. This would provide the flexibility to allow States, disposal facility operators, and waste generators to account for specific State or local regulatory constraints and economic considerations in determining whether they would choose to implement this disposal option for protective management and disposal of these wastes.

DATES: To ensure that your comments will be considered in future actions related to this document, please submit your comments no later than March 17, 2004.

ADDRESSES: Comments may be submitted by mail to: Air and Radiation Docket, Environmental Protection Agency, EPA West Room B108, Mailcode: 6102T, 1200 Pennsylvania Ave., NW., Washington, DC 20460, Attention Docket ID No. OAR–2003–0095. Comments may also be submitted electronically, or through hand delivery/courier. Follow the detailed instructions as provided in Unit I.B of the **SUPPLEMENTARY INFORMATION** section. Please be aware that mail addressed to EPA headquarters may experience delays in delivery resulting from physical security screening. We will consider that fact when evaluating comments received after the end of the comment period.

FOR FURTHER INFORMATION CONTACT: Dan Schultheisz, Radiation Protection Division, Office of Radiation and Indoor Air, Mailcode: 6608J, United States Environmental Protection Agency, Washington, DC, 20460–0001; telephone (202) 343–9300; e-mail *schultheisz.daniel@epa.gov.*

SUPPLEMENTARY INFORMATION:

I. General Information

A. How Can I Get Copies of Related Information?

1. *Docket.* EPA has established an official public docket for this action under Docket ID No. OAR–2003–0095. The official public docket consists of the documents specifically referenced in this action, any public comments received, and other information related to this action. Although a part of the official docket, the public docket does not include Confidential Business Information (CBI) or other information whose disclosure is restricted by statute. The official public docket is the collection of materials that is available for public viewing at the Air and Radiation Docket in the EPA Docket Center (EPA/DC), EPA West, Room B102, 1301 Constitution Ave., NW., Washington, DC. The EPA Docket Center Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air and Radiation Docket is (202) 566–1742.

2. *Electronic Access.* You may access this **Federal Register** document electronically through the EPA Internet under the ''**Federal Register**'' listings at *http://www.epa.gov/fedrgstr/.* It will also be available, along with general information relevant to this ANPR, such as Frequently Asked Questions (FAQ), through EPA's Radiation Program Home Page at *http://www.epa.gov/radiation/.*

An electronic version of the public docket is available through EPA's electronic public docket and comment system, EPA Dockets. You may use EPA Dockets at *http://www.epa.gov/edocket/* to submit or view public comments, access the index listing of the contents of the official public docket, and to access those documents in the public docket that are available electronically. Once in the system, select ''search,'' then key in the appropriate docket identification number.

Certain types of information will not be placed in the EPA Dockets. Information claimed as CBI and other information whose disclosure is restricted by statute, which is not included in the official public docket, will not be available for public viewing in EPA's electronic public docket. EPA's policy is that copyrighted material will not be placed in EPA's electronic public docket but will be available only in printed, paper form in the official public docket. To the extent feasible, publicly available docket materials will be made available in EPA's electronic public docket. When a document is selected from the index list in EPA Dockets, the system will identify whether the document is available for viewing in EPA's electronic public docket. Although not all docket materials may be available electronically, you may still access any of the publicly available docket materials through the docket facility identified in Unit I.A.1.

For public commenters, it is important to note that EPA's policy is that public comments, whether submitted electronically or in paper, will be made available for public viewing in EPA's electronic public docket as EPA receives them and without change, unless the comment contains copyrighted material, CBI, or other information whose disclosure is restricted by statute. When EPA identifies a comment containing copyrighted material, EPA will provide a reference to that material in the version of the comment that is placed in EPA's electronic public docket. The entire printed comment, including the copyrighted material, will be available in the public docket.

Public comments submitted on computer disks that are mailed or delivered to the docket will be transferred to EPA's electronic public docket. Public comments that are mailed or delivered to the docket will be scanned and placed in EPA's electronic public docket. Where practical, physical objects will be photographed, and the photograph will be placed in EPA's electronic public docket along with a brief description written by the docket staff.

For additional information about EPA's electronic public docket visit EPA Dockets online or see 67 FR 38102, May 31, 2002.

B. How and To Whom Do I Submit Comments?

You may submit comments electronically, by mail, or through hand delivery/courier. To ensure proper receipt by EPA, identify the appropriate docket identification number in the subject line on the first page of your comment. Please ensure that your comments are submitted within the specified comment period. Comments received after the close of the comment period will be marked ''late.'' EPA is not required to consider these late comments, but will do so at its discretion.

1. *Electronically.* If you submit an electronic comment as prescribed below, EPA recommends that you include your name, mailing address, and an e-mail address or other contact information in the body of your comment. Also include this contact information on the outside of any disk or CD ROM you submit, and in any cover letter accompanying the disk or CD ROM. This ensures that you can be identified as the submitter of the comment and allows EPA to contact you in case EPA cannot read your comment due to technical difficulties or needs further information on the substance of your comment. EPA's policy is that EPA will not edit your comment, and any identifying or contact information provided in the body of a comment will be included as part of the comment that is placed in the official public docket, and made available in EPA's electronic public docket. If EPA cannot read your comment due to technical difficulties and cannot contact you for clarification, EPA may not be able to consider your comment.

i. *EPA Dockets.* Your use of EPA's electronic public docket to submit comments to EPA electronically is EPA's preferred method for receiving comments. Go directly to EPA Dockets at *http://www.epa.gov/edocket,* and follow the online instructions for submitting comments. To access EPA's electronic public docket from the EPA Internet Home Page, select ''Information Sources,'' ''Dockets,'' and ''EPA Dockets.'' Once in the system, select ''search,'' and then key in Docket ID No. OAR–2003–0095. The system is an ''anonymous access'' system, which means EPA will not know your identity, e-mail address, or other contact information unless you provide it in the body of your comment.

ii. *E-mail.* Comments may be sent by electronic mail (e-mail) to *a-and-r-Docket@epa.gov*, Attention Docket ID No. OAR–2003–0095. In contrast to EPA's electronic public docket, EPA's e-mail system is not an ''anonymous access'' system. If you send an e-mail comment directly to the Docket without going through EPA's electronic public docket, EPA's e-mail system automatically captures your e-mail address. E-mail addresses that are automatically captured by EPA's e-mail system are included as part of the comment that is placed in the official public docket, and made available in EPA's electronic public docket.

iii. *Disk or CD ROM.* You may submit comments on a disk or CD ROM that you mail to the mailing address identified in Unit I.B.2. These electronic submissions will be accepted in WordPerfect or ASCII file format. Avoid the use of special characters and any form of encryption.

2. *By Mail.* Send your comments to: Air and Radiation Docket, Environmental Protection Agency, EPA West Room B108, Mailcode: 6102T, 1200 Pennsylvania Ave., NW., Washington, DC 20460, Attention Docket ID No. OAR–2003–0095.

3. *By Hand Delivery or Courier.* Deliver your comments to: Air and Radiation Docket in the EPA Docket Center, EPA West Room B108, 1301 Constitution Ave., NW., Washington, DC, 20004, Attention Docket ID No. OAR–2003–0095. Such deliveries are only accepted during the Docket's normal hours of operation as identified in Unit I.B.

4. *By Facsimile.* Fax your comments to (202) 566–1741, Attention Docket ID. No. OAR–2003–0095.

C. How Should I Submit CBI to the Agency?

Do not submit information that you consider to be Confidential Business Information electronically through EPA's electronic public docket or by e-mail. Send or deliver information identified as CBI only to the following address: Dan Schultheisz, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Mailcode: 6608J, 1200 Pennsylvania Ave., NW., Washington, DC 20460, Attention Docket ID No. OAR–2003–0095. You may claim information that you submit to EPA as CBI by marking any part or all of that information as CBI (if you submit CBI on disk or CD ROM, mark the outside of the disk or CD ROM as CBI and then identify electronically within the disk or CD ROM the specific information that is CBI). Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

In addition to one complete version of the comment that includes any information claimed as CBI, a copy of the comment that does not contain the information claimed as CBI must be submitted for inclusion in the public docket and EPA's electronic public docket. If you submit the copy that does not contain CBI on disk or CD ROM, mark the outside of the disk or CD ROM clearly that it does not contain CBI. Information not marked as CBI will be included in the public docket and EPA's electronic public docket without prior notice. If you have any questions about CBI or the procedures for claiming CBI, please consult the person identified in the **FOR FURTHER INFORMATION CONTACT** section.

D. What Should I Consider as I Prepare My Comments for EPA?

You may find the following suggestions helpful for preparing your comments:

1. Explain your views as clearly as possible.
2. Describe any assumptions that you used.
3. Provide any technical information and/or data you used that support your views.
4. If you estimate potential burden or costs, explain how you arrived at your estimate.
5. Provide specific examples to illustrate your concerns.
6. Offer alternatives.
7. Make sure to submit your comments by the comment period deadline identified.
8. To ensure proper receipt by EPA, identify the appropriate docket identification number in the subject line on the first page of your response. It would also be helpful if you provided the name, date, and **Federal Register** citation related to your comments.

Acronyms and Abbreviations

We use many acronyms and abbreviations in this preamble. For your convenience and reference, they are:

AEA—The Atomic Energy Act
AEC—The Atomic Energy Commission
ANPR—Advance notice of proposed rulemaking
CED(E)—Committed effective dose (equivalent)
CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act (also known as Superfund)
CFR—Code of Federal Regulations
DOE—The United States Department of Energy
EPA—The United States Environmental Protection Agency
FR—**Federal Register**
FUSRAP—Formerly Utilized Sites Remedial Action Program
GTCC—Greater-Than-Class C low-level radioactive waste
HWIR—Hazardous Waste Identification Rule
LAMW—Low activity mixed waste
LARW—Low activity radioactive waste
LLRW—Low-level radioactive waste
MCL—Maximum Contaminant Level
MLLW—Mixed low-level radioactive waste
MW—Mixed waste
NESHAPS—National emission standards for hazardous air pollutants
NRC—The United States Nuclear Regulatory Commission
OMB—The Office of Management and Budget
ORIA—EPA's Office of Radiation and Indoor Air
OSW—EPA's Office of Solid Waste
OSWER—EPA's Office of Solid Waste and Emergency Response
RCRA—The Resource Conservation and Recovery Act
RCRA—C—Subtitle C of RCRA
TEDE—Total effective dose equivalent
TENORM—Technologically Enhanced Naturally Occurring Radioactive Materials
TRU—Transuranic waste
TSCA—Toxic Substance Control Act
UMTRCA—Uranium Mill Tailings Radiation Control Act
USACE—United States Army Corps of Engineers
UTS—Universal Treatment Standards

What Do We Mean by Certain Terms?

Throughout this ANPR, we refer to "Low-Level Radioactive Waste," "Mixed Waste," "Low-Activity Low-Level Radioactive Waste," "Low-Activity Mixed Waste," and "Low-Activity Radioactive Waste." Each of these terms has a distinct meaning within the context of this document (though not necessarily a regulatory or statutory definition). We want to avoid confusion wherever possible, so we offer these definitions to help you better understand the discussion.

When we say "Low-Level Radioactive Waste" (or LLRW), we always mean a specific kind of radioactive material defined at section 2(16) of the Nuclear Waste Policy Act as radioactive waste that is not spent nuclear fuel, high-level waste, transuranic waste, or uranium and thorium mill tailings. Under 10 CFR part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," the NRC regulates disposal of LLRW in near-surface disposal facilities. The NRC has defined three classes of LLRW in part 61 (classes A, B, and C) based on their radionuclide content and half-life. Under the part 61 waste classification and disposal site design, siting, and waste acceptance scheme, waste with radionuclide content that exceeds Class C still is regulated as LLRW, but generally is not acceptable for near-surface disposal. The Department of Energy (DOE) regulates LLRW under its own AEA authority (*see* DOE Order 435.1).

When we say "Mixed Waste" (or MW), we always mean waste that is regulated under both the Resource Conservation and Recovery Act (RCRA) as hazardous waste and under the AEA as radioactive material. This document is concerned only with MW containing LLRW, so-called mixed low-level waste (MLLW). MLLW can include LLRW Classes A, B, and C, and greater-than-class C. Non-AEA radioactive wastes mixed with hazardous waste are not technically MW, although they may be managed in a similar way.

We are introducing today the term "low-activity" to represent the idea that some radioactive wastes may contain radionuclides in small enough concentrations to allow them to be managed in ways that are fully protective of public health and the environment but do not require all of the radiation protection measures necessary to manage higher-activity radioactive material. As used in this document, "low-activity" is a conceptual term that does not have a statutory or regulatory meaning. This document outlines and requests public comment on methods that could be used in future actions to define "low-activity" wastes. "Low-activity" wastes would be subsets of broader waste categories, such as those defined previously. This document discusses several types of "low-activity" waste, including:

- "Low-activity" LLRW;
- "Low-activity" MW (LAMW);
- "Low-activity" radioactive waste (LARW)—this is a broad category that includes low-activity LLRW and LAMW, as well as other wastes such as those primarily regulated at the State level (*e.g.*, TENORM wastes, where the term "technologically enhanced" means that human activity has concentrated the natural radioactivity or increased the potential for human exposure).

Finally, when we say "byproduct material" we are using the definition in section 11e of the AEA. The discussion in section III of this document focuses on "pre-UMTRCA byproduct materials" not regulated by the NRC. ("Pre-UMTRCA byproduct materials" are tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content that NRC has concluded are outside its jurisdiction under section 11e.(2) of the AEA. This is discussed further in section III.B of this document. The FUSRAP cleanups address much of the pre-UMTRCA byproduct material.)

Questions for Public Comment

Consistent with the purpose of an Advance Notice of Proposed Rulemaking, we are asking many questions about the concepts described in this document. Because this document covers a broad variety of topics and possibilities, we note throughout the text the issues on which we would like public comment. We have also collected questions at the end of sections II, III, and IV, and additional questions may be found in the ''Request for Information'' sections (*see* the ''Outline of Today's Action''). The questions at the end of each section are focused on the material presented in those sections; however, commenters may feel that information in a later section is relevant to a question in an earlier section, or vice versa. We encourage commenters to address the questions as they believe most appropriate. Further, we welcome comments on any aspect of the text, not just on those points for which we specifically request comment. However, to facilitate our evaluation of and response to public comment, we ask that commenters clearly identify which issue(s) they are addressing and refer to relevant portions of the text in their comment.

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I. Why Are We Publishing Today's ANPR?

Today's ANPR introduces a variety of approaches that might be applicable to certain low-activity radioactive waste categories (LARW).[1] We (the Environmental Protection Agency) seek public comment on the appropriateness of these approaches towards a coherent framework assuring appropriate management and disposal of such a diverse set of LARW. As discussed below, our intent is to develop a regulatory framework applicable to all LARW, which could include disposal of LARW at RCRA facilities, whether radioactive material addressed by the Atomic Energy Act under the jurisdiction of NRC or not. Our more immediate focus regards a simpler but protective approach to the present dual regulatory system applicable to low-activity mixed waste (LAMW). We seek comment on approaches that would reduce the burden of the dual regulatory framework for LAMW. One possibility would be to establish a regulatory framework to allow, under certain conditions, the disposal of LAMW at hazardous waste landfills under the purview of Subtitle C of RCRA. Under this approach, we and NRC could reach agreement on the appropriate conditions under which such disposal could take place. Ideally, the conditions that would apply to disposal of low-activity waste would be much simplified over those requirements that now apply to low-level waste disposal facilities which allow the disposal of higher concentrations of radioactive material. Upon such agreement, NRC would need to take regulatory action to allow AEA material under its jurisdiction to be sent to Subtitle C landfills. This would, in

[1] It is important to understand that the term ''low-activity'' does not have a precise statutory or regulatory definition. We use the term throughout today's action to refer to wastes in which the radioactivity is low enough to potentially allow management alternatives that do not incorporate the entire range of radiation control practices, such as disposal at RCRA Subtitle C landfills. The situations and conditions that would define ''low-activity'' waste are the subject of today's action and potentially future rulemakings.

effect, expand the disposal options available for LAMW.

We recently took a similar approach to minimize dual regulation for mixed waste. Recognizing the compliance difficulties associated with the dual regulatory framework applicable to mixed waste, we promulgated subpart N to 40 CFR part 266 (''Conditional Exemption for Low-Level Mixed Waste Storage, Treatment, Transportation and Disposal''). (*See* 66 FR 27218, May 16, 2001.) This conditional exemption provides for a reduced regulatory burden for facilities that store, treat, transport, or dispose of mixed low-level waste (MLLW). Under certain conditions, certain mixed wastes are exempt from RCRA regulation, leaving only the requirements of the AEA to govern their storage, treatment, transportation.

In addition to LAMW, there are a variety of wastes with relatively low concentrations of radioactivity such as certain TENORM waste, certain AEA materials and certain decommissioning wastes for which the present institutional framework is less than clear. Some wastes are tightly regulated from origin through final disposal while others are presently unregulated. These wastes present a variety of radiological risks and, ideally, wastes with similar risks should be managed proportionately to the risk they represent. In this regard, there are a variety of tools that may achieve acceptable risk levels, with regulatory controls being one such tool. However, we recognize that other tools, such as voluntary guidance, ''best practices,'' industry standards, and the like have the potential to result in acceptable risk levels. In section III of this document, we seek comment on the use of these non-regulatory approaches for assuring and achieving acceptable risk levels from the disposal of these various wastes and what role EPA should play in creating a consistent and protective framework for limiting risk. Just as importantly, our ANPR seeks information regarding the characterization of wastes that fall in these categories, or information on other wastes that might be considered in conjunction with those named in this ANPR. Such information can only help to better characterize the risk inherent in these waste categories and lead to a more consistent, protective institutional framework.

We believe that the approach presented in today's action could provide the necessary flexibility for the safe disposal of LAMW and other LARW and might facilitate site cleanups. Informal discussions with various stakeholders (commercial mixed waste generators, DOE, disposal facility operators, State regulators, public interest groups) suggest a broad level of interest in the potential advantages of this approach. Today's document offers an opportunity for stakeholders to provide detailed comment on a variety of concepts and possibilities that could be used in a future rulemaking. If affected entities demonstrate support for such a rulemaking and provide information needed to develop technical and economic analyses, we would have a strong basis to pursue this effort beyond the ANPR stage. Similarly, NRC could use the approach described in this document to develop regulations addressing the disposal of LAMW or other low activity radioactive wastes from its (or Agreement State) licensees. In an effort that may affect the disposal of LARW, NRC held a workshop on May 21–22, 2003, to discuss alternatives for safely controlling solid materials that have no, or very small amounts of, radioactivity. One alternative for that material is placement in a RCRA Subtitle C (hazardous waste) or Subtitle D (solid waste) disposal facility. Therefore, some of the issues discussed in that workshop may be similar to some of the approaches discussed in this ANPR. Background materials (including the information collection efforts conducted by NRC) and current activities (including recent documents issued and plans for stakeholder input), as well as transcripts of the workshop, can be found at *http://ruleforum.llnl.gov/cgi-bin/rulemake?source=SM_RFC&st=ipcr.*

II. How Can the Disposal of LAMW Be Simplified?

As noted above, we have recently promulgated regulations that describe conditions under which RCRA defers to the NRC and Agreement State requirements under the AEA for the storage, treatment, transportation, and disposal of mixed low-level waste. We based this deferral on our determination that the AEA requirements as addressed by NRC's regulations for management of radioactive waste offered an adequate degree of human health and environmental protection when compared to that offered by RCRA for the hazardous components of MLLW. Our RCRA authority is much more comprehensive and wide-ranging than our AEA authority. Under RCRA, we define hazardous waste and regulate hazardous waste generation, transportation, treatment, and disposal, including the operation of facilities handling hazardous waste. However, RCRA specifically excludes certain AEA material from its jurisdiction (40 CFR 261.4(a)(4)). Under the AEA, for the protection of the general environment, we can establish generally applicable radiation protection standards that apply outside the boundaries of locations under the control of persons possessing or using radioactive material. NRC and DOE are responsible for establishing requirements for disposal of AEA material by such persons. For example, we have used this AEA authority to establish effluent release limits from facilities comprising the uranium fuel cycle in 40 CFR part 190. In the case of low-activity mixed waste a dual regulatory framework already exists to address the storage, treatment, transportation, and disposal of such waste. With the promulgation of subpart N to 40 CFR part 266, some of these requirements are eased but widespread implementation of this rule awaits adoption by the States before it can be implemented. (See 66 FR 27257, May 16, 2001.)

