Natural Resources
Defense Council

1350 New York Ave., N.W.
Washington, DC 20005
202 783-7800
Fax 202 783-5917

# Comments of the Natural Resources Defense Council

on

# Working Draft #3 of U.S. Environmental Protection Agency Proposal to Revise 40 CFR Part 191: Environmental Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste

Thomas B. Cochran
Senior Scientist

Dan W. Reicher
Senior Attorney

December 13, 1991



40 West 20th Street
New York, New York 10011
212 727-2700
Fax 212 727-1773

71 Stevenson Street
San Francisco, CA 94105
415 777-0220
Fax 415 495-5996

617 South Olive Street
Los Angeles, CA 90014
213 892-1500
Fax 213 629-5389

212 Merchant St., Suite 203
Honolulu, Hawai'i 96813
808 533-1075
Fax 808 521-6841

The Natural Resources Defense Council (NRDC) is pleased to submit these comments on Working Draft #3 of the Environmental Protection Agency proposed revisions of 40 CFR Part 191: Environmental Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste. In these comments we answer the six questions presented in the draft preamble, discuss some other critical issues, and provide additional specific comments. It must be emphasized, however, that these comments are preliminary in nature and do not address all of the relevant issues or concerns. We will submit more comprehensive comments when the standards are officially proposed.

Assuming the appropriate choice of the options presented, we believe Working Draft #3 takes some positive steps toward strengthening and clarifying the regulations but that additional revisions are necessary if the standards are to adequately protect human health and the environment and properly respond to the decision of the First Circuit Court of Appeals in NRDC v. EPA, 824 F.2d 1258 (1st Cir. 1987).

## I. SIX QUESTIONS

**QUESTION 1**

**Two options are presented in Section 191.03 and 191.14 pertaining to maximum exposures to individuals in the vicinity of waste management, storage and disposal facilities: a 25 millirems/year ede limit and a 10 millirems/year ede limit. Which is the more appropriate choice and why?**

NRDC does not agree with either the 25 millirem or 10 millirem option for 191.03 or 191.14. In the case of 191.03 management and storage standards we believe that 10 millirem is unnecessarily high. There is no reason why management and storage facilities cannot and should not meet a far stricter standard. The routine liquid and gaseous radioactive emissions at waste management and storage facilities should be essentially zero.

We believe that a standard on the order of 2 millirem is appropriate for 191.03. This would entail a 1-in-10,000 lifetime cancer risk as opposed to a 1-in-2000 risk at 10 millirem and 1-in-800 risk at 25 millirem. This risk level is still not even close to the 1-in-1,000,000 lifetime risk objective that EPA applies to pesticides in foods.[1]

In the case of 191.14, we believe that 4 millirem is a more appropriate and equally achievable figure. This would bring the standard in line with the SDWA standard. In its analyses of individual risk, EPA assumes that drinking water will be the exclusive exposure pathway. See "High-Level and Transuranic Radioactive Wastes, Background Information Document for Final Rule," (August, 1985) at 8-7. A 4 millirem exposure would entail a lifetime risk of a fatal cancer of 1-in-5000.

---

[1] See, for example, Environmental Protection Agency, "Captan: Intent to Cancel Registrations; Conclusion of Special Review, Notice of Final Determination" Federal Register, February 24, 1989, pp. 8121-8122.

In the draft preamble (p. 49) EPA attempts to justify the 10 millirem limit pointing to its consistency with 40 CFR 61, the EPA standards for radioactive air pollutants. This is not an apt comparison. These air pollution standards set limits on radioactive emissions from current nuclear activities. Individuals who bear the risks of the emissions from such facilities are also likely to enjoy some of the benefits of the regulated activities. In contrast, the future individuals who will have to bear the risks of nuclear waste will almost certainly not enjoy any direct benefits of the activities which produced it. These individuals also have no voice in today's decision. Under these circumstances, more restrictive exposure limits are appropriate.

Strict limits are also important to ensure the selection of a robust geologic site, the development of substantial engineered barriers and cannisters, and the use of a high-integrity waste form. Lax standards do not aid in making choices with respect to these key features of a repository.