In an effort to further reduce the burden of this dual regulatory framework for mixed waste, one option would be to promulgate a standard (such as regulatory limits for radionuclides in the waste) in coordination with the NRC allowing the disposal of LAMW in Subtitle C (hazardous waste) RCRA landfills. We believe an appropriate rulemaking by EPA and NRC of this nature will achieve the same level of protectiveness while at the same time significantly reducing the effort (and cost) otherwise required to comply with two separate regulatory regimes. We focus on disposal because we are aware of a few thousand small generators who store their mixed waste indefinitely because of the lack of disposal options, or the high costs of disposal. We are concerned that this situation may lead to mishandling, illegal dumping, or the elimination of research on, and use of, medical diagnostic techniques resulting in less than optimum health care. A protective regulatory framework that is less expensive and less burdensome would encourage prompt disposal of such waste, avoiding the risks of mishandling and illegal disposal, while improving options for health care. Some Subtitle C treatment standards for land disposal result in stabilized, solidified, or vitrified treatment residues that will immobilize radiological components, as well as hazardous constituents. Also, RCRA requires landfills to have certain engineered barriers to minimize infiltration and prevent releases. These factors make disposal of LAMW in RCRA hazardous waste landfills an attractive approach for a rulemaking. The key in this approach would be to determine what concentrations of radioactivity in LAMW are appropriate for disposal in a RCRA Subtitle C landfill. As the preamble to subpart N to 40 CFR part 266 noted, an evaluation of the requirements embodied in the respective regulatory frameworks for RCRA and AEA revealed that both offer significant protections to human health and the environment. (See 66 FR 27223, May 16, 2001.) In the following sections, we discuss more fully the option of pursuing a rulemaking allowing disposal of LAMW in a RCRA Subtitle C landfill.

A. What Needs To Be Done To Allow Protective Disposal of LAMW?

Because mixed waste contains both a hazardous chemical component and a radioactive component, the safe disposal of low-activity mixed waste must combine elements pertinent to both types of hazards. The RCRA regulatory standards and permitting process provide for control of the chemically hazardous waste components. If EPA pursues rulemaking for the disposal of LAMW, we would focus on the controls necessary to ensure protective disposal of the radioactive component of the waste. We do not propose to change, either directly or indirectly, any of the RCRA provisions regulating the disposal of the chemically hazardous components of the waste. For the radioactive component of the waste, limits on the concentration of radiological waste that can be disposed of in a RCRA Subtitle C landfill may be the most straightforward method to use. These limits would be protective of the public health and would take into account the waste forms derived from the RCRA treatment standards and the design and performance of engineered barriers associated with such landfills.

1. Assess Characteristics of LAMW

The characteristics of low-activity mixed waste are important factors in determining whether a given disposal concept will be appropriate. By ''characteristics'' we mean the properties that will influence our technical analysis of LAMW disposal, because they affect the way the waste will behave in a Subtitle C disposal cell and potential radiation exposure to people. Properties of interest will include physical form and chemical composition of the wastes, and radionuclide content (specific radionuclides and their concentrations).

There is limited information available on mixed waste, particularly when compared to waste that is only low-level radioactive or RCRA hazardous. The most comprehensive survey of commercial mixed waste was conducted by NRC and EPA in 1992 (''National Profile on Commercially Generated Low-Level Radioactive Mixed Waste,'' NUREG/CR–5938). A summary of this survey is available at *http://www.epa.gov/radiation/mixed-waste/nat-prof.htm.* NRC indicated that, based on 1990 practices, commercial facilities generated about 3,950 cubic meters of mixed waste annually and held another 2,120 cubic meters in storage. The profile divides mixed waste properties and generation into five categories: medical facilities, academic institutions, government institutions, industrial facilities, and nuclear power plants. For various reasons, such as improved waste management practices and information collected by a few States, we believe the volumes of mixed waste being generated today may be significantly lower than those described in NRC's profile. For example, when developing our mixed waste rule of May 2001, our discussions with mixed waste generators suggested that the industry has recognized the limited progress in developing mixed waste treatment and disposal capacity and taken steps to reduce mixed waste generation in order to reduce the associated financial and regulatory burden.

Mixed waste (and therefore LAMW) is also generated by DOE. In fact, DOE has a legacy of environmental and process wastes requiring disposal and significant volumes are expected in the future as DOE sites undergo continued cleanup. As discussed in more detail later (see section II.J), DOE has indicated that tens of thousands of cubic meters of low-level radioactive waste that is mixed waste (MLLW) may be considered for disposal in commercial disposal facilities. Some fraction of this waste may have concentrations low enough to qualify as LAMW. The approach presented in this ANPR may also facilitate the cleanup of contaminated DOE sites in a protective, expedited, and cost-effective manner. We request comment on the application of a rulemaking based on this approach to DOE LAMW.

We encourage mixed waste generators to give us their perspective on the current status of mixed waste generation, storage, and disposal. In particular, we would like to know whether generators believe the 1992 EPA/NRC profile accurately describes the state of mixed waste generation today and how their mixed waste experience compares to that profile. Further, since an approach using radionuclide concentration limits to define LAMW for disposal at Subtitle C facilities may be the most workable, we would like generators to tell us which radionuclides are of most concern to them and the concentrations that would address a significant portion of their waste (*e.g.*, what concentration of a particular radionuclide is found in 25%, 50%, 75% of a generator's waste).

2. Assess Alternative Disposal Methods

Because we are focusing on simplifying disposal of LAMW, we must assess the suitability of land disposal methods that have features that could contribute to containment and isolation of low concentrations of radionuclides or treated hazardous constituents. Disposal facilities meeting this description would include:

- Low-level radioactive waste facilities licensed under 10 CFR part 61;
- Hazardous waste disposal facilities permitted under RCRA Subtitle C;
- Uranium mill tailings facilities operating under 10 CFR part 40; and
- Solid waste disposal facilities permitted under RCRA Subtitle D.

Today's ANPR focuses on hazardous waste facilities permitted under RCRA Subtitle C. We do not see a need to address low-level waste facilities, which are licensed with conditions on acceptable radionuclides and concentrations (which may vary for each licensed facility). Further, the rule we issued in 2001 at 40 CFR part 266, subpart N established conditions under which mixed waste could be sent to an NRC or Agreement State licensed low-level waste facility without requiring a RCRA permit. Similarly, while NRC has explored the possibility of allowing mill tailings facilities to accept RCRA hazardous and low-level radioactive waste, those facilities are not generally able to accept either without site-specific licensing. Finally, at this time, we do not expect to extend our disposal concept to RCRA Subtitle D (non-hazardous solid waste) landfills. However, the most recent EPA standards for such facilities (40 CFR part 258) require them to have engineered features that are similar in many ways to Subtitle C facilities. Further, our recent Hazardous Waste Identification Rule (HWIR) effort was intended to identify levels at which hazardous constituents pose a sufficiently low risk that they may be sent to Subtitle D facilities. (*See* 66 FR 27266, May 16, 2001.) We also note that NRC, in collaboration with the State of Michigan, has recently concluded that certain very low-activity wastes from the decommissioning of the Big Rock Point nuclear facility may be sent to a

Subtitle D landfill. (*See* 66 FR 63567–63568, December 7, 2001.) Other States have also determined that Subtitle D facilities may offer sufficient protection for certain types of radioactive material.[2] Therefore, we request comment on the suitability of Subtitle D facilities for low concentrations of radionuclides, under what conditions such disposal would be appropriate, and how comparable Subtitle D and Subtitle C facilities should be considered. We also request comment on the suitability of other types of disposal facilities not mentioned above.

a. RCRA Subtitle C Land Disposal. The design requirements for RCRA Subtitle C hazardous waste landfills include engineered barriers (*e.g.*, liners, see 40 CFR part 264, subpart N) while the hazardous waste itself must be treated to meet the land disposal restriction (LDRs) requirements. (*See* 40 CFR part 268.) Determining when disposal of LAMW at Subtitle C landfills is appropriate could involve deriving limiting radionuclide concentrations in the waste through modeling the performance of these disposal cells. We would consider the effectiveness of the RCRA-permitted landfill disposal cells under a variety of performance and release scenarios. These performance scenarios would take these design and waste treatment requirements into account and would anticipate the range of site-specific conditions at disposal sites that may occur in practice. The scenarios could assess performance of the RCRA Subtitle C design with respect to ground-water contamination under various climatic and hydrogeological conditions.

Scenarios could also evaluate worker exposure situations, including both the worker at the disposal site and the transportation worker. RCRA facilities are highly regulated and implement measures to protect workers against associated hazards. The personal protective equipment provided to RCRA workers might be expected to offer some protection against radiological constituents. Presuming low concentrations of radionuclides (which we would expect would keep exposures well below those allowable for workers at AEA-licensed disposal facilities), these workers might not need to be considered as occupational workers for the purposes of a radiation protection program under NRC regulations. Indeed, if the benchmark for exposure is low enough, from a radiological perspective, these workers would be more like members of the general public in the exposures they would be likely to receive (requirements related to RCRA hazardous waste would still apply). Other scenarios could also be considered as appropriate to assure the protection of the public health and the environment. Consequently, this approach would establish concentration limits appropriate for RCRA Subtitle C landfills accepting LAMW without requiring site-specific performance assessments. As a point of reference, consistent with the concept of LAMW (and "low-activity" waste in general), radionuclide concentration limits would not exceed the values NRC has established for Class A radioactive waste, as described in 10 CFR 61.55. (*See* 47 FR 57473, December 27, 1982.) See section II.D for a more detailed discussion of our concept for modeling.

b. Establish a Risk or Dose Basis for Allowable Concentrations. The basic modeling scenarios provide a method for identifying appropriate risk-or dose-based concentration limits on radionuclides in LAMW.[3] However, we still must consider the appropriate level of risk or dose on which the concentrations would be based. We are considering a number of factors in selecting an appropriate level, including other risk management decisions for radiation protection. In this regard, we are also working with NRC to understand how risk considerations will be incorporated into NRC's selection of a regulatory approach. We give more detail on these factors in section II.D.4.

3. Coordination With the Nuclear Regulatory Commission

Because a significant purpose of our proposed approach is to address low-activity mixed waste generated by NRC licensees, we and NRC will work closely together in modifying the existing regulatory structure to encourage more flexibility in LAMW disposal. The lack of facilities to treat and dispose of mixed waste has been the subject of Congressional hearings and EPA and NRC were encouraged to devote resources to develop a strategy to address these issues.[4] Concern was also expressed to the Council on Environmental Quality about this problem, which "has persisted for over 11 years [with] no resolution in sight."[5] The Council was asked what action was being taken to create alternatives for dealing with these waste streams.[6] We and NRC have worked together in the past to develop guidance and regulatory solutions for certain broad mixed waste issues.[7]

In that vein, EPA and NRC view the disposal of LAMW in a Subtitle C RCRA landfill as a viable approach deserving further examination through a public notice and comment process. EPA and NRC believe this approach has the potential to offer needed flexibility in the regulation of mixed waste and be fully protective of the public health and the environment. This approach would also be consistent with actions taken by both agencies to address specific situations. Note that the NRC, in consultation with us, has issued guidance such that, under certain conditions, radioactively contaminated electric arc furnace dust containing cesium-137 below specified levels—the result of accidental melting of sealed sources by steel mills—appropriately may be disposed of in commercially operated RCRA hazardous waste facilities (62 FR 13176, March 19, 1997).

We anticipate that implementing the disposal option discussed in today's action for all low-activity radioactive waste, including those waste streams discussed in section III, will require regulatory action by both agencies (although our respective responsibilities clearly vary for the different waste streams). We invite commenters to provide their perspective on the appropriate roles of the two agencies in developing regulatory standards and implementing them for waste generators

[2] The State of Texas allows certain radioactive material with half-life less than 300 days to be disposed in solid waste landfills. (See Texas Administrative Code, Title 25, Chapter 289, Section 202(fff).) In 2001, the Radiation Focus Group of the Association of State and Territorial Solid Waste Management Officials (ASTSWMO) stated "Currently, prohibitions against all radioactive materials are too broad" and that "the list of radioactive materials that should be excluded from landfills * * * should include only wastes that are long-lived, and/or soluble, or otherwise pose a significant hazard." ("Detection and Response to Radioactive Materials at Municipal Solid Waste Landfills," Final Report, July 18, 2001.)

[3] A "risk-based" limit would consider the probability that a person being exposed to radiation would develop a health effect. A "dose-based" limit would consider the amount of radiation exposure that person could receive. The correlation between risk and dose is not the same for every radionuclide.

[4] Hearing Before the Subcommittee on Energy and Power of the Committee on Commerce, House of Representatives, 104th Cong., 2d Sess., Sept. 5, 1996, Serial Number 104–114.

[5] Hearing Before the Subcommittee on Oversight and Investigations, of the Committee on Energy and Natural Resources, United States Senate, 104th Cong., 2d Sess., Sept. 26, 1996, Serial Number 104–775, at 71.

[6] *Id.*

[7] EPA and NRC have issued joint guidance on mixed waste testing ("Joint EPA/NRC Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste," 62 FR 62079, November 20, 1997) and disposal ("NRC/EPA Siting Guidelines for Disposal of LLMW," OSWER Directive 9480.00–14, June 1987; "Joint NRC/EPA Guidance on a Conceptual Design Approach for Commercial LLMW Disposal Facilities," OSWER Directive 9487.00–8, August 3, 1987). These documents are available at *http://www.epa.gov/radiation/mixed-waste*.

and disposal facilities, including the appropriate level of Federal and/or State oversight. What regulatory arrangement, including division of responsibilities between EPA and NRC, would be most likely to facilitate the safe management and disposal of these wastes? We would also welcome suggestions as to the most effective ways to minimize the effects of dual regulation.

In our discussions, NRC has identified several regulatory options that it might apply to LAMW. We discuss these potential NRC regulatory approaches to LAMW in section II.F, and have included some questions to elicit public comment on those approaches. However, NRC will discuss issues specific to NRC's regulatory system in greater detail as it proceeds through its own rulemaking process. Our action today focuses more on technical and policy questions surrounding the use of RCRA–C technology and regulatory framework for disposal of LAMW, the applicability of the RCRA–C technology to other low-activity radioactive wastes, and non-regulatory approaches that might prove effective in managing and disposing of low-activity wastes. We encourage commenters to respond to all questions in today's action.

B. Why Is There a Need To Simplify Disposal of LAMW?

1. Dual Regulatory Structure

Mixed waste is regulated under both RCRA and the AEA. The need to comply with two separate regulatory systems, each of which is targeted to a different component of the waste, creates a certain regulatory and economic burden on mixed waste generators. While many of the requirements of the two systems have similar purposes (*e.g.*, inspections), they can have the effect of creating two distinct regulatory compliance infrastructures. Generators (as well as treatment and disposal facilities) must achieve compliance with both systems. In some cases, these requirements may appear to be duplicative.

Approximately 3000 small volume generators store mixed wastes, in part because disposal options are extremely limited. Some estimates are that the number of individual sites storing mixed waste could be significantly higher, though there is greater uncertainty in these estimates. The lack of disposal options for these generators causes increased management costs. It also can result in mishandling and perhaps illegal dumping of the waste. Some mixed waste has been in storage for over a decade. These concerns are not limited to small generators. The EPA rule discussed in section II.B.2 was largely driven by power companies' concern over dual regulation of mixed waste. We believe, in general, that treatment and permanent disposal of waste, when available, is preferable to storage.

Also, we are concerned that the high costs and difficulty of disposing of mixed waste will cause doctors, hospitals, and diagnostic laboratories to suspend certain procedures, which could result in the provision of less than optimum health care.[8] There are reports that the inability to store and dispose of radioactive waste has caused researchers to avoid scientific procedures that are known to be effective and to develop less effective alternatives.[9] We also are concerned that such problems indirectly may be hampering medical research.

We believe it is possible to alleviate the problem if more of the facilities that can accommodate hazardous waste safely were allowed, under certain conditions, to dispose of LAMW. Of the commercial facilities currently permitted to dispose of hazardous waste under RCRA, only one is also licensed to dispose of AEA radioactive waste (and mixed waste). (This facility and one other that we are aware of that has applied for a license to dispose of AEA radioactive waste are special cases, as their original plans involved accepting radioactive waste.) This situation may be due, in part, to the additional burden faced by the RCRA disposal facility operators in applying for a site-specific license under 10 CFR part 61 or its equivalent to establish a full-fledged low-level radioactive waste (LLRW) disposal facility. Both 10 CFR part 61 and RCRA Subtitle C describe fairly lengthy, data intensive, and costly processes for regulatory approval. The somewhat different focus of the two systems (RCRA as ''technology based'', part 61 as ''performance based'') may also serve to limit the number of facilities willing to demonstrate compliance under both regulatory systems. (See section II.C for more detail on the licensing-permitting issue.) A few commercial Subtitle C landfills have accepted non-AEA radioactive waste with the approval of State authorities, which supports our belief that, with the proper controls, the RCRA–C technology can provide protective disposal of certain types of radioactive material. Issues associated with non-AEA radioactive wastes are discussed in section III.

We asserted RCRA authority over the hazardous portion of mixed waste in the mid-1980s; however, section 1006 of RCRA states that the AEA takes precedence over RCRA in cases where the regulatory requirements are inconsistent. Because the approach we are considering would rely on RCRA Subtitle C landfill technology, and because low-activity mixed waste would have relatively low concentrations of radionuclides, our approach would permit the disposal of LAMW if it met RCRA–C regulations and practices. This implies that the risks to workers, the public, and the environment (including ground water) presented by the radioactive portion of LAMW would be effectively minimized considering the controls already in place at the RCRA–C landfills. Waste generators would also bear responsibility for ensuring that their waste met conditions for disposal as low-activity mixed waste.

This approach would take into account the practicalities of implementing LAMW disposal at RCRA-permitted hazardous waste landfills, rather than transforming them into more AEA-like facilities. We believe that this will introduce sufficient flexibility as to allow LAMW generators to take advantage of additional disposal options. Similarly, the number of commercial facilities currently permitted under RCRA to accept hazardous waste (roughly 20) is significantly higher than the number licensed to accept low-level waste (3) or mixed waste (1), offering the prospect of greater competition and disposal capacity. Though this comparison is instructive, we do not want to limit our focus to commercial disposal facilities. A significant number of companies have been issued permits for their own ''captive'' or privately-owned hazardous waste disposal facilities, which typically accept waste only from generators owned by or affiliated with the landfill operator. It is conceivable that mixed waste generators might be among those with access to such facilities. These facilities must meet the same RCRA permitting requirements as commercial facilities and therefore, this approach should be equally appropriate for the receipt of LAMW. We request comment on whether we should consider only a subset (*i.e.*, only the commercial or private sector) of the RCRA–C universe in our analyses. On a related topic, should RCRA landfills operated by DOE on its own sites be considered within the scope of this approach?

[8] Kaye, Gordon J, ''The Crisis in LLRW Disposal Short- and Long Term Effects on the Biomedical Community,'' Newsletter for Appalachian Compact Users of Radioactive Isotopes, June 1991.

[9] Isaac, Peter G, *et al.*, ''Nonradioactive Probes,'' Molecular Biology, p 259–160, vol. 3, June 1995.

2. Recent EPA Mixed Waste Actions

As described above, on May 16, 2001, we promulgated regulations related to the storage, treatment, transportation, and disposal of mixed low-level radioactive waste (subpart N of 40 CFR part 266). These regulations describe conditions under which MLLW can be exempted from certain RCRA hazardous waste requirements. In particular, a generator of MLLW may store and treat the waste at the generator's facility without obtaining a RCRA permit (required for hazardous waste treatment, disposal, and on-site storage beyond 90 days), as long as the storage and treatment take place in tanks or containers and conform to the generator's AEA license conditions. Similarly, transportation to an AEA-licensed low-level radioactive waste disposal facility, and subsequent disposal, may also take place solely according to AEA requirements. However, eligible MLLW must still meet the RCRA land disposal treatment standards prior to transportation for disposal at a licensed low-level waste disposal facility.

We believe our conceptual approach to disposal of low-activity mixed waste is complementary to the regulations we promulgated in subpart N. We believe that a significant proportion of MLLW could qualify as low-activity mixed waste (just as most low-level waste is in the lowest-activity class), depending on where the technical analyses indicate the limits should be set. The approach we are outlining today would also significantly increase disposal options, if fully implemented. Compared to the three operating low-level radioactive waste disposal facilities, there are roughly twenty commercial RCRA Subtitle C disposal facilities operating today, with many more that take waste from only a limited number of generators.

The approach we took in promulgating the subpart N disposal requirements relied on a comparison of the RCRA and AEA requirements for disposal. In that context, and recognizing that RCRA waste meeting the treatment standards for land disposal would likely be significantly lower in risk, we determined that AEA disposal requirements offered sufficient protectiveness for the hazardous constituents in MLLW. Our approach to establishing disposal standards for low-activity mixed waste is similar in concept. For example, our approach would consider the effects of waste form for the treated LAMW and containerization in minimizing the availability of radionuclides in the waste for release in the presence of water. However, our approach will rely on modeling to determine when the risk to workers and the public from disposal of radionuclides is acceptably low. The LAMW concentration limits developed under this approach will be analogous to the RCRA concentration-based treatment standards that reduce the toxicity and mobility of hazardous constituents in the waste. Additional measures that support and build public confidence in this determination, such as ground-water monitoring for radionuclides, may be advisable.

There will be unavoidable overlap of the mixed waste eligible for disposal under the two rules. Our subpart N regulations cover a broader spectrum of MLLW, while we expect the LAMW concept to address only the lower-activity portion of that MLLW spectrum. Generators with waste eligible under both rules may make their disposal choice based on cost, access to a disposal facility, and regulatory constraints.

C. How Would the RCRA Regulatory Framework Support a Viable Disposal Concept?

We propose to rely to a large extent on the protections offered by the RCRA hazardous waste disposal facilities for disposal of low-activity mixed waste. We believe that the RCRA Subtitle C requirements provide a uniform level of waste containment and isolation technology that warrants confidence in their ability to address low concentrations of radionuclides; although RCRA does not regulate on the basis of radioactivity, there is no general prohibition on disposal of material not regulated as hazardous in a hazardous waste facility, and some RCRA facilities are permitted to accept certain types of TENORM waste. In addition, requirements related to hazardous waste characteristics have evolved over the life of the Subtitle C program to the point that they are tightly controlled through application of treatment standards. Below we discuss several points that we believe provide strong support for the LAMW disposal approach.

1. Technological Basis for Disposal (RCRA Hazardous Waste Landfill Criteria)

To assess the protectiveness of LAMW disposal at RCRA–C facilities, we first need to understand how the disposal cell itself will contribute to the isolation of radionuclides. It is recognized that RCRA and AEA employ different regulatory philosophies. RCRA has explicit engineering and construction criteria for Subtitle C landfills. Therefore, any permitted RCRA–C facility is expected to meet these basic criteria and they can be accounted for in the technical analyses. In contrast, as discussed further in section II.C.4, AEA low-level waste facilities in 10 CFR part 61 must meet certain performance objectives to be licensed. Thus the AEA approach allows for some variation among AEA facilities, depending upon factors such as climate and site geology. This provides flexibility in facility design in that it can be tailored to the hazard of the waste. Ultimately, the purpose of both systems is to contain and isolate the waste in order to protect public health and the environment.

We believe RCRA's uniformity of design, and the specific engineering features required, provide assurance that RCRA–C facilities can limit contact of waste with water (and subsequent leachate generation) and should allow disposal of LAMW containing low concentrations of radionuclides. The RCRA regulations describing landfill attributes are located in 40 CFR part 264, subpart N. They require, among other things, that a disposal facility have:

- A cap on the disposal cell that minimizes infiltration of liquids, promotes drainage, minimizes erosion, accommodates settling and subsidence, and has permeability no greater than that of the disposal cell liner system or natural subsoils;
- A liner system beneath the disposal cell constructed of materials of specified thickness, hydraulic conductivity, physical strength, and chemical resistance;
- A leachate collection and removal system capable of limiting leachate depth above the liner to 30 cm; and
- A leak detection system constructed with a specific slope and materials of a certain thickness, hydraulic conductivity, physical strength, and chemical resistance.

2. RCRA Treatment Standards

Besides having specific requirements for disposal cell construction, RCRA also requires that hazardous waste be treated prior to land disposal. This treatment may serve two purposes: First, it can reduce the concentration of hazardous constituents in the waste, which also reduces the associated risk; second, it may change the physical form of the waste, which can change the volume of the waste, make the waste easier to handle, reduce the likelihood of releasing hazardous constituents from the waste, or reduce the likelihood that the waste itself will migrate out of the disposal cell (*e.g.*, as a liquid or leachate) and reach ground water. (By contrast, NRC requirements address waste characteristics, but NRC does not require specific treatment methods for waste prior to disposal. However, low-level radioactive waste is generally compacted, which reduces volume and increases stability but also increases radionuclide concentrations on a per unit volume basis. In addition, liquids and chelating agents must be minimized or otherwise managed to limit their impact on facility performance.)

The RCRA Universal Treatment Standards (UTS) are located in 40 CFR part 268. Most are in the form of concentration limits of the respective hazardous constituents, but some are in the form of specified treatment technology (particularly in the case of hard-to-treat wastes). The UTS are based on the level of reduction that can be achieved by available technology, not on risk reduction. However, by reducing the concentration of toxic constituents, the practical effect is some reduction in risk. We would appreciate comments on the need for measures, such as waste treatment to a specific waste form, that would help ensure that radionuclide concentrations established under the approach outlined today remain protective when implemented.

We expect this approach to require that low-activity mixed waste comply with the RCRA UTS before allowing disposal at RCRA–C facilities, in keeping with existing restrictions. To the extent that treatment involves some kind of waste stabilization or solidification, we would consider this advantageous to keeping radionuclides immobilized in the disposal cell. We ask readers whether they believe there are situations in which compliance with the UTS may be unnecessary or inadvisable for wastes containing radionuclides. We request comment on the need to require a certain waste form for LAMW and the desirability of having standards (*e.g.*, concentrations) that are dependent on waste form. We also request comment on whether a rule should explicitly require segregating treated LAMW meeting the UTS from untreated hazardous waste (waste disposed of before treatment standards were required). This would limit potential interactions with chemicals that could influence the ability of radionuclides to move in the environment. We believe this is probably not necessary, as disposal cells that were open prior to the treatment requirements are likely to have been closed for some time.

3. RCRA Disposal Facility Operating Standards

RCRA is also explicit about how the facility must approach operational functions, both while the facility is operating and during the closure and post-closure phases. In particular, facility operators must follow specific procedures regarding (*see* 40 CFR part 264):

- Inspections—the facility operator must inspect equipment and procedures in accordance with a written schedule (including inspecting the installation of the liner and leachate collection system), must inspect the operation of the landfill after storms, and must inspect the leachate collection system regularly during operation and post-closure;
- Recordkeeping—the facility operator must maintain inspection records for at least three years and maintain records detailing the location, dimensions, and contents of disposal cells;
- Monitoring/corrective action—the facility operator must conduct a ground-water monitoring program and implement corrective action when a hazardous constituent is detected in ground water at concentrations that exceed those listed in the facility's permit;
- Closure/post-closure—the facility operator must install a permanent cap on the disposal cell that complies with engineering specifications, must have an approved closure plan that minimizes the need for further maintenance, must perform maintenance that becomes necessary throughout the post-closure period, and must submit a survey plat showing the locations and contents of disposal cells.

4. How Does AEA Licensing Compare to RCRA Permitting?

Both the NRC and EPA have designed their disposal regulations with the intent of isolating waste from the environment to minimize exposures from the radiological or chemical constituents (in this document, we are focusing on the NRC requirements for LLRW disposal under 10 CFR part 61). There are a number of broad similarities between the two regulatory approaches that could translate into ''simplified'' AEA oversight. For example, both the AEA and RCRA:

- Accept and regulate near-surface disposal as a means to contain and isolate waste;
- Include measures to limit infiltration into the disposal cell (such as a cover/cap);
- Require site monitoring during operations;
- Require continued maintenance after facility closure; and
- Recognize that there are certain site characteristics to be avoided (such as floodplains and other geologic hazards).

However, there are also some noteworthy differences in the technical requirements for waste disposal. Some of these differences exist because of the way the regulations are written and implemented. RCRA regulations are more prescriptive and design-based than are the NRC requirements. Although both systems have basic requirements for site selection, RCRA does not require a landfill seeking a hazardous waste disposal permit to conduct performance assessments (site-specific modeling) to assess how waste disposal at the facility will protect human health and the environment after facility closure. Instead, by requiring a uniform (minimum) level of technology designed to provide containment and prevent releases, RCRA places the burden on the technology to perform as expected and thereby protect the public and environment. For example, RCRA requires that a disposal cell have a double liner constructed of certain materials and a leachate collection system capable of performing to certain specifications. RCRA regulations say, in effect, ''this level of technology is protective.'' An important point is that, under RCRA, leachate from a hazardous waste disposal cell is hazardous waste, and must be collected and treated accordingly. Similarly, leachate containing radionuclides could be newly generated mixed waste and be treated accordingly. We request comment on how we should address radionuclides in the LAMW leachate, particularly if the LAMW has been disposed of under some exemption from NRC requirements.

On the other hand, NRC, in its regulations under the AEA, focuses more on standards of performance, rather than on construction specifications. The NRC has established a maximum dose level to the public; however, the burden is on the facility operator to satisfy the licensing authority that the facility, as sited and constructed, will not allow that dose to be exceeded. Thus, the NRC regulations require a detailed, site-specific operational and post-closure performance assessment to show that the facility will perform adequately. NRC regulations say, in effect, ''show that the level of technology you select, combined with the characteristics of the site you have selected, will meet this level of protection.'' License conditions, often including monitoring facility performance, are then established to ensure that the level of protection is achieved.

The nature of the waste can also affect the time needed for the hazard to diminish. RCRA establishes a minimum period of 30 years for facility maintenance and monitoring after closure of the disposal cell (with extensions as necessary to protect human health and the environment). NRC assumes a minimum period of 100 years for active maintenance, with control of the site continuing for an indefinite period before license termination because of the variety and concentration of radionuclides that could be disposed at such a site. Performance assessments conducted to meet 10 CFR part 61 licensing requirements include projections well beyond both the 30- and 100-year active institutional control periods.

The environment in the disposal cell (*e.g.*, pH, temperature, moisture) can affect the decomposition of many hazardous constituents (primarily organics, as many heavy metals persist essentially forever). Radionuclides, however, break down more predictably than do hazardous constituents. A radionuclide remains radioactive, and will take the same time to decay, regardless of its physical and chemical environment. Because some radionuclides take hundreds or thousands of years to decay, under the AEA, facilities are not expected to maintain perfect containment for these long periods until the waste is no longer radioactive. In fact, evaluations of AEA facilities typically include situations in which the disposal system does not perform as well as expected, with resulting limited releases. These projected limited releases become the basis for performance assessments used to make compliance or licensing decisions. Under NRC regulation, the combination of engineered barriers, waste form requirements, and natural site characteristics are evaluated to assure that the concentration of radionuclides reaching the accessible environment does not exceed regulatory limits. Although AEA regulatory practice focuses on preventing infiltration, if the cell cover degrades it is preferable for infiltrating water to move quickly out of the disposal cell in order to minimize contact time with the waste (avoiding a ''bathtub'' situation). Thus, this approach of recognizing the potential for limited releases delays and spreads out the releases over time and minimizes peak doses. In practice, many long-lived radionuclides will not move with ground water, but will remain within the general area of disposal because of their chemical characteristics. (Assumptions and knowledge about the mobility of individual elements in various environments influence the selection of modeling parameters. Typically, conservatism is introduced into performance assessments to help account for uncertainties in long-term modeling. It should also be noted that the behavior of a particular element in the environment will be essentially the same whether it is radioactive or not.) In this vein, NRC regulations expect the evaluation of a potential disposal site for ''at least a 500 year time frame'' while also considering the ''indefinite future.''[10]

There are several fundamental issues to be considered in determining the feasibility of an approach involving simplified NRC oversight for RCRA-C facilities, particularly where NRC requirements are more extensive than RCRA requirements. Areas of overlap in which one regulatory regime would take primacy also are important. These issues include:

- *Post-Closure Care:* Should operators be required to maintain the facility for periods longer than the minimum 30 years required by RCRA? (RCRA has discretion to extend this period, and some States have done so.) What about for 100 years, with the expectation of longer site control, as NRC requires?
- *Land Ownership:* RCRA allows private ownership of disposal sites, with the possibility of future sale. NRC licensing under 10 CFR part 61 is contingent on eventual ownership of the site by a Federal or State government entity.
- *Financial Assurance:* AEA disposal facilities generally put up a higher initial financial assurance than RCRA facilities to account for longer periods of care.
- *Ground-Water Monitoring and Corrective Action:* If there are releases of hazardous constituents, RCRA authorizes corrective action (corrective action for hazardous constituents might be effective for AEA materials combined with the hazardous constituents). RCRA regulations have specific requirements for ground-water monitoring of hazardous constituents (40 CFR 264.92–94), which are incorporated into the facility permit. While NRC regulations have general requirements for site monitoring ''capable of providing early warning of releases of radionuclides from the disposal site before they leave the site boundary'' (10 CFR 61.53), they do not contain separate ground-water standards. Detailed monitoring requirements may be developed in the facility license.

This ANPR addresses the possibility of alternate disposal methods for LARW. We will work with NRC to develop appropriate concentration limits that are protective of the general public and that minimize the need for additional NRC requirements. However, NRC may decide that additional requirements on generators or disposal facilities are necessary for NRC to meet its obligations under the AEA. We request comment on these issues.

D. What Methods Could Be Used To Assess the Risk of Disposing of LAMW?

1. Modeling as a Basis for Establishing Risk or Dose Basis

Mathematical modeling is a fundamental tool of radioactive waste management. It assists regulators in assessing expected releases (and subsequent doses) to the environment from disposal facilities over periods of hundreds to thousands of years. However, these projections over time should not be viewed as firm predictions. Instead, they can give regulators and the public confidence that certain limits will not be exceeded. Actual ''proof'' of performance would involve active measures such as facility monitoring.

2. Comparison of Risks From Radioactive and Hazardous Waste Disposal

The public may not have a good understanding of the relative risks from radiation and hazardous waste. It is probably true that many people would consider radioactive waste to be more of a danger than hazardous waste. It is important that the public be informed of the risks involved in our approach and be satisfied that those risks are managed appropriately. We have included a general discussion of risks from both types of waste below.

The risk from radioactive material depends on the type of radiation emitted and the path(s) of exposure. Gamma radiation is most significant for external exposures. Alpha emissions are of most concern for inhalation. NRC requirements for land disposal typically put limits on radiation doses to the public. Dose can be converted to risk, although risk can also be calculated directly from exposures; the results tend to differ for the two methods, and dose itself can be expressed in several ways that may not be equivalent (a more detailed discussion of various dose standards is located in section II.D.5). As discussed above, facilities seeking an NRC radioactive waste disposal license

[10] 10 CFR 61.7(a).

must satisfy the licensing authority that they can meet these limits through long-term performance assessments. The performance assessment evaluates the projected inventory of radionuclides in the disposal cell at closure and models the movement of those radionuclides in the environment using site-specific conditions.

RCRA considers risk when deciding which wastes should be defined as hazardous. RCRA evaluates how individual constituents, when land disposed, will behave in the environment over long periods of time. Listed wastes (those designated by F, K, P, or U waste codes) automatically include substances that have a lifetime cancer risk of 10^{-4} or higher to a nearby receptor (*i.e.*, exposures to the contaminant would cause a fatal cancer to one person or more in a population of 10,000). RCRA lists substances with a lifetime cancer risk between 10^{-4} and 10^{-6} on a case-by-case basis. It does not list those substances with a lifetime cancer risk less than 10^{-6} (*i.e.*, fewer than one in 1,000,000). For non-cancer toxic effects, if the concentration of the constituent in leachate exceeds the drinking water treatment standard for that constituent (*i.e.*, the ''Hazard Quotient'' is greater than or equal to 1), the waste is listed as hazardous. Toxicity characteristic wastes (designated by the D waste code) are defined at the concentration that corresponds to a 10^{-5} lifetime fatal cancer risk. In determining whether to list a waste as hazardous, RCRA does not focus on individual site characteristics, but conducts generalized assessments that consider climatological and hydrogeological variations around the country along with how much of a particular waste is generated and how many sites across the country might accept such waste, and does not credit the engineered features required in the regulations (as we would expect to do for LAMW).

Since 1998, hazardous waste must meet the Universal Treatment Standards (UTS) in 40 CFR part 268 before being land disposed. The UTS are constituent-specific concentration or treatment technology standards that effectively reduce the toxicity, although the waste must still be disposed of as hazardous. Our recent Hazardous Waste Identification Rule (HWIR) effort is intended to establish risk-based constituent concentrations at which listed hazardous wastes could ''exit'' regulation under Subtitle C. They could then be disposed of as ''solid waste'' under Subtitle D.

In sum, both the NRC and RCRA approaches serve to limit the risk to the public from waste disposal. Although we plan to conduct modeling of the disposal cell (that may combine aspects of the site-specific and generalized approaches), we will also examine the NRC and RCRA disposal regulations to support the modeling efforts.

3. Modeling Scenarios

The modeling effort would have two aims. The first aim would be simply to assess the performance of the generic RCRA-C design in terms of long-term radionuclide containment. The second aim would be to derive limits for radionuclide concentrations in the wastes to be disposed of in such a facility. Both NRC and EPA will have to be satisfied with the modeling to successfully implement this approach. EPA's modeling approach is detailed below and will be coordinated with the NRC.

a. Situations to be Addressed. The initial step in a risk or dose assessment is to determine how a person might be exposed to the material in question. If there is no exposure, as for the period when waste is contained and isolated within an intact disposal cell, the risk or dose will be zero. There are four situations that could result in human exposures to the radionuclides in low-activity mixed waste:

- The gradual degradation of the disposal cell through expected natural processes, which results in radionuclide releases over long periods of time (100 years or more);
- Releases caused by ''off-normal'' events, such as unusually high precipitation over a period of years;
- Exposures to RCRA disposal facility workers handling LAMW; and
- Exposures caused by human activity that disrupts the disposal site.

These scenarios are discussed in more detail in the following sections. We request comment on the adequacy of these scenarios and whether there are others we should consider. We recognize that similar scenarios could be used to describe potential exposures to the hazardous constituents already handled at the facilities under consideration, and that such exposures may be of equal or greater risk than would be presented by radionuclides; however, our purpose in this discussion is to determine the best way to demonstrate that the RCRA technology is adequately protective for radionuclides.

b. Long-term Disposal Cell Performance. i. General Discussion. To model the long-term performance of the RCRA hazardous waste disposal cell, assumptions must be made about the initiation of failure of the cap and liner system to allow water to enter the cell, interact with the wastes, and exit the disposal cell to the surrounding area. Once released from the disposal cell, contaminated water would percolate downward through the unsaturated zone above the local water table, eventually reaching the water table and migrating laterally in the direction of ground-water flow toward a receptor at some distance from the disposal facility. For this conceptual model, the receptor is a person living close to the facility who receives doses from the use of contaminated ground water. Other pathways of exposure would include the surface transport of waste accidentally spilled during operation of the disposal facility.

With this simple conceptual model, potential releases from the disposal cell can be calculated for assumed waste concentrations by specifying the other parameters involved in contaminant transport calculations. Important factors for consideration in the modeling calculations include:

- Rainfall rates;
- Thickness of the unsaturated zone under the disposal cell;
- Distance from the disposal cell to the well supplying water to the receptor;
- Drinking water consumption rate from the contaminated well and amounts of contaminated food consumed;
- Ground-water flow rates;
- Effectiveness of the cap in controlling water infiltration and the liner in retarding contaminant movement;
- Radionuclide retardation effects (primarily sorption into the geologic media and solubility constraints); and
- Radioactive decay along the flow paths.

To test the performance of the disposal cells, we would model a wide range of site-specific conditions in arid and humid climatic settings as well as variations in hydrogeologic conditions, such as variations in the thickness of the unsaturated zone below the disposal facility and ground-water flow rates in the saturated zone. Variations in all these parameters will affect the exposures incurred by the receptor for the scenarios analyzed. We would expect to base our modeling on data available for actual sites in order to capture the variation in various site parameters. We could use the data for DOE sites, because they represent a wide range of climatic and hydrogeologic conditions across the nation, and because they are relatively well-characterized and a good data base of site-specific conditions is available for them. We also could use site data from RCRA-C facilities across the nation; the most comprehensive approach would probably be to create a combined data set to ensure that the modeled sites reasonably address the range of potential waste disposal facilities subject to RCRA-C landfill requirements. We would expect to adopt a conservative approach to selecting model parameters, as described in more detail later. Additional sensitivity studies would be done to identify the variables that most prominently control disposal cell performance and exposures to the hypothetical receptor outside the facility.

We expect to address a variety of site characteristics and exposure scenarios in the analyses described below. These analyses will encompass a broad range of potential conditions from which waste concentrations could be derived for uniform waste acceptance criteria nationwide. It is possible that some hazardous waste landfills could dispose of waste containing higher concentrations of radionuclides than would be appropriate for the ''average'' facility while maintaining the appropriate level of protection for the public and environment. For example, waste acceptance criteria could be derived by explicitly examining site characteristics, such as annual precipitation levels. Alternatively, disposal facilities with unique features, such as very deep ground-water tables, may be able to safely contain wastes with higher radionuclide content than the levels defined in a broadly applicable standard. Therefore, we request comment on whether individual disposal facilities should be given the opportunity to demonstrate that they can accept waste with radionuclide concentrations that exceed those that would be established by such a standard.

The basic scenario to model would be an expected performance case, in which the disposal cell degrades over time and radionuclide releases from the bottom of the cell infiltrate the underlying unsaturated zone and move into the saturated zone. From that point, the ground-water flow in the saturated zone carries radionuclides laterally to a well supplying the water needs of a defined receptor (person) living near the former disposal cell. The modeling would allow us to calculate exposures to the receptor from direct ingestion of drinking water and ingestion of food produced using contaminated ground water from hypothetical wells. We could also examine the impact of volatile radionuclides, such as might be encountered during irrigation. These radionuclides can sometimes give significant exposures through inhalation. However, we would expect ingestion exposures from various ground-water uses to be much higher than those from inhalation of volatile radionuclides.