We are troubled by EPA's failure to explicitly incorporate the As-Low-As-Reasonably-Achievable (ALARA) concept in 191.03 and 191.14 as well as other applicable sections of Part 191. ALARA is, and has always been, a fundamental tenet of radiation protection that should figure prominently in the EPA standards.

**QUESTION 2**

**A new assurance requirement is presented in Section 191.13 that would require a qualitative evaluation of expected releases from potential disposal systems over a 100,000-year timeframe. Are such evaluations likely to provide useful information in any future selecting [sic] of preferred disposal sites?**

NRDC believes the requirement for site comparisons based on qualitative comparisons of potential releases over 100,000 years could prove very useful. However, EPA should not limit the requirement to a qualitative evaluation. Instead, the agency should recommend a quantitative comparison where possible, recognizing the uncertainties involved in projecting releases and risks far into the future.

**QUESTION 3**

**Two options are presented in Section 191.14 and 191.23 pertaining to the length of time over which the individual and ground water protection requirements would apply: a 1,000-year duration and a 10,000-year duration. Which is the more appropriate timeframe and why?**

In the draft Preamble EPA recognizes: (1) that the 10,000-year timeframe is achievable for repositories which are carefully sited and designed (p. 48); (2) that adopting a 10,000-year timeframe would make the individual protection requirement consistent with the containment requirement and other EPA regulations (UIC and RCRA no-migration) (p.48); (3) that in most of the cases studied, no exposures occurred for more than one thousand years after disposal (p. 76), i.e. that radionuclide releases may not even occur at any sites within 1,000 years (p.

25). Basic logic and sound health protection therefore dictate adoption of a timeframe no shorter than 10,000 years.

Additionally, the First Circuit raised serious doubts about the legitimacy of the 1000-year limit. The standards would likely be challenged again if EPA maintained the same timeframe in the new regulations in the absence of compelling new information contradicting the agency's current conclusions about the efficacy of the 10,000-year timeframe.

**QUESTION 4**

**In Subpart C the Agency proposes to prevent degradation of "underground sources of drinking water" beyond the concentrations found in 40 CFR 141--the National Primary Drinking Water Regulations. The Agency is aware, however, that there may be some types of ground waters that warrant additional protection because they are of unusually high value or are more susceptible to contamination. Should the Agency develop no-degradation requirements for especially valuable ground waters? If so, what types of ground waters warrant this extra level of protection?**

EPA should definitely develop no-degradation requirements for especially valuable ground waters. EPA recognizes that the standards at issue are intended to influence site selection and design for a repository as opposed to setting traditional "end-of-the-pipe" limits. Therefore, it is critical that the standards be written so as to either effectively rule out the siting of a repository in an area with especially valuable groundwater, or require a design that ensures a zero-release. Any concern about the stringency of such a no-degradation approach should be lessened by the fact that it would have

limited application given the handful of sites that might be considered for a repository. While we cannot provide a complete list of ground waters warranting no-degradation protection, it should at least include the waters referred to in assurance requirement 191.13(f) with the definition of "ecologically vital ground water" expanded as described infra in our comment on definition 191.01(o).

**QUESTION 5**

**Two options are presented in Notes 1(d) and (e) of Appendix B pertaining to the transuranic waste unit; a 1,000,000 curies option and a 3,000,000 curies option. Which is the more appropriate TRU waste unit and why?**

NRDC believes that 3,000,0000 curies is the minimum acceptable transuranic waste unit. See the April 2, 1991 Comments of the New Mexico Environmental Evaluation Group, pp. 12-15. As indicated in the draft preamble (p. 30), under some circumstances a value of 6,000,000 curies, or even higher, would be more appropriate. EPA should define both a minimum value and a procedure for calculating whether a higher value is warranted.

**QUESTION 6**

**The Agency is investigating the impacts of gaseous radionuclide releases from radioactive waste disposal systems and whether, in light of these releases, changes to the standards are appropriate. To assist us in this effort, we would appreciate any information pertaining to gaseous release source terms, chemical forms, rates, retardation factors, mitigation techniques and any other relevant technical information.**

Of course EPA must regulate all potential gaseous radionuclide releases from disposal systems, including C-14. EPA has already resolved the issue of whether gaseous radionuclides should be controlled when it established 40 CFR 190, to regulate similar releases from other parts of the uranium fuel cycle.