We believe that the modeling approach should be appropriately conservative. By ''conservative,'' we mean that we would select modeling parameters so that releases from the disposal cell are more likely to be over-estimated than under-estimated. This approach helps to account for uncertainty by incorporating an additional margin of safety. However, it would not be appropriate to be overly conservative. Focusing on ''worst case'' conditions leads to reliance on unrealistic modeling results. Major areas of conservatism could include:

• The distance from the disposal cell to the receptor well could be assumed to be short—
—Prevents expected dilution of the contamination plume with larger volumes of ''clean'' ground water
—Less radionuclide retardation by soils along ground-water flow path
—Institutional control over site may prevent a well close to the disposal cell
—Early detection of radionuclide release could trigger facility closure and corrective action

• Radionuclide retardation parameters could be selected for less retardation and faster transport

• Disposal facility cap and liner could be assumed to fail sooner than normally anticipated after facility closure
—Cap and liner designed to exceed RCRA 30-year post-closure monitoring period
—Assumption of failure introduces infiltration and flow through disposal cell earlier than normal, when radionuclide inventories are highest.

As stated above, a primary purpose of modeling the long-term performance of the RCRA–C disposal cell would be to derive radionuclide concentrations in wastes that would assure that exposures from any disposal cell releases would be at acceptably low levels to support a simpler NRC regulatory process for the disposal of low-activity radioactive waste at RCRA-permitted hazardous waste landfills. We expect that modeling will show that some radionuclides reach the receptor well within the modeling period. For these radionuclides, waste concentration limits would likely be calculated by simply scaling the exposures calculated in the modeling exercise to the acceptable level of protection (we request comment on the appropriate level of protection to consider for this approach in section II.D.5). These limits would function as waste concentration limits for implementing the RCRA–C disposal option. Wastes with radionuclide concentrations higher than established in the rule would not be eligible for disposal in the RCRA–C disposal cell, although consideration could be given to including in the rule specific additional conditions that would permit such disposal (essentially, a ''graded'' approach in which more extensive radiation protection measures are applied as radionuclide concentrations increase). Another alternative would be to allow a disposal facility to petition to have higher waste concentration limits based upon the results of site-specific performance assessments. However, this would make it more difficult for NRC to pursue a simplified regulatory approach.

ii. ''Wet'' and ''Dry'' Sites. We believe that using a conservative modeling approach will incorporate a significant margin of safety sufficient to compensate for any uncertainties in the eventual performance of the RCRA–C disposal design. Assessing just how significant the margin of safety will be depends on how waste radionuclide concentrations will be applied to disposal facilities. We see two basic approaches, discussed generally below. We request comment on these and other potential approaches.

The first option (''Option 1'') would be to have all disposal facilities use the same waste concentration limits regardless of the projected disposal cell performance. Experience tells us we would expect to see significant variation in performance under the wide range of climatic and hydrogeologic conditions that we model. Essentially, Option 1 imposes the concentration limits determined for the worst case disposal cell we would model on all potential disposal sites, regardless of the relative merits of any particular site conditions. Option 1 would thus add an additional level of conservatism to an already conservative approach. This approach has the potential to significantly decrease the usefulness of the rule by placing additional limitations on the waste streams addressed by our proposal (*i.e.*, waste concentration limits based on a ''worst case'' situation). An advantage of Option 1 is that it is simple to implement, in the sense that no variations in the waste concentration limits would be permitted.

Option 2 would allow different concentration limits to be used depending on the projected performance of the disposal facility. For example, performance modeling might indicate that sites with lower rainfall and deeper ground-water tables perform significantly better with respect to limiting off-site doses from radionuclides that can be transported away from the disposal cells by infiltrating ground water. Such a result would not be surprising, simply because the travel time for radionuclides to produce an off-site dose to individuals is likely to be longer if infiltration is less and it takes longer to reach ground water in the first place. For these ''dry'' sites, higher waste concentrations for those radionuclides readily transported with ground water could apply to the disposal facility while still meeting the same exposure limits as the ''wet'' sites (with higher rainfall and shallower ground-water tables). For both options, the exposure limits which underlie the rule would be the same. If site conditions leading to superior overall performance were clearly seen in the modeling, Option 2 would take advantage of that projected performance, whereas Option 1 would not.

Should Option 2 prove preferable, we would then face the challenge of defining desirable site conditions that would allow disposal of waste with higher radionuclide concentrations in some subset of RCRA–C facilities. In general, annual precipitation is an important parameter (and is also one for which data can be obtained easily), but often varies too much to be used by itself to characterize site behavior. Experience in modeling the movement of radionuclides through the environment, as well as empirical observation, indicate that the depth from the bottom of the disposal cell to the ground water is another important parameter that also is measured easily. Although depth to ground water also can vary (*e.g.*, with seasonal variation in precipitation), we believe that it could be possible to use precipitation and depth to ground water, in combination with other parameters, to distinguish sites that can accept higher concentrations of some radionuclides without presenting undue hazards to human health and the environment. This approach essentially favors sites that have long travel times from the disposal cell to the ground-water table (generally through some combination of deep ground water and soil types that tend to slow the movement of infiltrating water) and limited infiltration of water through the cap to the waste layer (generally through a combination of low precipitation and high evapotranspiration).

We recognize that there are many other parameters that affect radionuclide transport. However, it may be difficult to obtain the necessary information, and necessarily more complex to devise a method to combine the parameters. We encourage public comment on the concept of distinguishing among sites, as well as ideas on methods to make that distinction. As an initial point of review for interested commenters, we have examined this issue for relatively small Subtitle D facilities in remote locations. Because many of these facilities are in communities with limited resources, we determined that ground-water monitoring could be limited if annual precipitation (including evapotranspiration) was less than roughly 25 inches, as long as there is no evidence of ground-water contamination. We also developed a screening tool for Subtitle D facilities seeking no-migration variances that considers precipitation, depth to ground water, net infiltration, evapotranspiration potential, and permeability of the unsaturated zone. This approach implicitly estimates travel time from the disposal cell to the ground water. See ''Preparing No-Migration Demonstrations for Municipal Solid Waste Disposal Facilities: A Screening Tool,'' EPA530–R–99–008, February 1999 (available at *http://www.epa.gov/osw*).

We are aware that the approach embodied in Option 2 is somewhat different from that taken by existing RCRA regulations. RCRA is a national program and we have written regulations accordingly. In practice, this means that all members of the regulated community have to meet the same standard, whether it is numeric or technological (*i.e.*, a site with ''good'' transport characteristics does not get to accept higher concentrations of hazardous constituents than sites with relatively poorer characteristics). Under certain conditions, the standard may be adjusted to meet the regulated party's specific circumstances (*e.g.*, through a delisting petition or variance). In these cases, we create a process that an applicant can use to justify an alternative standard. This would be somewhat analogous to allowing a disposal facility operator to calculate site-specific concentration limits, as we discussed earlier in this section.

Another option would be to set other restrictions on site characteristics for RCRA-permitted landfills accepting low-activity mixed waste for disposal. We believe the modeling should be conducted with the intent that any facility that could be sited and permitted under RCRA Subtitle C could safely dispose of LAMW. However, some commenters may believe that some locations would not be appropriate for radionuclide disposal without additional conditions or site-specific analysis, especially if these locations have relatively poor overall transport characteristics or geologic features such as fractures in the subsurface that might provide faster transport pathways to the ground water. If we were to identify such criteria that go beyond the existing RCRA criteria (*i.e.*, if simply having a RCRA permit is not sufficient), what should they be? If a site did not meet the basic eligibility criteria, should there be an alternative ''qualification'' process (*e.g.*, through the type of site-specific analysis discussed earlier in this section)? For purposes of an implementable standard, the basic eligibility criteria would need to be clearly defined in the rule itself (NRC may or may not require additional conditions or restrictions on waste streams under its authority before RCRA–C facilities could accept those wastes). We also would need to clearly relate these specific characteristics to a performance objective. Therefore, we also ask that commenters provide supporting technical or scientific information that describes how their recommendations would improve facility performance, and how they would define ''good'' performance. The criteria could include climatological characteristics such as annual precipitation, transport characteristics of the unsaturated zone, depth to ground water, or proximity to other features that affect site suitability. These minimum criteria then would be factored into the basis for deriving radionuclide concentrations from off-site exposures.

We also note that RCRA authorized States can issue standards that are more stringent than the national program. This means that some States could already have siting criteria for RCRA facilities that explicitly address some of the factors mentioned above. We would welcome comments that identify such criteria and indicate the technical and scientific basis for their adoption. As we have stated before, we believe that the modeling should be sufficiently conservative to account for reasonably anticipated variations in site performance, so that special conditions would not be necessary.

iii. Modeling Timeframe. Another factor in modeling the long-term performance of a disposal cell is the time period covered by the modeling. We believe that a 1,000 year modeling period may be appropriate, although we also expect to examine performance over longer times (*e.g.*, up to 10,000 years) to see how well a 1,000 year modeling period captures the behavior of most radionuclides. There is no consensus on the most appropriate time for performance assessments. Periods from 100 years to 10,000 years have been used in assessments for various waste disposal methods. While NRC regulations do not specify a time period in 10 CFR part 61, NRC guidance in ''A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities,'' NUREG–1573 (2000), endorses a 10,000-year modeling period for licensed LLRW sites. However, NRC generally uses a 1,000-year period for assessing the dose consequence of residual radioactive material at the time of license termination. NRC has its radiological criteria for license termination in 10 CFR part 20, subpart E. The 1,000-year period is typical for evaluations of low-level waste disposal (as opposed to high-level waste or spent fuel disposal, which generally focus on much longer time periods), and is specified by DOE for performance assessments at its disposal facilities (DOE Manual 435.1–1, ''Radioactive Waste Management Manual''). However, some believe that modeling for low-level radioactive waste must also look at periods well beyond 1,000 years (to 10,000 years or longer) to fully address the possibility of significant change to the site from erosion or other long-term or cyclic processes. Others believe that a modeling period of 1,000 years or longer stretches the credibility of what modeling can reasonably project, and that at most it is possible to examine with confidence only a few hundred years (particularly with near-surface facilities, which are more easily affected by climatic or geologic changes than are deep subsurface facilities). We believe that 1,000 years may be appropriate because it is likely that the rule will involve such low radionuclide concentrations that the value of modeling over longer periods becomes more questionable in the light of expected changes in surface conditions over longer periods. It may also be appropriate to consider periods on the order of 100 years as more consistent with the RCRA approach to post-closure site care. We request comment on the appropriate timeframe for modeling.

c. ''Off-Normal'' Events. In assessing the long-term performance of the disposal cell, we typically use fairly well defined climatic conditions (*e.g.*, precipitation rates) and incorporate assumptions about the behavior of the engineered cap and liner. However, we must also consider what happens when the system departs from ''normal'' behavior. Situations to be examined would include heavier than normal precipitation over a period of years (or possibly the indefinite future), alternative cap and liner degradation scenarios, and the possibility that the rate of water entering into the disposal cell would exceed the rate exiting the cell, causing water levels to rise inside the cell. In such a situation (also known as the ''bathtub effect''), waste remains in contact with water and radionuclide concentrations can build up in the water collected in the disposal cell, so that when releases to the subsurface occur, radionuclide concentrations are higher than they would be if the water spent less time in contact with the waste. Alternatively, continued heavy precipitation could cause the water level to overflow the disposal cell, providing a surface pathway for radionuclide transport.

d. Disposal Facility Worker. For radionuclides that remain immobile under the off-site exposure modeling described above (*i.e.*, those that do not reach the receptor well within the modeling period, even with conservative transport assumptions), there must be another means of developing waste concentration limits. One approach that might be considered is the possible exposure that workers at the RCRA disposal facility might receive because of radiation from the waste material. In this case, exposures to the RCRA-C worker would also serve as a benchmark for public exposures, both during the facility's operational life and after final closure. Assessing worker dose will allow estimations of exposures to the public without relying on excessively speculative exposure scenarios; as discussed below, we believe that anyone who is not directly handling the waste will receive much lower exposures than would be expected of a worker.

The worker exposure analysis being considered would serve two functions. First, it would limit potential exposures to the general public in a manner that is generally consistent with the risk management approach for radiation exposure to members of the general public that EPA uses in its regulatory programs and NRC uses at fully-licensed low-level waste disposal facilities. We would expect exposures to people not directly handling waste to be much less than the exposures considered as a reference level for modeling. We believe that this will ensure that actual exposures to true members of the general public, such as visitors during the operating life of the facility, will be minimal. We believe such an approach is appropriate for the disposal of low-activity mixed waste under this proposal. Second, it should provide a reasonable basis for NRC, and Agreement States, to determine whether significant additional worker protection requirements beyond those of RCRA are necessary. Specifically, whether NRC should consider requiring inclusion of training, personal dosimetry, record keeping and reporting, in its regulatory approach. The goal is to identify radionuclide concentrations that are low enough for the NRC to conclude that it is unnecessary to consider RCRA workers as occupational workers under NRC regulations. We also note that workers handling AEA material are subject to NRC's occupational radiation standards, rather than Occupational Safety and Health Administration (OSHA) standards. Workers handling non-AEA material are subject to the ionizing radiation standards issued by OSHA, which are found in 29 CFR 1910.1096. We anticipate that NRC's consideration of worker protection requirements would be likely to address the necessary elements of the OSHA requirements.

We emphasize that we do not intend to set a standard for worker exposure. However, we are considering modeling several worker exposure scenarios to assist in setting the radionuclide concentration limits for LAMW. Some scenarios might assume that the waste already has been treated and stabilized in a cement/concrete mixture, or in a less dense medium such as polyethylene. This would mean that the radionuclides most likely to be limited by a worker scenario are those that emit strong gamma radiation. Alpha, beta, and weak gamma emissions are not as likely to be able to escape the stabilized waste form to expose the worker. However, we are also considering scenarios involving bulk waste that is neither solidified nor containerized. These scenarios would present a greater risk of waste becoming airborne, leading to exposure by inhalation or ingestion. In such cases, the alpha, beta, and weak gamma emissions would be of more importance than for stabilized waste forms. We seek comment on the proportion of bulk waste that might be disposed under this rulemaking.

e. Transportation Worker. It might be necessary to consider exposures to a worker involved in transporting waste to the RCRA disposal facility. The transportation worker would most likely be exposed through pathways similar to a disposal facility worker who handles waste containers within the facility. In such a case, we would make assumptions about how close the worker is to the waste and for what length of time. We would also consider Department of Transportation requirements for transportation of radioactive material.

f. Post-Closure Site Use. The worker exposure modeling we envision would also help assure limited exposures to the public in the future, when all waste is buried and the site is closed. Because existing regulations allow RCRA sites to remain privately owned, it is possible that a site could be made available for some limited (surface) use after closure. People who casually traverse the site, or even spend hours at a time engaged in an activity, would not be expected to receive doses that exceed those calculated for the worker, and therefore such doses should be acceptable.

When a Subtitle C disposal facility closes, RCRA requires that the owner/operator file a survey plat with the local land-use authorities and the EPA Regional Administrator that shows the location of all hazardous waste units.[11] The survey plat must note that the future use of the land is restricted in accordance with applicable regulations. The deed to the property also must state that it has been used to manage hazardous waste and must cite the appropriate restrictions on future use. At a minimum, use of the property that will disturb the integrity of the final cover, the liner, or other parts of the containment system is not permitted unless necessary to protect human health and the environment, or if such use will not increase the potential hazard to human health and the environment.

The facility's owner or operator must construct the final closure cap to minimize infiltration and erosion and accommodate settling or subsidence with little maintenance (40 CFR 264.310, although active maintenance would be possible during the post-closure care period). Even in the event of some noticeable erosion of the cap, which would not occur until well after final closure, doses to an exposed person should remain well within acceptable public dose limits. Because of the multi-layer cap construction, erosion by itself should not be sufficient to expose the waste. We believe that the controls established by RCRA will be adequate to prevent intrusion, more extensive use, or disruption of the site. NRC may apply the 10 CFR part 20, subpart E, unrestricted use standard of 25 mrem to RCRA sites chosen for disposal of low-activity mixed waste. If subpart E is applied, NRC might not impose additional facility requirements. On the other hand, NRC could decide that additional controls for such sites are necessary. Specifically, NRC could impose extended post closure care, restricted access after closure, limitations on land use and restricted site ownership requirements to such disposal sites. In this ANPR, we are assuming that such additional requirements will not exist.

Although we believe limited use of an undisturbed LAMW disposal site is not likely to present a significant risk to members of the public, we must consider the possibility of more extensive use involving a disturbance of the disposal cell. A common scenario for such an analysis involves a person who builds a house on the disposal site, where the construction involves excavation of some portion of the disposal cell, disturbing the waste layer and scattering of the contaminated material on the surface. The foundation and basement could be constructed at some depth in the disposal cell, and the resident could engage in small-scale crop production or raise some livestock on the contaminated site. Further, in locating water to support the resident, it might be assumed that a well is drilled through the disposal cell, involving some exposure to the driller(s) as contaminated material is brought to the surface.

This last possibility introduces the prospect that some disturbance of the cell would enhance transport of radionuclides to the off-site receptor. In past actions (*e.g.*, geological disposal) we have addressed a person who uses heavy equipment, such as a drill rig, to penetrate the waste layer and cell liner, essentially creating a pathway for radionuclides to move through the unsaturated zone to the aquifer. If one assumes this type of drilling scenario, how would such a disturbance affect the release and transport of radionuclides? The most likely effect would be to create a pathway for the transport of material containing radionuclides through the unsaturated zone into direct contact with the aquifer. We would expect that only a very small volume of waste would be affected by such action. Whether the waste is solidified or not, the bulk of the radioactive material would be likely to stay within the confines of the original disposal cell. It is also clear that there would be no change in the way radionuclides are released from the waste material remaining in the cell. Once a radionuclide is released, however, the penetration may provide a preferred pathway that decreases the travel time through the unsaturated zone.

If they could occur, the types of site disturbances described above would happen at some time in the future beyond the end of the RCRA post-closure period. We do not consider such disturbances to be very likely, given the site controls prescribed by RCRA regulations,[12] but must examine them as an extreme scenario. In its rulemaking for 10 CFR part 61, NRC concluded that the possibility of extensive inadvertent intrusion activities at near surface disposal facilities was not credible for waste in a structurally stable waste form (that is, as long as the waste remained in a form recognizably man-made, either in a stabilizing medium or container, intruders would determine that it should not be disturbed).[13] If we assume that the intrusion occurs after any solidified waste has broken down or containers have degraded, this would likely be several hundred years beyond site closure, suggesting that shorter-lived radionuclides will have decayed. We note that hazardous constituents that do not degrade over time, such as heavy metals, will still be present in the disposal cell and may present a risk comparable to or greater than the risk from radionuclides. We also note that the closure requirements described above apply to Subtitle C facilities. As commenters consider the applicability of this approach to Subtitle D facilities (*see* section II.A.2), it would be appropriate to consider whether the same post-closure exposure scenarios would apply to those facilities.

4. Other Considerations Affecting the Risk Analysis

a. Use of Part 61 Classification System. For LLRW, the NRC system defines three waste classes (A, B, C) by the concentration of each radionuclide. Class A has the lowest concentrations of short- and long-lived radionuclides and is the least restrictive in terms of packaging requirements. Classes B and C have more stringent packaging and stabilization requirements. Class C waste must be located at least 5 meters below ground. NRC does not consider low-level radioactive waste that exceeds Class C concentrations (''Greater-than-Class C'' waste) to be generally suitable for disposal in a near-surface facility. Some radionuclides do not move easily with ground water (or are very short-lived) and may also not be significant contributors to worker or post-closure

[11] 40 CFR part 264, subpart G.

[12] 40 CFR part 264.

[13] *See* Draft Environmental Impact Statement on 10 CFR part 61, NUREG–0782, Vol. 2, page 4–53, Sept. 1981.

public exposure. This means that the limiting concentrations could be very high if we relied solely on the various modeling scenarios we have identified. In some cases the limiting concentrations from modeling may exceed the maximum concentrations established by the NRC for Class A low-level radioactive waste (*see* 10 CFR 61.55). In these cases, we believe that it might be appropriate to set the concentration limit equal to the Class A maximum value.

It is important to use credible modeling scenarios to the extent possible to establish the capability of the RCRA–C technology for radionuclide containment and isolation, and not to rely on the Class A restriction or other such considerations, except in special cases. We are concerned that it could be very difficult for us and NRC to justify a ''simplified'' regulatory approach if a significant number of radionuclides were at their Class A maximum values. That is, it would be less likely that the resulting concentration limits would be appropriate for disposal in RCRA–C facilities in the absence of significant NRC licensing criteria. In any event, it would defeat the purpose of simplifying LAMW disposal to require RCRA–C facilities to undergo a complicated licensing process.

b. Waste Form and Packaging. An important factor in this analysis is waste treatment prior to disposal. Mixed waste must undergo treatment for its hazardous constituents to comply with the RCRA land disposal restrictions of 40 CFR part 268. Treated RCRA waste often is solidified or stabilized in some type of encapsulating medium to prevent migration of the remaining hazardous constituents. Cement/concrete is the most common encapsulating medium because of its ready availability, cost, and experience in its use. Other encapsulating technologies, such as vitrification or use of polymers or ceramics, are less common but may be more effective than cement/concrete at binding mobile constituents. There are no such treatment requirements for Class A LLRW, other than restrictions on liquid content (although LLRW must be treated ''to reduce to the maximum extent practicable'' the hazard from non-radiological material). The modeling is expected to consider various waste forms. Of the available encapsulating technologies, we would consider use of cement/concrete as the most conservative case. Though a common practice, stabilization is not necessarily a requirement for compliance with land disposal restrictions. If solidification or stabilization is not the treatment standard for a particular hazardous constituent, RCRA requires that the solidified waste form be tested to show that it meets the prescribed treatment standard. We request comment on whether it is reasonable to assume a stabilized waste form as a treatment of choice for LAMW and whether a rule should require waste stabilization. Such a requirement, however, could make the disposal of bulk low-activity waste in RCRA C landfills prohibitively expensive. (Bulk wastes could include such items as soil, demolition debris, and slag or other industrial process residuals.) Alternatively, it may be appropriate to have a different set of concentration limits for disposal of bulk wastes.

As stated earlier, we request comment on the possibility of individual disposal facilities developing alternative concentration limits. The performance of less-common encapsulating technologies could be a factor in permitting such alternative calculations. However, there are limited data available compared to the extensive literature available on cement/concrete. In addition to comment, we request information regarding the long-term performance of encapsulating technologies, particularly as they pertain to radionuclides.

Waste containers also provide a barrier against radionuclide releases, as well as adding structural stability to the waste form. Containers are typically drums or boxes, made of metal or polymer. It is not unusual for RCRA treatment to result in a waste form that is solidified inside a container (for example, mixing ash or other treatment residue with cement). NRC regulations require Class B and C LLRW to be in containers; if Class A waste is not in containers, it must be segregated from the waste that is in containers. We request comment on the need to specify container requirements in the rule.

c. Activity Caps. As stated above, under our basic concept, wastes with radionuclide concentrations higher than established in the rule would not be eligible for disposal in the RCRA–C disposal cell. However, waste with higher concentrations might be acceptable if the total number of curies in the disposal cell remained below a certain level (in conjunction with or in lieu of concentration limits). This could mean placing limits on the total curies of radionuclides disposed of at a site, inventory limits on specific radionuclides, or waste volume limitations (as an indirect and more conservative method to limit activity, since not all the waste would be expected to contain the maximum radionuclide concentrations). Further, because modeling the performance of facilities over the long term involves estimates of the inventory of radionuclides present at site closure, limits of this type would help reduce uncertainty in those estimates. We request comment on this issue. We also request comment on how facilities could demonstrate compliance with such activity limits, how such demonstrations might relate to on-going operations at a RCRA–C facility, and the limitations to such an approach.

d. *Unity Rule.* Overall doses to a receptor could be limited through a ''sum of fractions'' approach similar to the methodology used in 10 CFR 61.55. Under this approach, a disposal facility could accept waste containing multiple radionuclides only if the sum of the fractions of the individual radionuclide concentration limits did not exceed one (or ''unity''). For example, a disposal facility could not accept waste containing radionuclides X, Y, and Z at concentrations $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{3}$ of their individual concentration limits because $\frac{1}{2} + \frac{1}{3} + \frac{1}{3} > 1$. Concentration tables might be based on several methods of analysis, such as long-term performance assessment and worker exposure, and a simple sum of fractions approach may not be the most appropriate way to account for the different methods used to derive waste concentrations. It is also possible that peak exposures from different radionuclides in a long-term performance assessment may be separated by hundreds of years (given differences in half-life and environmental mobility), indicating that summing may not be appropriate even if the exposure mechanisms are the same. NRC derived its tables in 10 CFR part 61 from a common analysis for all radionuclides,[14] and issued separate tables for short- and long-lived radionuclides. As we are coordinating this effort with NRC, we request comment regarding alternative methods to accomplish the same goal of limiting overall doses.

5. Risk or Dose Basis for a LAMW Standard

The modeling described in section II.D.3 will be designed to protect members of the public during the operating life of the disposal facility and beyond. By modeling long-term facility performance, ground water and future residents near the disposal facility will be protected. Basing radionuclide

[14] *See* Draft Environmental Impact Statement on 10 CFR part 61, NUREG–0782, Vol. 2, Section 7–2, September 1981.

concentrations in the waste on a worker exposure analysis ensures that people at or near the site while waste is being handled are not exposed to unacceptable levels of radiation (*see* section II.D.3.d). Also, we expect that exposures to people who might be at the site after the facility is closed would be well within acceptable public dose limits. The radionuclide concentrations in the mixed waste will be based on levels that are bounded by the risk management approach for radiation exposure to members of the public that EPA uses in its regulatory programs and NRC uses at licensed low-level waste disposal facilities. There are a range of possible exposure levels that could be considered to be consistent with EPA risk management policies. We believe setting dose or risk limits within these values will be appropriate for the disposal of mixed waste under the approach. We, in cooperation with the NRC, intend to select exposures that should result in concentration limits that will be protective for all RCRA–C facilities, should minimize the need for additional NRC requirements, and will help generators to dispose of a considerable portion of their mixed waste.

Numerous factors will play a role in deciding what reference exposure levels should be used. Many of these factors reflect prior Federal and non-Federal risk management decisions related to radioactive waste management and disposal, supporting technical information, and risk levels applied under different statutory and regulatory actions. The regulatory approach selected by NRC may be an important factor.

When we use the term ''risk'' in general, we are talking about correlating exposures to contaminants with health effects resulting from those exposures. Risk is often expressed as the likelihood of an exposure resulting in a given health effect within a population. A risk of 10^{-4} for example, means that a level of exposure will cause (on average) a health effect in one person out of a population of 10,000. Where radiation is concerned, there are two basic ways to express this correlation (radiation risk focuses on cancer, either incidence or fatality). Radiation protection standards (including those issued by EPA) have traditionally been written in terms of dose (*e.g.*, in millirem), which is an expression of the physical effect on body tissue of the energies transmitted by radiation. Dose can be translated to risk; however, there have been a number of different ways to calculate dose (*see* Table 1), and the correlations with risk are affected by the dose system used. Our current estimates are that an annual committed effective dose equivalent of 15 millirem (mrem), incurred each year for a period of 30 years, carries a lifetime risk of fatal cancer of approximately 3×10^{-4} (3 in 10,000). This is an ''average'' dose, and the correlation will differ for individual radionuclides (*i.e.*, taking each radionuclide separately, the lifetime risk associated with an annual exposure of 15 mrem may be somewhat higher or lower than $\times 10^{-4}$). It is generally estimated that the average person in the United States can expect to receive an annual dose of about 300 mrem from natural sources, such as cosmic radiation, radon, and naturally occurring radionuclides in soil, rocks, and building materials.

The other way to express this correlation is to calculate risk directly. This is the approach used by our Superfund program in determining cleanup levels, and applies methods developed more recently than the dose-to-risk correlations. The differences in risk estimates using the two methods can be significant for some radionuclides; however, in some cases the direct risk calculation is higher, in other cases the conversion from dose gives the higher risk. The dose-to-risk method is more familiar to the radiation community and consistent with radiation protection standards, while the direct calculation of risk is more consistent with the way non-radiation hazards (such as RCRA hazardous waste) are evaluated. We request comment on which method should underlie the calculation of radionuclide concentration limits in LAMW.

To provide perspective, we examined risk management decisions we made in areas other than radiation risk. Though the RCRA corrective action standards do not specify radionuclides (61 FR 19432, May 1, 1996), cleanup levels are to be determined on a site-by-site basis, using other promulgated standards where appropriate. Generally, EPA considers 10^{-4} to 10^{-6} to be the acceptable lifetime risk range for all contaminants. However, the preference is for remedies at the lower (more protective) end of the risk range; 10^{-6} is considered a point of departure, and applying situation-specific factors may result in risk within the target range but above 10^{-6}. The RCRA corrective action standards also are designed to be consistent with Superfund.

In order to provide context for the reference exposure levels that will be used to derive the limiting radionuclide waste concentrations, we list current EPA and NRC radiation limits in Table 1, which are given in terms of dose. It is important to understand that some of these limits are in the ''whole body'' format, while other, more recent limits are in the ''effective dose'' format. Further, the ''committed'' effective dose (CED) explicitly accounts for internal radiation contributions from radionuclides remaining in the body from earlier intakes (the ''total'' effective dose equivalent, or TEDE, has a similar purpose). The dose under the ''old'' format translates into different doses for different radionuclides under the ''new'' format. The translation depends on how a particular radionuclide distributes itself throughout the body. Iodine, for example, preferentially deposits in the thyroid, which is a very small organ. Iodine's effective dose at the 4 mrem/year whole body or any organ Maximum Contaminant Level (MCL) for drinking water is less than 1 mrem/year. However, in an evaluation completed in December 2000, we reaffirmed that the radionuclide MCLs derived from a 4 mrem/yr whole body dose generally fall within our target lifetime risk range of 10^{-4} to 10^{-6} when more recent risk assessment methods are applied (65 FR 76716, December 7, 2000).

TABLE 1.—CURRENT EPA AND NRC RADIATION DOSE LIMITS

Uranium Fuel Cycle (40 CFR 190.10(a))	25 mrem/year whole body, 75 mrem/year thyroid, mrem/year any other organ.
Generally Applicable Standard for Management and Storage of Spent Nuclear Fuel (SNF) and High Level Waste (HLW) (40 CFR 191.03).	25 mrem/year whole body, 75 mrem/year thyroid, mrem/year any other critical organ.
Land Disposal of Low-Level Radioactive Waste (10 CFR 61.41)	25 mrem/yr whole body, 75 mrem/yr thyroid, 25 mrem/yr any other organ.
Decommissioning Nuclear Facilities (10 CFR 20.1402)	25 mrem/yr TEDE, all pathways (unrestricted use, although use of alternative criteria may allow up to 100 mrem/yr TEDE)).
Generally Applicable Individual-Dose Standard for Disposal of SNF and HLW (40 CFR 191.15).	15 mrem CED/year.

TABLE 1.—CURRENT EPA AND NRC RADIATION DOSE LIMITS—Continued

Individual-Protection Standard for Disposal of SNF and HLW at Yucca Mountain, NV (40 CFR 197.20).	15 mrem CEDE/year.
National Emission Standards for Hazardous Air Pollutants (40 CFR part 61).	10 mrem EDE/year.
SNF and HLW Disposal Limit for Underground Sources of Drinking Water (40 CFR 191.24, 197.30).	4 mrem/year for manmade beta- and photonemitting radionuclides whole body or any internal organ, 15 pCi/l alpha 197.30) 5 pCi/l radium.
Maximum Contaminant Levels for Community Drinking Water systems (40 CFR 141.16).	4 mrem/year for manmade beta- and photonemitting radionuclides whole body or any internal organ, 15 pCi/l alpha, 5 pCi/l radium, 30 micrograms/liter uranium.

Our analysis of our 40 CFR part 191 standard for disposal of spent nuclear fuel and high-level waste found that, for the radionuclides and conditions associated with disposal of those wastes, 15 mrem/year under the more recent effective dose method carries a risk roughly equivalent to a 25 mrem/year dose using the whole body method.[15]

As noted above, facilities licensed under 10 CFR part 61 must limit all-pathways exposures to the public (as calculated through long-term performance assessment) to 25 mrem/year (whole body), and facilities requesting license termination without restrictions on future site use must satisfy the licensing authority that doses will not exceed 25 mrem/yr total effective dose equivalent (TEDE) from all potential pathways. However, in both of these situations dose assessments are typically well below these regulatory thresholds. In selecting a reference exposure that would be used to derive concentration limits and allow for a simpler regulatory approach, we believe it would be appropriate for facilities operating under such a simplified approach to consider doses as being at or below the level applicable to other types of licensed facilities.

When compared to public exposures, there may be some additional flexibility in selecting a reference exposure level for the worker exposure scenario. For one thing, pathways such as inhalation and direct radiation, rather than ground water, would be expected to predominate. An evaluation of worker exposures will also consider the fact that these doses would not be to the broader public from radionuclides in the environment, but generally would be limited to a fairly small group of individuals. It may also be that workers would not expect to receive consistent annual exposures for a period of years because certain exposure scenarios might not occur regularly. Nevertheless, workers may be examined in the context of both maximally exposed members of the public and as workers under NRC exposure regulations (workers handling AEA material are subject to NRC occupational requirements even if the facility is not licensed). The goal is to coordinate the selection of a level that provides appropriate protection and will not cause NRC to require significant additional worker protection requirements.

We request comment on the appropriate level of protection to use in our analyses (*e.g.*, on a dose basis, 1 mrem, 10, 15, 25; on a risk basis, 10^{-4}, 10^{-5}, 10^{-6}; lifetime or annual exposure). We would like commenters to address whether the same level(s) should apply to all analyses, or whether specific types of modeling (*e.g.*, long-term performance or worker protection) should be based on different exposures, and if so, why. Would it depend on when the exposures would occur? The predominant pathways? Who the exposed person would be?

On a related issue, some of the radionuclides we examine may also have toxic effects separate from their radioactive properties. Many of these elements, such as lead, have already been evaluated within the RCRA framework. Others have not. Uranium, for example, is known to have effects on kidney function that may be of more concern than its radiation effects. The drinking water MCL in Table 1 did consider these toxic effects. How should we address such situations? Are there other elements that would be of particular concern?

E. What Legal Authority Does EPA Have Under the AEA?

The crux of our approach would be to provide an additional regulatory avenue for expanding the availability of mixed and other low-activity radioactive waste disposal options. Typically, when EPA establishes radiation protection standards, the statutory authority is the Atomic Energy Act of 1954, as amended,[16] and Reorganization Plan No. 3 of 1970 (the Plan).[17] The Plan transfers to EPA the ''functions of the Atomic Energy Commission (AEC) [now the NRC and the DOE] under the Atomic Energy Act'' to the extent that those functions consist of establishing ''generally applicable environmental standards for the protection of the general environment from radioactive material.''[18] The Plan defines standards as ''limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.''[19] The functions of the AEC under the AEA include the authority to ''establish by rule, regulation, or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property. * * * 42 U.S.C. 2201(b). To the extent that such rulemaking activity involves the establishment of generally applicable environmental standards this authority is vested in the Administrator of the EPA.

F. What Regulatory Approaches Could NRC Take With Respect to Disposal of LAMW?

NRC has provided us with general information on regulatory approaches it would consider for low-activity mixed waste disposal. These are:

1. Regulatory Approaches that Could Apply to RCRA Facilities

• Specific License for RCRA–C Disposal Facility—In this case, NRC would modify its regulations to allow a RCRA–C landfill facility wanting to accept for disposal LAMW meeting the

[15] 58 FR 66402, December 20, 1993.

[16] 42 U.S.C. 2011 *et seq.* (1994).

[17] Reorganization Plan No. 3 of 1970. 35 FR 15623 (1970). Published October 6, 1970; effective December 2, 1970. 84 Stat. 2086 (1970) (codified at 5 U.S.C. App. 1).

[18] *Id.* at section 2(a)(6).

[19] *Id.*

specified conditions (*e.g.*, radionuclide concentration limits) to apply for a specific NRC license under NRC regulations, such as 10 CFR part 61. NRC would assess the protections offered by RCRA–C technology on a site-specific basis. NRC would retain its authority to enforce and inspect as in the case of all NRC licensees.

- General License for RCRA–C Disposal Facility—In this case NRC would modify its regulations (*e.g.*, 10 CFR part 61) through rulemaking to include RCRA–C disposal facilities as a class of facilities under an NRC general license that enables the facility to accept (''possess'') LAMW for disposal. Disposal facilities would not have to supply applications or paperwork to NRC for specific approval of a license. NRC could choose to place additional conditions or requirements on the disposal facility in granting a general license, or could defer completely to the protection offered by the RCRA–C requirements. An example would be that the facility meets RCRA–C requirements and that the LAMW accepted by the facility meets the concentration limits established in accordance with the approach presented in this ANPR. Under a general license, NRC retains its authority to inspect and enforce its requirements, including issuance of civil penalties where warranted; however, in this case, it may be appropriate for NRC to rely on EPA for facility oversight.
- Exemption for RCRA–C Disposal Facility—In this case, NRC would modify its regulations, as appropriate, to exempt RCRA–C disposal facilities that accept LAMW from NRC requirements (including requirements to obtain an NRC or Agreement State license), and modify 10 CFR 20.2001 to allow transfer of waste to exempted facilities. This would essentially be NRC deferring regulatory oversight of licensed material at the disposal site to a regulatory system that already has jurisdiction over the non-AEA portion of the waste and has demonstrated sufficient protectiveness for specified concentrations of radionuclides. Failure of a RCRA–C facility to meet the conditions of the exemption could lead to regulatory action by NRC. NRC would still maintain the ability to conduct inspections; however, in this case, it may be appropriate for NRC to rely on EPA for facility oversight.

2. Regulation of LAMW Generators

NRC could modify its regulations, as appropriate, to allow the LAMW generator to transfer certain material to an approved RCRA–C facility for disposal under one of the above approaches.

We request comment on these options.

G. How Might DOE Implement a LAMW Standard?

DOE regulates the management of its own LLRW and the radioactive component of its mixed waste under the authority granted to DOE by the AEA. The AEA and principles of sovereign immunity limit the States' ability to regulate DOE's management and disposal of its own AEA materials, including the radioactive component of MW. Because DOE is ''self-regulating'' under the AEA, the low-activity mixed waste disposal approach presented in this ANPR would not be applicable to DOE LAMW unless DOE takes action under its AEA authority to implement it. Several options for implementation are plausible. Most DOE wastes are disposed of in facilities at the generating site. For situations where sufficiently protective on-site disposal is not feasible, costs are excessive, or off-site disposal is otherwise advantageous, other disposal alternatives are considered. DOE could establish some sort of internal authorization process before allowing LAMW to be transported and disposed at a RCRA Subtitle C landfill. Alternatively, DOE could choose to exempt LAMW meeting the radionuclide concentrations derived in this approach from its AEA regulatory purview and send such waste to its own RCRA Subtitle C landfills or commercial Subtitle C landfills accepting such waste. Because of the potentially larger volumes of LAMW generated by DOE, stakeholder interests and concerns should be given consideration by DOE in determining how DOE would implement the approach suggested in this document.

1. DOE's ''Authorized Limits'' System

At present, DOE has in place a process to evaluate waste on a ''case by case'' basis to determine the radiological risk. This ''authorized limits'' system allows DOE generating sites to provide waste characterization information to support disposal at non-AEA regulated facilities. Approvals for disposal of volumetrically contaminated waste (as opposed to surface contamination) are given by the Assistant Secretary of Environment, Safety and Health. DOE also seeks to ensure that releases are consistent with the receiving facility's waste acceptance criteria and are coordinated with, and acceptable to, facility operators and Federal, State, and local regulators. DOE's approach relies on a disposal facility's existing procedures to maintain protectiveness, and typically does not place additional radiation protection requirements on the facility operator. The rule could provide a more uniform basis for allowing such disposal. Because DOE is self-regulating under the AEA, the rule would not limit DOE's ability to dispose, at facilities not regulated by NRC or Agreement States, wastes that have been evaluated on a ''case by case'' basis pursuant to DOE's existing ''authorized limits'' process.

DOE manages its operations through a series of directives, including Orders (which describe basic requirements), Manuals (more detailed procedures), and Guides (recommendations or ''best practices''). The ''authorized limits'' process described above is included in DOE's Order 5400.5, ''Radiation Protection of the Public and the Environment'' (note that the ''authorized limits'' decisions are handled through the radiation protection program, not the waste management program). Adopting the approach presented in this ANPR would probably require DOE to revise one or more of its directives.

2. DOE's Radiological Control Criteria

For several years, DOE has been developing an approach similar to the disposal concept in today's action. DOE has been modeling exposures from treatment, transportation, and disposal to assess the feasibility of setting uniform limits that would allow certain mixed waste meeting established activity limits to be handled solely within the RCRA system. DOE believes its analyses show that a significant portion of its mixed waste could be handled without presenting a significant radiological risk, and believes that the approach presented here has the potential to facilitate that process. Throughout the development of this process, DOE has sought advice and review from Federal agencies and State regulators, and kept them apprised of its progress and intent.

H. How Would States Implement the Standard?

1. Would States Be Required To Implement the Standard?

Even if we and NRC both take regulatory action to allow LAMW disposal, it is likely that much of the actual implementation will occur at the State level. Many States are authorized to carry out both AEA regulatory functions and RCRA programs. There are 32 NRC Agreement States and 45 States are authorized under RCRA to carry out a mixed waste program. Under section 274b of the Atomic Energy Act, States can enter into agreements with the NRC such that the NRC relinquishes Federal authority and the Agreement States assume regulatory responsibility over certain byproduct, source, and small quantities of special nuclear material under State laws. The degree of compatibility for such programs is determined by NRC. (NRC also retains certain functions, such as licensing and oversight of nuclear power plants.) NRC also reviews Agreement State programs for continued adequacy to protect public health and safety and compatibility with NRC's regulatory programs. We understand that State programs will have to evaluate carefully this approach and any implementing regulations issued by the NRC as they would apply to specific hazardous waste disposal facilities. We also understand that some States have statutory restrictions on disposal of radionuclides with hazardous waste, and that others may be otherwise opposed to allowing such disposal. However, many States already allow disposal of waste with very low radionuclide concentrations in RCRA Subtitle C or D landfills on a case-by-case basis. The approach that we are presenting in this ANPR would not affect NRC's or the States' authority under the AEA to make such individual decisions for mixed waste under their purview. However, identifying acceptable concentrations of radionuclides in LAMW (and/or low-activity radioactive waste in general) in cooperation with the NRC, should allow a more consistent approach supported by rigorous technical analyses while providing a regulatory framework to ensure that disposal of LAMW/LARW in hazardous waste landfills is protective of human health and the environment.

Previous discussions with State regulators have raised a number of important questions that we believe all States should consider, including:

- Whether a disposal facility's RCRA permit would need revision;
- How even reduced dual regulation would affect the disposal facility's day-to-day operation (assuming NRC and/or DOE opt to exert some authority over the disposal facility);
- How corrective actions would be addressed;
- To what extent public input should be sought; and
- Whether the State should consider further limits on the facilities or the waste.

Our authority is limited and our standard may not resolve all such issues. Changing the regulatory system for mixed waste disposal requires action from both Federal and State authorities to provide a workable, protective, and comprehensive institutional framework. We recommend that States consider how they might use their distinct authorities to assist in developing such a framework. We welcome comment from States that would facilitate a workable approach to a meaningful standard incorporating radionuclide concentrations in the waste. We are also interested in knowing whether States believe such a standard should allow the flexibility to dispose of higher concentrations if disposal facilities implement additional radiation protection provisions or demonstrate site-specific conditions particularly favorable for containment and isolation of radionuclides.

2. State Programs

a. Facility Permitting/Public Participation. Although we believe that the technical approach to low-activity mixed waste disposal is sound, we recognize that we are considering disposal of radionuclides in facilities that were not sited or permitted with the expectation that they would receive significant quantities of such material. We anticipate that States will view the facility's RCRA permit as one means to ensure the State retains the level of RCRA oversight it believes necessary, although legal considerations suggest that the ability to use a RCRA permit as a vehicle to implement provisions related to AEA material would be limited. We also believe that public participation in the States' adoption of this proposed approach to LAMW disposal is necessary. In general, we believe that the existing RCRA permitting and NRC or Agreement State regulatory processes should provide ample opportunity for public involvement. We request comment on this assumption.

If EPA decides to conduct a rulemaking, public participation will necessarily be part of that process. In addition, when a RCRA permit is modified, the extent of the modification determines the amount of public participation required. For example, if a facility wants to accept a completely new waste stream for disposal (that is, a fundamentally different kind of waste), this is a significant permit modification requiring certain public participation activities. However, adding additional constituents to the ground-water protection program is less significant because it may not by itself represent a change in the way the facility operates or the waste it handles. Again, there would be legal considerations involved in addressing AEA material through the RCRA permit.

We anticipate that NRC might choose from a variety of alternatives, described in section F, to implement the approach described in this ANPR. NRC will conduct a rulemaking with public participation to establish the manner in which it will implement the approach presented here.

We are interested in public comment on the issue of public participation, and how the States' adoption process would provide an opportunity for public participation.

b. Implementation at the Disposal Facility. Although a RCRA–C disposal facility that accepts low-activity mixed waste under the approach presented here may have to modify its operations, we are optimistic that these modifications will not have to be extensive or costly. The facility certainly may need to instruct its workers on the potential effects and proper handling of radioactive material and take steps to limit exposures, although it may not have to apply a full radiation worker program that includes dosimetry. Most facility requirements related to radionuclides likely will be extensions of the administrative, recordkeeping, environmental monitoring, and reporting requirements already involved in hazardous waste disposal. We expect to model a fairly conservative worker exposure scenario, in part, to keep additional requirements minimal. We expect that NRC will address during its rulemaking process the issue of the appropriate level of worker training and procedures needed, if any, to limit exposures to LAMW.

The one major aspect of the facility's operation that may need significant modification is waste acceptance. Because the LAMW disposal concept is based on the radionuclide content of the waste, the facility must be able to verify that the waste accepted for disposal complies with the rule. This situation is analogous to the current requirement that hazardous waste comply with the land disposal restrictions in 40 CFR part 268. In that case, both the generator and treatment facility must certify that the waste does or does not meet the standards in part 268, and attach any supporting information, including waste analysis. Before it can dispose of waste, the disposal facility must have the appropriate certifications and supporting information, and must make certain that the waste accepted for disposal indeed meets the RCRA land disposal restrictions.

At present, generators of low-level radioactive waste are required to certify, before disposal, the radiological content of their LLRW. Generators of LLRW frequently base their characterizations on process knowledge when workers' exposure to radiation is of concern and knowledge of the waste generating process allows adequate characterization of radionuclide activity. It is common practice to store waste for a period that allows short-lived radionuclides to decay to minimal levels. The most common types of treatment for LLRW are solidification or compaction of dry waste. A treatment facility may simply calculate radionuclide concentrations based on the extent of volume increase or decrease. Disposal facilities commonly use hand-held instruments to survey the exterior of waste containers, which may provide sufficient information to characterize the waste; however, packages are not normally opened for sampling in order to limit occupational exposures. This is in keeping with good health physics practice.

Under the approach presented here, RCRA-permitted hazardous waste disposal facilities will continue to ensure that mixed waste complies with the land disposal restrictions. If the generator sending LAMW for disposal at a RCRA-permitted hazardous waste facility is required to certify compliance with applicable regulatory requirements, it may or may not be necessary for a landfill to conduct independent radiological sampling. The cost associated with extensive radiological sampling and analyses might be a critical factor in a disposal facility's willingness to accept LAMW. Facilities also may perform external radiological surveys to maintain worker safety, if necessary or deemed appropriate. We expect that under the approach presented here, the waste generator would bear primary responsibility for compliance with the standards, including those under RCRA. The generator would thus be responsible for providing the information necessary to determine whether the waste can be disposed of as LAMW at the hazardous waste disposal facility. It might be necessary for the generator to provide analytical confirmation of the radiological content of the waste prior to treatment or disposal. We invite comment on the most appropriate way to ensure that radionuclide concentrations in waste sent for disposal comply with the criteria that would be established, and on whether practices common at RCRA facilities might need modification to limit potential exposures to workers.

In a related question, we would like commenters to consider whether a rule should address volume averaging or ''blending'' of wastes to meet the radionuclide concentrations. RCRA regulations prohibit dilution as a means of meeting treatment standards; however, assuming that LAMW has met the RCRA standards, to what extent should higher-activity waste be allowed to combine with lower-activity waste to meet radionuclide concentration limits? Recently, NRC raised a similar question as part of a rulemaking effort for 10 CFR 40.51(e). (*See* 67 FR 55175, August 28, 2002.) Should this be permitted for waste from similar processes, or with the same radionuclides or RCRA waste codes? This question may be more important in the context of other low-activity radioactive wastes that are not RCRA hazardous, which are discussed in section III. For example, TENORM wastes can be high in volume with significant variation in radionuclide content, and usually a narrow range of radionuclides. Should blending be allowed for these waste streams? Would ''post-blending'' analytical results be necessary to demonstrate compliance with concentration limits, or would knowledge of ''pre-blending'' concentrations be sufficient? What would be the problems associated with analyzing blended waste?

c. *Agreement States.* Under section 274b of the Atomic Energy Act, States can enter into agreements with the NRC such that the NRC relinquishes Federal authority and the Agreement States assume regulatory responsibility over certain byproduct, source, and small quantities of special nuclear material under State laws. The degree of compatibility for such programs is determined by NRC. (NRC also retains certain functions, such as licensing and oversight of nuclear power plants.) NRC has established requirements for specific program elements which States must meet. These compatibility requirements consider trans-boundary issues and program element effects on public health and safety. Depending on the outcome of the NRC rulemaking and the degree of compatibility required for State programs, a LAMW rule could be implemented differently among Agreement States.

d. *Non-Agreement States.* In States that have not entered into agreements with NRC under section 2746 of the AEA, NRC regulations apply directly. Approximately one-third of the States are not Agreement States.

3. Regional Low-Level Radioactive Waste Compacts

The Low-Level Radioactive Waste Policy Act authorizes and encourages States to form regional ''compacts'' to address their long-term disposal needs for ''commercial'' low-level radioactive waste. Most compacts do not plan to accept mixed waste. In general, the terms of a compact spell out the process for selecting a ''host'' State; picking an appropriate site for the disposal facility; and funding site selection, construction, and operation. The ultimate purpose of the compact is to ensure that its member States are self-sufficient and able to manage commercial LLRW generated within the compact. At present, there are ten compacts, encompassing 44 States. Six States remain unaffiliated with any compact. Only the Northwest Compact has an operational waste disposal site, in Richland, WA. The Rocky Mountain Compact may use the Northwest Compact site by agreement. The Barnwell site in South Carolina will remain open to States outside the Atlantic Compact for several more years.[20] Some compacts have delayed their siting process, and at least one compact and several unaffiliated States apparently have no intention of siting disposal facilities. To date the siting of new compact facilities has had very limited success. A number of compact host States, including California, Illinois, Nebraska, Texas, and North Carolina, have expended large amounts of time and money, and undergone a great deal of sensitive political debate, without yet establishing new disposal sites. Regional compacts have procedures to allow waste to enter and exit the compact, which could influence the disposal of low-activity mixed waste at RCRA facilities. Compacts may determine that it is necessary to approve RCRA facilities that accept LAMW as ''regional'' disposal facilities. The limited number of compacts with LLRW disposal facilities has lessened the impact of these ''cross-boundary'' issues thus far. We request comment on how the approach would impact regional low-level waste compacts.

I. Request for Information: LAMW

In order to assist us in planning and conducting our future deliberations related to low-activity mixed waste, we are requesting the voluntary submission of data describing the present situation with respect to the storage, management, transportation, and disposal of LAMW. We are aware that some States perform annual inventories of the different kinds of radioactive waste generated or disposed annually

[20] Barnwell may accept waste from outside the Atlantic Compact (South Carolina, Connecticut, and New Jersey) as long as the non-regional waste does not cause the facility to exceed overall volume limits. Those overall volumes drop from 160,000 cubic feet in fiscal year 2001, the year after South Carolina joined the Atlantic Compact, to 35,000 cubic feet in fiscal year 2008. Under current plans, generators outside the Atlantic Compact will not have access to Barnwell after 2008.

and any data relating to LAMW is welcome. We are also aware of numerous generators that store, rather than dispose, LAMW because of the regulatory and economic difficulties associated with disposal. We would welcome data from a variety of generators on these matters to obtain a more accurate picture of the present issues associated with storing and disposing of LAMW. We would also welcome comment and information from the perspective of companies that operate low-level radioactive waste disposal facilities or RCRA Subtitle C hazardous waste landfills.

We realize that there are quite a number of different generators of LAMW, such as

- Industrial-manufacturing facilities
- Industrial-research and development facilities
- Other industrial facilities
- Academic institutions
- Medical facilities (hospitals and colleges)
- Medical research facilities
- Federal facilities
- Nuclear power plants and associated fuel cycle facilities

To supplement and update currently available data, we are requesting the following types of information (information with clearly labeled units is appreciated):

- *LAMW Generation, Treatment, and Disposal:* For individual waste types or categories of waste, current low-activity mixed waste generation rates and storage, treatment, and disposal practices. Data on types of mixed waste generated, RCRA codes, radionuclide concentrations, storage and treatment techniques, and disposal practices for these waste types or categories of waste, and data on waste volumes before and after treatment would be very useful and informative. In terms of waste concentrations, information that describes the amount of waste within different concentration ranges would be most useful and would assist in gauging the potential usefulness of a standard aimed at LAMW.
- *LAMW Cost Data:* The costs associated with the management of LAMW, including storage costs, costs of sampling and analysis for compliance with RCRA vs AEA requirements. This could include the costs for meeting the universal treatment standards, pre-treatment and treatment costs (by method), packaging and transport costs, disposal costs, and reporting and recordkeeping costs. To the extent the costs can be broken out for meeting RCRA vs AEA requirements, greater understanding of the regulatory burden posed by each authority would follow.
- *Impacts of Actions to Facilitate Disposal:* We also request comments regarding the potential effects of a standard to facilitate the disposal of LAMW. If such a standard were in place today, and such waste could be disposed in a RCRA Subtitle C landfill with little, or no, further NRC requirements, would such a standard enhance the conduct of your business? For example, would it free up resources that could be better directed? Would research or manufacturing activities be facilitated, knowing that a potentially more cost-effective disposal method became available for a certain kind of waste? What impacts, if any, would there be on the choice of health care options? What factors (*e.g.*, economic, regulatory) would influence your decision to dispose of or accept LAMW for disposal under such a standard? Would limiting a standard to commercial RCRA–C facilities be an important consideration? How might this affect DOE disposal policies? How do disposal facilities view the need for a permit modification or AEA license?

J. Background Information Regarding LAMW

In 1976, RCRA authorized us to regulate hazardous waste from ''cradle to grave.'' This includes the minimization, generation, transportation, treatment, storage, and disposal of hazardous waste. The definition of solid waste in the RCRA legislation specifically excludes source, special nuclear, or byproduct material as defined by the AEA of 1954, as amended. In the 1984 Hazardous and Solid Waste Amendments to RCRA, Congress established land disposal restrictions (LDR) for hazardous waste and directed us to establish treatment standards for hazardous waste. Hazardous waste has been prohibited from land disposal unless treated to our established standards in 40 CFR part 268.

Mixed waste is regulated under multiple authorities: by RCRA, as implemented by us or authorized States for hazardous waste components; and by the AEA of 1954, as amended, for radiological components as implemented by either the DOE (for radioactive waste subject to DOE's AEA authority), or the NRC or its Agreement States (for all other mixed waste). DOE is responsible for the disposal of, but does not regulate, commercial Greater-than-Class C mixed waste. Under the AEA, EPA has the authority to issue certain generally applicable environmental standards.

Low-activity mixed waste is a special class of mixed waste. It may be viewed as waste that meets the definition of hazardous waste under RCRA and, under AEA, is LLRW containing ''low'' radionuclide concentrations. In this context, ''low'' concentrations are concentrations no higher than Class A LLRW, as defined in 10 CFR 61.55.[21]

1. Commercial LAMW

The radioactive component of mixed waste, and by extension, LAMW is regulated by either the Nuclear Regulatory Commission and the Agreement States (for commercial facilities) or the DOE (for DOE's energy and defense related activities). Commercially-generated (*i.e.*, non-DOE) LAMW is produced across the country, at nuclear power plants, fuel cycle facilities, pharmaceutical companies, medical and research laboratories, universities, and other facilities. Processes such as medical diagnostic testing and research, pharmaceutical and biotechnology development, and generation of nuclear power result in some mixed waste. The last comprehensive evaluation of mixed waste was published in a 1992, known as the joint EPA and NRC ''National Profile on Commercially Generated Low-Level Radioactive Mixed Waste'' (NUREG/CR 5938). Accordingly, 3,950 cubic meters of low-level radioactive mixed waste was generated in the United States in 1990, while another 2,120 cubic meters were in storage. Of the 3,950 cubic meters generated in 1990, about 72% were liquid scintillation counting fluids, 17% were other organics and aqueous liquids, 3% were metals, and 8% were ''other'' waste. Approximately 3000 small volume generators were storing mixed waste. A report published by DOE in 1995 revisited the issue of mixed waste. Using the data from the ''National Profile,'' this report examined the variety of options available for managing commercially-generated mixed waste and reached the following conclusions (''Mixed Waste Management Options: 1995 Update,'' DOE/LLW–219):

- Most, but not all, mixed waste can be treated by commercially available technology.
- Approximately 128 cubic meters per year of commercially generated waste volumes would require disposal

[21] Note that LLRW is defined by exclusion, that is, by what it is not. For example, the Low-Level Radioactive Waste Policy Act of 1980 defines LLRW as radioactive material that is not high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in section 11e.(2) of the AEA (*i.e.*, uranium or thorium mill tailings).

in a jointly regulated mixed waste disposal facility.

More recent information reported in our advance notice of proposed rulemaking regarding increased flexibility in RCRA regulations for storing mixed low-level radioactive waste (64 FR 10064, March 1, 1999) confirms the continued storage of mixed waste due to lack of treatment and reasonable disposal options. In particular, the Electric Power Research Institute documented such problems for certain mixed waste from nuclear power plants. EPA visits to nuclear power plants, hospitals, and universities in 1998 found small amounts of mixed waste with no commercially available treatment technologies, and our discussions with the American Chemical Society and the International Isotope Society further highlighted the difficulty of treating and/or disposing of certain mixed waste.

2. DOE LAMW

The DOE also continues to generate mixed waste (and therefore LAMW). In fact, DOE has a legacy of environmental and process wastes that require disposal. For many decades, many DOE sites did not dispose of their waste streams in a timely manner, allowing these wastes to accumulate in storage. DOE has indicated that continued indefinite storage of such wastes is unacceptable; however, continued storage in many cases was deemed necessary because appropriate treatment methods were not available. The Federal Facilities Compliance Act of 1992 recognized this situation and directed DOE to develop plans and timetables for treatment and disposal of mixed waste at its sites. DOE determined that it was necessary to conduct a programmatic review of waste management activities throughout the DOE complex. As a result, DOE has reviewed its options for managing of different categories of radioactive waste, including LLRW and MLLW. (*See* the ''Final Waste Management Programmatic Environmental Impact Statement (WM PEIS),'' DOE/EIS–0200F, May 1997.)

The WM PEIS evaluated various options for managing and disposing of MLLW and identified preferred alternatives, narrowing the list of sites that would be capable of treating or disposing of MLLW. In evaluating the role of the various DOE sites within each option, the following criteria were applied to the sites in question (WM PEIS Summary, Table 1.6–1):

- Consistency
- Cost
- Cumulative impact
- DOE mission
- Economic dislocation
- Environmental impact
- Equity
- Human health risk
- Implementation flexibility
- Mitigation
- Regulatory compliance
- Regulatory risk
- Site mission
- Transportation

DOE worked with affected States, stakeholders, and Tribal Nations to provide input towards qualitative criteria such as equity and stakeholder acceptance.

On February 18, 2000, DOE announced its record of decision regarding the treatment and disposal of MLLW. Accordingly, MLLW will be treated on a regional basis at the Hanford Site, the Idaho National Engineering and Environmental Laboratory, the Oak Ridge Reservation, the Savannah River Site, or on-site; MLLW will be disposed at the Hanford Site and the Nevada Test Site. (See ''Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site,'' 65 FR 10061, February 25, 2000.) DOE has indicated that 43,000 cubic meters of MLLW from waste management operations will require off-site disposal, considering both waste in storage and waste to be generated over the next 20 years. While the above referenced record of decision did not address the use of commercial disposal facilities, DOE's decision does not preclude use of commercial treatment or disposal facilities for DOE's MLLW. DOE has estimated that approximately 22,000 cubic meters of MLLW from waste management operations may be considered for commercial disposal facilities. In addition, 53,000 cubic meters of MLLW from environmental restoration activities may be considered for commercial disposal facilities. Significant additional volumes of MLLW may also be generated from future cleanup activities. There is no breakdown of how much of this waste may be ''low activity'' MLLW. (See ''Information Package on Pending Low-Level Waste and Mixed Low-Level Waste Disposal Decisions to be made under the Final Waste Management Programmatic Environmental Impact Statement,'' U.S. Department of Energy, September 1998.)

K. Questions for Public Comment: Disposal Concept for LAMW

We request public comment on a number of aspects related to this action. In addition to the questions raised earlier in this action, the questions below generally highlight areas in which there is a lack of information or there are a variety of approaches that may prove viable. You are not limited to responding to the specific questions below; as always, you are welcome to comment on any aspect of this document or questions raised earlier in the text. In particular, we ask:

1. Is our description of the problems associated with mixed waste accurate? For example, what is the present status regarding the ability to dispose of low-activity mixed waste in a protective and cost-effective manner? Are some generators, such as medical or other researchers, using less current practices to avoid generating mixed waste? (section II.B.1)

2. What new information is available concerning the characteristics, treatment, storage, and disposal of LAMW? (II.A.1)

3. Is the approach we have outlined to allow disposal of LAMW in RCRA–C facilities viable? Would it help to alleviate generators' concerns?

4. What roles should EPA and NRC take in further developing this approach? Are there other actions that can be taken to minimize dual regulation or facilitate permanent disposal of LAMW? (II.A.3)

5. Are radionuclide concentration limits adequate for limiting the impacts from LAMW?

6. What concentration limits would address a significant proportion of your mixed waste? (II.A.1)

7. Should any rule or guidance apply only to commercial RCRA–C disposal facilities (roughly 20 operating)? To privately-owned facilities? To DOE facilities? (II.B.1)

8. Should a rule address disposal of low-activity material in RCRA–D (solid waste) facilities? (II.A.2)

9. Should such a rule apply to DOE wastes? Are there special issues associated with DOE waste (*e.g.*, characterization, knowledge of historic generating processes, volumes)? (II.G)

10. What additional requirements would be necessary for RCRA facilities (*e.g.*, related to post-closure care, land ownership, financial assurance, monitoring and corrective action)? (II.C.4)

11. Are the exposure scenarios we have outlined adequate? Is there a method other than modeling that could effectively determine the protectiveness of RCRA–C disposal of LAMW? (II.D.3.a, b)

12. What is the appropriate way to select site data for modeling? What level

of conservatism is appropriate? (II.D.3.b.i)

13. Should disposal facility operators have the opportunity to calculate site-specific radionuclide concentration limits? For mobile radionuclides only? Based on specific practices to protect workers? (II.D.3.b.i, H.1)

14. What is the appropriate way to assess long-term protection? Is dose the appropriate measure? Is risk? Based on annual or lifetime exposures? What about radionuclide concentrations in the environment (as a basis for modeling)? (II.D.5)

15. What is the appropriate level of protection to derive waste concentrations (in terms of risk or dose)? Should the same level apply to all exposure scenarios? (II.D.5)

16. Should such a standard have different waste concentration limits for ''dry'' sites versus ''wet'' sites? What criteria should we use to differentiate between ''wet'' and ''dry'' sites? Is there another generic way to distinguish ''better'' sites? (II.D.3.b.ii)

17. Should we establish minimum site suitability requirements? What should they be? How would your suggested requirements make LAMW disposal more protective? (II.D.3.b.ii)

18. What is the appropriate timeframe for modeling? (II.D.3.b.iii)

19. How should we evaluate a post-closure disturbance of the disposal site? (II.D.3.f)

20. To what extent should bulk waste be included in this approach? As a generator, is bulk waste a significant proportion of your waste? (II.D.3.d)

21. Should such a rule require a specific waste form, such as solidified/stabilized? Should different standards apply to different waste forms, or should a generator be able to demonstrate the performance of a particular waste form? Should containers be required? Should there be special conditions for bulk waste? (II.D.4.b)

22. What types of solidification/stabilization would be most effective at containing radionuclides? What are the relative costs of these methods? (II.D.4.b)

23. Is the Class A maximum an appropriate additional control on radionuclide concentrations? What other methods might we use? (II.D.4.a)

24. Should a curie or volume limit apply to each disposal facility, in addition to radionuclide concentration limits? To each disposal cell? To individual radionuclides? An overall limit, or an annual limit? (II.D.4.c)

25. Is the ''unity rule'' an appropriate method to limit exposures? Under what circumstances might it not be appropriate? How else might we achieve the same goal? (II.D.4.d)

26. How should the chemical toxicity of radionuclides, particularly those elements not addressed by RCRA regulations (*e.g.*, uranium), be considered in developing waste concentrations? (II.D.5)

27. What regulatory approach should NRC take? Are there particular advantages or disadvantages to each? What aspects of LAMW disposal need special consideration? (II.F)

28. How would States and facilities implement the rule? What concerns would States need to have addressed? (II.H)

29. RCRA requires ground-water monitoring for hazardous constituents. How should ground-water protection be addressed for radionuclides?

30. What factors would States, generators, and disposal facilities consider in supporting or opposing (choosing not to use) a standard for LAMW disposal? How would you characterize your interest in this approach? What would increase or decrease your interest?

31. Is it appropriate for the generator to be responsible for documenting compliance with waste form requirements? What is the best way to ensure that radionuclide concentrations in waste comply with a standard? How might disposal facility sampling procedures need to be modified? (II.C.2, H.2.b)

32. What level of public participation is appropriate? (II.H.2.a)

33. Should volume averaging or ''blending'' be allowed? Under what conditions? (II.H.2.b)

34. How will LAMW disposal facilities be affected by the regional low-level waste compacts? (II.H.3)

35. Do you anticipate cost savings if the approach in this document were to be implemented? Where would you expect to see cost savings?

III. Is It Feasible To Dispose Other Low-Activity Radioactive Wastes (LARW) in Hazardous Waste Landfills?

Aside from low-activity mixed waste, there are a variety of other wastes with ''low'' concentrations of radionuclides, which are either unregulated or are subject to an inconsistent or uncertain regulatory framework. While some of these other low activity wastes may be mixed waste, we are widening the scope of consideration here to include both mixed and non-mixed waste within each of these categories. Wastes included in this category are residuals from the processing of uranium or thorium ore that NRC has determined are not subject to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) (we refer to these residuals in this document as ''pre-UMTRCA byproduct material,'' much of which is subject to remediation under the Formerly Utilized Sites Remedial Action Program (FUSRAP)), certain categories of Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) wastes, and Atomic Energy Act (AEA) radioactive waste presently exempted from regulation.

A. How Would the Proposed Disposal Concept Apply to Other Low-Activity Radioactive Wastes?

1. From a Technological Perspective

The RCRA–C technology itself offers no barriers to extending the disposal concept to other low-activity radioactive wastes. There is no physical difference between a radionuclide in low-activity mixed waste and the same radionuclide in pre-UMTRCA byproduct material or TENORM waste. It may in fact be easier to assess the protectiveness of the landfill technology for pre-UMTRCA byproduct material or TENORM wastes, as they will contain a much narrower range of radionuclides (primarily uranium, thorium, and radium, with daughter products), and lesser amounts of other components that could have an effect on the physical and chemical behavior of the radionuclides in the disposal system, than will LAMW. Waste form and volume issues may be more important for these other low-activity waste streams in assessing their behavior in the disposal system. From a safety perspective, the RCRA-C disposal system should be no less effective for these other waste streams than for LAMW.

2. Pre-UMTRCA Byproduct Material

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) explicitly extended AEA jurisdiction to waste from the processing of uranium or thorium ore (''byproduct material'' newly defined in section 11e.(2) of the AEA) and designated NRC to regulate this material at active processing sites (see section III.D, ''Background Information Regarding Other LARW'' for more detail). ''Pre-UMTRCA'' byproduct material is physically and chemically very similar to 11e.(2) byproduct material regulated by NRC pursuant to its responsibilities under UMTRCA. Pre-UMTRCA byproduct materials are residuals from ore processing activities mixed with soil or residual contaminants of building debris. They comprise the majority of the material being remediated from commercial and residential properties under the Formerly Utilized Sites Remedial Action Program (FUSRAP) and are also found at some Superfund sites. Pre-UMTRCA material has generally been disposed in bulk and shipped by rail car to licensed or permitted disposal facilities. Most is relatively low-activity, because it resulted from the extraction of uranium or thorium from ore material. It has been disposed of at a limited number of RCRA Subtitle C disposal facilities having State permits that allow acceptance of low concentrations of certain radioactive materials (equating generally to ''unimportant quantities'' as defined by NRC). Materials with concentrations exceeding State RCRA permit conditions have been disposed in NRC or Agreement State licensed facilities.

3. TENORM

''Technologically Enhanced'' Naturally Occurring Radioactive Material is material (whether as a waste or product) in which the natural radioactivity has been concentrated or the potential to expose humans has been increased, generally through human activity (TENORM does not include material in its natural setting, such as soil or rocks that emit ''background'' radiation). TENORM waste can take a variety of forms, including soil, pipe scale, sludges from water treatment, and residues from processing of mineral ores. As the name suggests, some TENORM wastes are highly radioactive because the processes that produce them tend to concentrate the radionuclides. A number of RCRA Subtitle C disposal facilities accept certain types of TENORM waste (*e.g.*, commercial facilities in California, Idaho, and Texas). Only wastes that meet the radionuclide concentration limits derived for the RCRA-C disposal option described here would be candidates for disposal under that approach. Higher-concentration TENORM wastes would not be included.

4. Low-Activity LLRW/Source Material Exempted by NRC

Some wastes under the AEA are exempted from regulation. In particular, NRC deferred ''unimportant quantities'' of source material containing less than 0.05 % by weight uranium or thorium, from its regulation. Certain consumer products and some mining wastes may contain uranium or thorium originating from ores not meeting the 0.05% criterion. For example, zircon contains minute quantities of uranium and thorium and is used as a glaze for ceramics and metal molds. Thorium is used to make a more dense glass for prescription glasses. Uranium or thorium may be a side product emanating from certain phosphate extraction operations or rare earth mining.

Low-level radioactive waste that is not mixed waste currently has several disposal options, as noted in section II.H.3 above. However, generators have limited access to one of those facilities, and access to another facility will be limited in a few years. It might be advantageous to provide additional disposal options for low-activity LLRW that may not require the extensive radiation controls of 10 CFR part 61.

As previously noted, NRC held a workshop on May 21–22, 2003, to discuss alternatives for safely controlling solid materials that have no, or very small amounts of, radioactivity. One alternative for that material is placement in a RCRA Subtitle C or RCRA Subtitle D disposal facility. Therefore, some of the issues discussed in that workshop may be similar to some of the approaches discussed in this ANPR. Background materials (including the information collection efforts conducted by NRC) and current activities (including recent documents issued and plans for stakeholder input), as well as transcripts of the workshop, can be found at *http://ruleforum.llnl.gov/cgi-bin/rulemake?source=SM_RFC&st=ipcr.*

B. What Legal and Regulatory Issues Might Affect Applying the RCRA–C Disposal Concept to Other Low-Activity Radioactive Wastes?

1. Lack of Federal Regulation

As noted above, we believe it is reasonable, given the similarity in radiological characteristics and general similarity in physical attributes (*i.e.*, large volume), to evaluate the applicability of our low-activity mixed waste disposal concept to these other low-activity radioactive wastes. To the extent that such a regulation could cover a large percentage of low-activity pre-UMTRCA byproduct material and TENORM wastes, clarity and consistency in regulation would be achieved for wastes now addressed by a patchwork of regulations. Some of these waste streams are not currently regulated by Federal agencies (with the exception of FUSRAP or other waste generated from CERCLA site cleanups, where the Record of Decision specifies acceptable disposal), and there is no uniform State approach to regulating these wastes. Unfortunately, it is not clear at this time what single Federal authority might be invoked. For example, NRC has stated that pre-UMTRCA byproduct material and TENORM wastes do not fall under the purview of NRC's AEA authority. (*See, e.g.*, ''Issuance of Director's Decision Under 10 CFR 2.206,'' 65 FR 79909, December 20, 2000.) The logical implication of NRC's position is that the exclusion of ''source, special nuclear, and by-product material as defined by the Atomic Energy Act of 1954'' from the definition of ''solid waste'' under RCRA does not apply to pre-UMTRCA byproduct material that does not otherwise contain source material or would otherwise fall within NRC's AEA authority (*i.e.*, pre-UMTRCA byproduct material would be identical to TENORM in that regard). (*See* 40 CFR 261.4(a)(4).) Thus, EPA could perhaps use its RCRA authority to address these waste streams. However, while these wastes likely fall under RCRA jurisdiction by virtue of being ''solid waste'' (if not subject to AEA), there is no clear mechanism to regulate them under Subtitle C. There is no RCRA characteristic for radioactivity, and many mineral processing wastes are specifically excluded from regulation as hazardous (40 CFR 261.4(b), ''solid wastes which are not hazardous wastes''). While non-hazardous waste can be disposed of in Subtitle C facilities, disposal standards associated with non-RCRA hazardous properties of the waste (in this case, radioactivity) would generally be the purview of State authorities.

2. How They Are Regulated Now

a. Pre-UMTRCA Byproduct Material (FUSRAP). Because concerns over disposal of pre-UMTRCA byproduct material have been most closely associated with FUSRAP, we are focusing our attention on that program. FUSRAP was created to evaluate and remediate wastes generated as a result of activities of the Manhattan Engineer District and the Atomic Energy Commission beginning in the 1940s through the 1960s. These activities were related to the development of nuclear weapons. These wastes were first managed by the Atomic Energy Commission, then, in 1975 by the Energy Research and Development Administration, until 1997 by the Department of Energy, and since 1997 by the U.S. Army Corps of Engineers (USACE). USACE now manages such waste under CERCLA and internal guidance directives.

There has been some discussion of the legal authority under which such wastes should be managed. (See ''Corps of Engineers'' Progress in Cleaning Up 22 Nuclear Sites,'' GAO/RCED–99–48, February 1999.) Following transfer of FUSRAP to the Corps of Engineers, USACE requested a determination from NRC regarding the regulatory requirements for off-site disposal of waste generated through site cleanups. NRC determined that the largest-volume waste stream at FUSRAP sites, wastes that resulted from the extraction of uranium or thorium from ore material, was outside its jurisdiction because of the circumstances under which it was generated (pre-UMTRCA). NRC was later petitioned to review its position (February 24 and March 13, 2000). NRC reaffirmed its position in a 2000 Director's Decision (65 FR 79909, December 20, 2000). As a result, the off-site disposal of the bulk of waste from FUSRAP cleanups is unregulated at the Federal level except through the Superfund program (although USACE uses the CERCLA process at all FUSRAP sites, relatively few of the sites have actually been placed on the National Priorities List).

The Corps of Engineers has pursued a disposal program that includes use of RCRA Subtitle C facilities for its low-activity waste, with higher-activity waste sent to AEA-licensed facilities. Under USACE policies applicable to FUSRAP, appropriate State authorities are requested to verify approval of acceptance of FUSRAP materials prior to disposal. States have varied in their responses to USACE's disposal efforts, with some being receptive to RCRA facilities accepting waste and others opposing it. USACE plans to continue using Subtitle C facilities as a disposal option.

b. TENORM. Many TENORM wastes are also relatively low-activity. Many of these wastes are regulated by States. Wastes with similar radiological characteristics may be managed more or less rigorously from State to State. Some wastes are regulated primarily for chemically hazardous components. Some wastes are not regulated with regard to their radioactive content. Of course, in many instances, there is a lack of information on the radiological characterization of a given TENORM waste and undoubtedly, this has contributed to today's inconsistent regulatory framework. Examples of TENORM wastes include sludges and resins resulting from treating ground water for drinking water, scales and sludges arising from oil and gas production, tailings, slag, or residues from the mining and processing of a variety of ores, and the overburden remaining from the mining of uranium ores to name a few. (Uranium mines are not covered under the AEA. Rather, airborne radon emissions from underground uranium mines are addressed under the Clean Air Act. (*See* subpart B of 40 CFR part 61, 54 FR 51654, December 15, 1989.)) Ideally, wastes of similar characteristics presenting similar risks might be managed in a similar fashion.

Although these wastes include a wide variety of waste categories, some delineated by more or less clear institutional boundaries, there are some common traits that may allow the development of a common strategy for management and disposal. Many of these wastes include radioactive uranium and thorium, and/or the daughters of the radioactive isotopes of uranium or thorium, respectively. Many of the wastes are in bulk form, whether it be tailings, or sludge, or residues that might infer a similar management strategy, given a similar range in volumes. We welcome comment on appropriate risk-based strategies to manage and dispose of reasonably similar wastes in a similar manner. For example, would it be better to focus on wastes that are relatively well-controlled but may be somewhat higher in activity, such as drinking water treatment residues, or on larger volume wastes, such as soils, that have the potential for wider dispersal in the environment and subsequent exposures to the public? Which wastes are most difficult to manage? Which pose the greatest risks?

3. Existing Federal Regulations (Low-Activity LLRW)

From the perspective of the Atomic Energy Act, low-activity mixed waste is regulated identically to other forms of low-level radioactive waste. Some LAMW may be identical in radiological characteristics to low-activity LLRW. Logically, it is difficult to argue that the presence of additional hazards (*i.e.*, chemically hazardous material) makes the RCRA-C technology suitable for LAMW but unsuitable for non-mixed low-activity LLRW. However, there are currently several commercially operating disposal facilities capable of accepting low-activity LLRW (though generators will have limited access to two of the three commercial facilities), and the need for additional disposal options is not clear at this time. Nevertheless, we request comment on whether our rule should address non-mixed low-activity LLRW (these wastes would be subject to the same restrictions placed on LAMW in deriving concentration limits, such as using the Class A maximum values as an upper benchmark).

4. Potential for a New ''Class'' of Disposal Facilities

While we and NRC agree that RCRA Subtitle C landfills could offer appropriate protections for disposal of low concentrations of radionuclides, neither agency intends at this time to create a new regulatory structure comparable to the existing RCRA or LLRW requirements. Rather, the intent is to apply the necessary elements of radiation protection to the hazardous waste framework. In dealing with low-activity mixed waste, we believe this approach is sensible, as individuals disposing of mixed waste must comply with the requirements for both hazardous and low-level radioactive waste. Further, compared to the volume of materials disposed of in RCRA facilities, LAMW volumes are relatively small, even when considering DOE LAMW, so disposal capacity should not be excessively given over to LAMW. However, in extending this approach to pre-UMTRCA byproduct material, TENORM, or non-mixed low-activity LLRW (including that from DOE), we must recognize the potentially large volumes of waste that could be accepted at Subtitle C facilities. It is possible that facilities would apply to be sited and permitted under Subtitle C based on the prospect of taking low-activity waste that is not regulated under Subtitle C (or subject to RCRA at all), but may in fact be predominantly AEA material. This would not necessarily be inappropriate, since the intent is to demonstrate that the Subtitle C technology would be adequately protective in such a situation, but we believe it important to acknowledge the possibility. We request comment on this issue, and how we might alleviate any concerns.

C. Request for Information: Other LARW

To assist us in understanding the present situation regarding Pre-UMTRCA byproduct material, TENORM wastes, and other low activity radioactive wastes we request information to clearly understand the present regulatory framework associated with each waste and to provide more complete waste characterization. Information on these wastes has been produced by industry, States, Federal agencies, and academic institutions and it is important to garner up to date information to better guide our deliberations for future efforts. Along these lines, we welcome the following types of information:

- *Regulatory Requirements:* What are the significant regulatory requirements applicable to the waste in question? We recognize that a given waste might be covered under regulations issued by various levels of government (Federal, State, local) and may vary among jurisdictions (*i.e.*, from State to State).

• *Waste Generation, Treatment, and Disposal:* For individual waste types or categories of waste, we request current waste generation rates and storage, treatment, and disposal practices. Data on types of waste generated, RCRA codes, radionuclide concentrations, storage and treatment techniques, and disposal practices for these waste types or categories of waste, and data on waste volumes before and after treatment would be very useful and informative. In terms of waste concentrations, information that portrays the amount of waste within different concentration ranges would be most useful.

• *Cost Data:* The costs associated with the management and disposal of the waste in question: This could include storage costs, costs of sampling and analysis for compliance with regulatory requirements, the costs for meeting treatment standards, pre-treatment and treatment costs (by method), packaging and transport costs, disposal costs, and reporting and recordkeeping costs.

D. Background Information Regarding Other LARW

1. Pre-UMTRCA Byproduct Material (and FUSRAP)

The processing of ores to extract uranium or thorium (milling) generates large volumes of waste material (tailings). These tailings resemble fine, sandy soil and are generally relatively low in activity because the primary source of radioactivity has been reduced. However, because of the large volumes generated, if they are not properly controlled, these materials can present a long-term hazard to human health and the environment. In addition, the milling process can introduce chemical hazards into the waste. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) was passed to address management of tailings (11e.(2) byproduct material) and remediation of milling and tailings storage sites. These responsibilities were divided between DOE (for inactive sites) and NRC (for active sites). EPA was directed by UMTRCA to establish radiation protection standards to be implemented by DOE and NRC. These standards are found at 40 CFR part 192 (''Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings'').

The Formerly Utilized Sites Remedial Action Program (FUSRAP) was established as a program under the former Atomic Energy Commission in 1974. The original objective of this program was to identify, investigate, and take appropriate cleanup action at contaminated sites associated with the nation's early atomic weapons program. During the 1940s through the 1960s, the Manhattan Engineer District and later, the Atomic Energy Commission (AEC) used a variety of sites across the United States to process and store uranium and thorium ores for nuclear weapons. In the 1970s, the AEC evaluated these old weapons production sites to determine the risks to human health and the environment, taking into account new health and environmental standards. In 1975, this program was transferred to the newly formed (from the AEC) Energy Research and Development Administration, and subsequently in 1977 to its successor, DOE. Of the 400 sites that were revisited, 46 required some type of cleanup. DOE initiated cleanups in 1979 and completed cleanup of roughly half of the 46 sites by 1997. DOE managed tailings from FUSRAP cleanups in a manner consistent with its responsibilities under UMTRCA, although the FUSRAP sites were not among those identified by UMTRCA. Late in 1997, Congress transferred responsibility for FUSRAP to the U.S. Army Corps of Engineers. At the request of USACE, NRC considered its jurisdiction over pre-UMTRCA byproduct tailings generated by FUSRAP cleanups. NRC determined that its jurisdiction, as defined by UMTRCA, did not extend to tailings generated prior to passage of UMTRCA if the generating process had not been licensed by NRC (or its predecessor, the AEC).

2. TENORM

Numerous activities produce TENORM wastes, including mining (coal, metals, rare earths, and uranium), fertilizer production, oil and gas production, incorporation into consumer products, and treatment of ground water for drinking water among others. TENORM can be found in all 50 States. Total amounts of TENORM wastes produced in the United States annually may be in excess of 1 billion tons. In many cases, the levels of radiation are relatively low and dispersed in large volumes of waste. This causes a dilemma because of the high cost of disposing of radioactive waste in comparison with (in many cases) the relatively low value of the product from which the TENORM is separated. There are few disposal locations that can accept radioactive waste from licensed activities, and not many more that can take certain types of TENORM. Large quantities of TENORM wastes are currently undisposed and may be found at many of the thousands of pre-1970s abandoned mine sites and processing facilities around the nation. Of particular concern are the isotopes of uranium and thorium. Radium-226, a daughter of the decay of uranium-238, is troublesome because of its long half life (about 1600 years) and its relatively high radiotoxicity. Additional detailed information on TENORM may be found on our Web site at *http://www.epa.gov/radiation/tenorm/*. EPA has developed information on the categories of TENORM over the last fifteen years from our own independent studies, various rulemakings, data provided by States, and studies performed by industry.

3. Low-Activity LLRW/Source Material Exempted by NRC

Under the AEA, source material is uranium or thorium in any physical or chemical form. NRC has traditionally regulated source material if it contains one-twentieth of one percent (0.05%) or more by weight of uranium, thorium, or any combination of these two. Some mining and mineral extraction processes may also result in the production of uranium, or thorium, at concentrations under the NRC's threshold for regulation and hence, not be regulated under the AEA. Such low-activity source material may result from refining ores mined for other precious metals, rare earths, or phosphate processing. This low-activity source material may be regulated with regard to its chemical characteristics, rather than any radiological hazard associated with the commingled uranium or thorium. NRC has determined that ores containing less than 0.05% uranium or thorium by weight are not considered source material (10 CFR 40.4) and may be labeled as NORM or TENORM. AEA does not provide authority to regulate NORM or TENORM.

As described in section II.D.4.a, NRC classifies commercially generated LLRW in 10 CFR 61.55 as Class A, B, C, or Greater-Than-Class C (GTCC). All LLRW classes must meet minimum waste characterization requirements specified in § 61.56(a). Among these requirements, waste must be a solid with minimal free standing liquid, not explosive, pyrophoric, or capable of generating toxic gases; any hazardous, biological, pathogenic, or infectious waste must be treated to reduce to the maximum extent practicable these non-radiological hazards. Tables 1 and 2 of § 61.55 are used to determine waste class based on radionuclide content. Class A waste contains the lowest concentrations of short-lived and/or long-lived radionuclides. Class B waste contains low concentrations of long-lived radionuclides but larger concentrations of short-lived radionuclides; in addition to the requirements of § 61.56(a), Class B waste must meet the stability requirements of § 61.56(b). Class C waste contains the largest concentrations of long-lived radionuclides and/or short-lived radionuclides that are acceptable for near surface disposal, meets the same waste characterization requirements as Class B waste (minimum requirements and stability requirements), plus Class C waste requires additional measures to protect against inadvertent intrusion as listed in § 61.52(a). LLRW whose concentrations exceed the highest values in Table 1 or Table 2 is GTCC and not generally suitable for near-surface disposal.

Numerous studies and surveys have shown that Class A comprises the largest volume of LLRW compared to Classes B, C, and GTCC. For example, a nationwide assessment of LLRW received at commercial disposal facilities revealed that 97.6% (by volume) of the LLRW disposed was Class A. Class B and Class C comprised only 1.5% and 0.9%, respectively. (''1998 State-by-State Assessment of Low-Level Radioactive Wastes Received at Commercial Disposal Sites,'' May 1999, DOE/LLW–252.) For example, the 1996 survey of LLRW shipped from Connecticut to disposal facilities reports that Class A contributed only 8.9% of the total radioactivity in LLRW disposed in 1996; in 1999, Class A LLRW represented only about 2% of the total activity. For the period 1995–1999, Class A LLRW made up about 14% of the total activity. (''Low-Level Radioactive Waste Management in Connecticut—1996,'' prepared by the Connecticut Hazardous Waste Management Service, December 1997; figures for 1999 can be found in the October 2000 report.) A comprehensive analysis of the nationwide characteristics of commercial LLRW shipped for disposal between 1987 and 1989 indicated that Class A represented from 3.3% to 10.9% of the total radioactivity in LLRW disposed in any given year and 96.4% to 97.4% of the total volume in any given year. (''Characteristics of Low-Level Radioactive Waste Disposed During 1987 through 1989,'' NUREG–1418, December 1990.) Thus, while Class A LLRW may predominate the volume of waste sent to LLRW disposal facilities, Class A typically contributes only a small percentage of the total radioactivity disposed. Class A LLRW is limited to the lowest concentrations of short-lived and long-lived radionuclides in the NRC's waste classification system in 10 CFR 61.55, and much of the waste in Class A LLRW is incidentally contaminated trash. Class A LLRW with radionuclide concentrations at some fraction of the Class A limits, so-called low-activity LLRW may represent an acceptable candidate for disposal by alternative means, such as disposal in an RCRA Subtitle C landfill.

4. Decommissioning Wastes

When facilities that use or process radioactive materials are closed, they go through a process of decontamination and decommissioning to reduce the amount of residual radioactivity left at the site. The extent and type of contamination depends on the kind of work done at the facility, the length of time the facility operated, and the operational practices employed at the facility. For example, facilities that processed uranium or thorium ore, such as those involved in FUSRAP, will have a relatively narrow range of radionuclides (uranium, thorium, radium, and their decay products), but also tend to have contaminated soils from managing the processing wastes. Nuclear power plants, on the other hand, typically have to address a much wider spectrum of radionuclides generated by the fission process, but much waste will primarily consist of contaminated equipment. Because of its widely varied operations, the scope of contamination at DOE facilities and sites is likely to encompass that found at commercial facilities. The decontamination process also produces waste, such as the removal of surface contamination from buildings using high-pressure sprays.

Waste volumes from decommissioning vary widely. Some contaminated facilities lie unused for years before decommissioning, and a number of DOE sites are being evaluated for accelerated decommissioning schedules. The scope of waste from decommissioning can change during the process. For example, some buildings that are expected to be lightly contaminated, and therefore amenable to surface decommissioning, can be found to be more extensively contaminated, thereby affecting the decommissioning procedure. Similarly, soil contamination is often found to be more prevalent than anticipated. Another uncertainty at present surrounds the decommissioning of nuclear power plants. A few years ago, it appeared that nearly all reactors would be decommissioned at the end of their current licenses (a few have decommissioned in the past decade). Now, however, some utilities are pursuing license renewals. Assuming they operate to the end of the renewed license, that would push the major wave of decommissioning farther into the future.

In addition, technological advances in either decommissioning practices, radioactive waste treatment, or waste disposal could significantly affect the volumes and characteristics of these wastes. While we can say with certainty that some, and possibly a large percentage, of these wastes would be ''low-activity,'' we have no way of projecting the proportion that would be mixed waste or the actual waste characteristics. For purposes of modeling, we request information that would help us describe the wastes resulting from decommissioning.

E. Questions for Public Comment: Disposal of Other LARW in Hazardous Waste Landfills

1. Should a rule include pre-UMTRCA byproduct material, such as that generated by FUSRAP cleanups? Are there remaining public health or environmental concerns over management of this material? (section III.B.2.a)
2. What authorities are most appropriate to regulate disposal of pre-UMTRCA byproduct material?
3. Are there significant sources of pre-UMTRCA byproduct material, other than FUSRAP cleanups?
4. How does pre-UMTRCA byproduct material resemble or differ from 11e.(2) byproduct material regulated by NRC?
5. What Federal or State authorities presently regulate TENORM? What Federal or State authorities might be used to regulate TENORM?
6. What regulatory standards do State authorities apply to TENORM disposal? How might a rule simplify TENORM disposal?
7. What approach to managing similar TENORM wastes is most appropriate? Are there particular waste streams that need immediate attention (based on risk or occurrence)? (III.B.2.b)
8. Should volume averaging or ''blending'' be allowed for TENORM and other LARW? Under what conditions?
9. Should a rule include low-activity LLRW that is not mixed waste? What about source material exempted by NRC? Under what conditions? (III.B.3)
10. What issues are associated with siting new disposal facilities for these other LARW? How might they be alleviated? (III.B.4)

11. Would there be special concerns about waste from facility decommissioning? Would such concerns depend on the type of facility being decommissioned? Are there credible projections of the volumes and types of waste expected to be generated when decommissioning large numbers of nuclear reactors? (III.D)

IV. What Non-Regulatory Approaches Might Be Effective in Managing LAMW and Other Low-Activity Radioactive Wastes?

Many of the wastes just described appear to share similar physical and radiological characteristics. This might imply that a common approach, or a limited number of approaches, could effectively manage and dispose of such wastes. Such an approach could eliminate the need for separate actions addressing individual waste streams. The real question is to decide which approach (or approaches) may be most promising in terms of practicality, legal applicability, cost-effectiveness, and risk reduction potential. In order to develop meaningful approaches, it is necessary to obtain the advice of potentially affected stakeholders. We therefore welcome comment on some of the possible approaches to managing and disposing of these other categories of low-activity waste. We also welcome advice on new or innovative approaches that are not described below.

A. General Discussion

Our conceptual approach to disposal of low-activity mixed waste relies on regulatory actions by us and by NRC, although the envisioned regulatory action would be permissive (that is, it would allow actions not possible under the existing regulatory structure) and LAMW generators or disposal facilities could choose not to take advantage of the increased disposal flexibility. By contrast, as discussed above, some other low-activity wastes might not be as clearly addressed by us through regulatory action. However, we believe it is in the public's interest to address the issues presented by disposal of these other low-activity wastes. Therefore, we are considering how best to accomplish this through actions that do not involve rulemakings or other regulatory methods. These non-regulatory approaches may also be effective to some extent in addressing issues related to LAMW disposal.

1. Advantages and Disadvantages of Non-Regulatory Approaches

A prime complaint about regulatory programs is that they are too prescriptive and limit the flexibility of the regulated parties in meeting goals. This can be true, and to some extent they also limit the flexibility of regulatory agencies in improving the effectiveness of the program, because modifying a regulatory program takes significant time and resources. In addition, enforcement actions, while necessary to maintain the integrity of the program, by their very nature often result in adversarial relationships with limited trust. In short, the burden of regulatory programs to all parties can sometimes outweigh the positive benefits.

In a non-regulatory program, the regulatory agency and regulated community typically work more closely together to achieve a common goal. In many cases, the regulated parties participate in designing the program. Non-regulatory programs are usually less prescriptive, offering flexibility to participants to meet goals in the way they find most effective. In turn, the regulatory agency focuses less on strict compliance and more on technical assistance, training, guidance, and encouraging use of innovative technologies. The flexibility of such programs can make them easier to modify as found necessary. Compliance with regulatory requirements is still necessary, and some programs offer flexibility only to ''superior'' performers. Some programs encourage self-reporting by offering reduced penalties.

The main concern about non-regulatory approaches is that they can result in a lessening of regulatory oversight. When a regulatory agency reduces its emphasis on inspections and enforcement, allows ''innovative'' methods, and relies on self-reporting, there is always the potential for serious non-compliance with requirements and subsequent environmental damage. For example, offering reduced penalties for reporting findings of ''self-audits'' has been criticized as encouraging abuses.

2. Examples of Existing EPA Non-Regulatory Programs

EPA has developed a number of programs targeted to improve environmental performance. ''Partners for the Environment'' is the collective name for voluntary programs developed by EPA Headquarters or regional offices. These programs primarily involve agreements between EPA and individual regulated entities, and focus on taking performance to a level beyond simple compliance with regulatory requirements (or, in some cases, innovative approaches may be developed that provide some flexibility in the strict regulatory framework to achieve overall goals). In that sense, it may be difficult to apply non-regulatory approaches where there are competing requirements (as for mixed waste) or inconsistent requirements (as for individual States and TENORM). We offer this discussion not to endorse any specific program as especially suited to address low-activity radioactive wastes, but to encourage thought and comment about innovative approaches that might be developed, and to provide examples of the types of efforts EPA has traditionally embraced. Individual EPA programs include:

- Project XL (eXcellence and Leadership)—Project XL is a national pilot program that allows State and local governments, businesses and Federal facilities to develop with EPA innovative strategies to test better or more cost-effective ways of achieving environmental and public health protection. In exchange, EPA will issue regulatory, program, policy, or procedural flexibilities to conduct the experiment. Project XL uses eight criteria to assess potential projects, including producing superior environmental results, cost savings, or regulatory flexibility; demonstrating innovative processes; pollution prevention; and ability to transfer lessons or data to other facilities. ''Project XL for Communities'' also looks for strategies that provide economic opportunity and incorporate community planning. Project XL has approved projects related to mixed waste treatment.
- National Environmental Performance Track—The National Environmental Performance Track program is a voluntary partnership program that recognizes and rewards businesses and public facilities that demonstrate strong environmental performance beyond current requirements. It encourages continuous environmental improvement through the use of environmental management systems, local community involvement, and measurable results. Incentives to participants include public recognition, low priority for routine inspections, partnerships with State agencies, and regulatory changes to streamline requirements. There are nearly 300 participants in the program.
- Code of Environmental Management Principles (CEMP)—CEMP was developed in response to Executive Order 12856 (''Federal Compliance with Right-to-Know Laws and Pollution Prevention,'' August 3, 1993), which called for EPA to develop an environmental challenge program for Federal agencies. CEMP incorporates elements of state-of-the-art

environmental management systems (such as the ISO 14000 series) to emphasize sustainable environmental performance and an integrated view of environmental activities to move agencies ''beyond compliance.'' CEMP was reaffirmed as a basis for environmental performance and leadership in Executive Order 13148 (''Greening the Government Through Leadership in Environmental Management,'' April 21, 2000).

- Energy Star—Energy Star was introduced by the U.S. Environmental Protection Agency in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products, in order to reduce carbon dioxide emissions. EPA partnered with the U.S. Department of Energy in 1996 to promote the Energy Star label, with each agency taking responsibility for particular product categories. Energy Star has expanded to cover new homes, most of the buildings sector, residential heating and cooling equipment, major appliances, office equipment, lighting, consumer electronics, and other product areas.

3. National Academy of Sciences Studies

Though not limited to non-regulatory considerations, two efforts of the National Academy of Sciences (NAS) have a bearing on our approach to LARW. In 1999, NAS provided a report evaluating the existing guidelines for exposures to TENORM. NAS concluded that different guidelines among regulatory agencies were primarily related to policy, rather than scientific or technical, judgments. (*See* ''Evaluation of Guidelines for Exposures to Technologically Enhanced Naturally Occurring Radioactive Materials,'' National Academy Press, 1999.) In addition, NAS is about to conduct a study of options for managing LARW, including low-level radioactive waste, TENORM, and FUSRAP wastes. NAS could make recommendations for statutory, regulatory, policy, or other actions. Financial support for this study is being provided by EPA, NRC, DOE, USACE, and the Southeastern Low-Level Radioactive Waste Compact. We believe this study will help us in developing our rulemaking and in identifying other non-regulatory approaches that might prove effective. We intend to follow this study and, with this action, seek the views of the general public on these matters as input to develop an integrated strategy for assuring the proper management of such diverse wastes.

B. Non-Regulatory Approaches for LAMW and Other Low-Activity Radioactive Wastes

1. Develop Guidance

While establishing Federal regulations for pre-UMTRCA byproduct material and TENORM wastes faces certain hurdles, establishing guidance may achieve many of the same goals but without a complex regulatory framework. While guidance would not have the enforcement ''teeth'' of a regulation, guidance does provide a common reference point and to depart from such guidance risks damaged credibility for those industries or entities not following accepted guidance. Another question is what kind of guidance; Federal guidance, suggested guidance, joint guidance, and State guidance are all possibilities. It may be possible to establish Federal guidance for both pre-UMTRCA byproduct material and TENORM wastes but Federal guidance has traditionally been used to guide Federal agencies in matters related to radiation protection. Given that not all of this material falls under Federal agency purview, the usefulness of Federal guidance for pre-UMTRCA byproduct material and TENORM may be limited. While not Federal guidance, strictly speaking, we have published suggested guidance for dealing with the radioactive residues from treating drinking water. (*See* 56 FR 33091, July 18, 1991.) Guidance in the form of ''suggested State regulations'' has been developed over the years for a variety of radiation protection issues, including TENORM, by the Conference of Radiation Control Program Directors (CRCPD). Whether a unified guidance applicable to both pre-UMTRCA byproduct material and TENORM wastes is possible and practical is open to question. We welcome the views of stakeholders on this matter. Perhaps joint State-Federal guidance would be appropriate to cover both pre-UMTRCA byproduct material and TENORM wastes.

2. Partner With Selected Stakeholders To Develop Waste-Specific ''Best Practices''

An alternative approach to guidance might be a partnership between Federal, State, and industry representatives to establish ''best practices'' targeted to specific industries or waste types. Again, lacking the ''teeth'' of a formal regulation, a code of ''best practice'' creates a common reference point of accepted practice that brings peer pressure and public pressure on those entities failing to abide by such a code. Establishing such best practice that is endorsed and used by the industries in question may also lessen the need for formal regulation and result in cooperation rather than confrontation. It is possible that industry could establish an in-house panel of recognized experts and affected stakeholders that would develop, monitor, and facilitate the implementation of best practices by companies within a given industry, even allowing the use of the panel's code of ''best practices'' logo to companies abiding by this code. This might work in a manner similar to our Energy Star program, a voluntary program to identify and promote energy efficient products. We welcome views on the possible application of this approach, or other approaches. What wastes or specific industries could benefit most from this approach? How useful might the development of best practices be for the affected industries? What incentives exist or may be encouraged to promote the development and implementation of best practices?

In an action that combines aspects of the guidance and ''best practices'' approaches, EPA recently issued a ''Guide for Industrial Waste Management'' (EPA530R–03–001). EPA joined with members of State governments, tribes, industry, and environmental groups to develop this guidance on how best to manage non-hazardous industrial solid wastes, which are generated in much larger volumes than municipal solid wastes. The Guide is intended to be a practical resource, covering engineering and scientific principles applicable to developing and operating waste management units, effective communication, risk assessment, and other topics. Computer models and other tools are included in the Guide, which is also available on CD–ROM (EPA530–C–03–002). *See http://www.epa.gov/epaoswer/non-hw/industd/index.htm* for more information.

C. Request for Information: Non-Regulatory Alternatives to Our Disposal Concept

In general, we request information that would help us to evaluate whether non-regulatory approaches might be effective in addressing issues associated with low-activity radioactive waste management and disposal (see also questions in D, below). We also request information that would help us determine what types of non-regulatory actions would be most effective, how they would be developed, and who might need to be involved in their development. We welcome information on:

- The effectiveness of various non-regulatory programs at achieving their stated goals
- The relative cost of implementing a non-regulatory vs. regulatory program
- The ease of implementing a non-regulatory vs. regulatory program
- Whether existing non-regulatory programs could be used to address LARW

D. Questions for Public Comment: Non-Regulatory Alternatives to Our Disposal Concept

1. In general, do you think that a non-regulatory approach could be effective at addressing the problems associated with management and disposal of low-activity radioactive waste? Why or why not? (section IV)

2. What has been your experience with EPA non-regulatory programs, such as those described in section IV.A.2? Which programs have been most effective? Why?

3. What is your experience with non-regulatory programs at other Federal or State agencies?

4. Do you see particular aspects of LARW management and disposal that could not be addressed outside of regulatory action? Aspects that would be particularly amenable to non-regulatory action?

5. Is guidance a viable mechanism to support proper management of LARW? Who should develop such guidance? What topics should it cover? (IV.B.1)

6. Would a ''best practices'' approach to management of LARW give generators and disposal facilities sufficient support to ensure proper management practices? Would incentives to adopt a ''code of conduct'' be necessary? Could such a ''code'' encompass the wide range of generating processes and waste characteristics? How would regulators view such an approach? (IV.B.2)

7. What other non-regulatory approaches might be appropriate to address LARW management?

V. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review

Under Executive Order 12866 (58 FR 51735, October 4, 1993), EPA must determine whether a regulatory action is ''significant'' and therefore subject to Office of Management and Budget (OMB) review and the requirements of the Executive Order. The Executive Order defines ''significant regulatory action'' as one that is likely to result in a rule that may:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

OMB has determined that this Advance Notice of Proposed Rulemaking is ''non-significant'' according to the criteria of Executive Order 12866.

Dated: November 4, 2003.

Marianne Lamont Horinko,

Acting Administrator.

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