Some industry officials have argued that the proposed C-14 standard under Part 191 should be weakened. We believe, however, that it should be tightened. Kr-85 (which is controlled under Part 190) is similar to C-14 in that once it is released to the environment it spreads globally and can result in a significant number of health effects even though the individual risks may be small. It obviously makes no sense to weaken or eliminate controls on C-14 which produces even larger numbers of health effects. This was the position NRDC took in our September 15, 1975 comments on Part 190 with respect to whether C-14 should be regulated. Logically, the two radionuclides, Kr-85 and C-14, should meet the same basic standard in terms of health effects permitted by their release. There is no basis for establishing a weaker standard for C-14 under Part 191 (waste disposal) than what has already been implemented for Kr-85 under Part 190 (fuel reprocessing).

40 CFR 190.10 (b) permits the release of only 50,000 Ci Kr-85/Gw-y, which translates into about 1700 Ci/1000 MTHM. In terms of committed effective dose equivalent/curie, C-14 is about 1000 times more hazardous than Kr-85. Therefore, the release limit

for C-14 in Table 1 should be on the order of 2 curies, instead of 100 curies, to be compatible with 40 CFR 190.10 (b).

In its November 26, 1991 and December 5, 1991 comments, DOE argues that EPA's release limit for C-14 is not consistent with the levels of acceptable risk on which other standards are based. DOE's argument is totally flawed, because it does not recognize the difference between individual risk limits and collective dose limits. C-14 exposes an immense number of people -- essentially the global population over many generations -- to individually small doses. Even though the individual risk may be small, the total projected health effect can be very large. If one took DOE's argument seriously, EPA should never have promulgated 40 CFR 190(b) to control Kr-85, I-129 and H-3, where the individual risks are also small. As the EPA staff fully recognizes, we control these emissions to limit total health impacts not individual risks.

One of DOE's proposed solutions for meeting the EPA C-14 release limit would be to vent the C-14 before emplacement in the repository. This is an outrageous proposal that demonstrates the lengths DOE might go to avoid environmental requirements. Will DOE next propose to dispose of high-level waste by diluting it in the Great Lakes? EPA should include an explicit provision prohibiting release of waste to the environment to avoid the Part 191 requirements.

## II. OTHER CRITICAL ISSUES

In this section we comment on three critical issues not adequately addressed above in our answers to the EPA Questions: the stringency of standards; whether emplacement of wastes in a repository constitutes underground injection; and how human intrusion should be dealt with in the standards. EPA should consider adding additional questions on these and other topics in the draft preamble.

### A. Stringency of Standards

In the wake of the First Circuit decision striking down the standards, we were hopeful that interested parties would take the Court's decision to heart and support a strengthening of the standards consistent with the law. Instead, we see a strong push from many quarters to weaken the standards. The call seems to have gone out that the standards must be adjusted to fit the existing sites.

We feel strongly that this is the wrong approach and sends the wrong signal to the public. The result can only be to further undermine public confidence in the high-level waste program. A recent University of Pennsylvania study of public attitudes toward siting the Yucca Mountain repository found that the imposition of strict standards is a critical element in

convincing residents of a potential host state that a repository will be safe.[2]

We also believe EPA would have a difficult time trying to provide a fair and objective basis for diverging from the Safe Drinking Water Act levels. Drinking water supplies are among our most important natural resources, especially in the western United States. To adopt standards that permit contamination of these precious supplies at levels above what the law provides is not only an affront to future generations but to our own as well.

On a related note, increasingly one hears the EPA high-level waste standards criticized for being so much more stringent than EPA's hazardous waste landfill requirements. The high-level waste standards apply for 10,000 years while the hazardous waste standards generally focus attention on a site for a 30-year period. This is a specious comparison.

As the First Circuit found, the regulatory equivalent of deep geologic disposal of radioactive waste is not surface disposal but instead deep well injection of hazardous waste. EPA's deep well injection regulations for restricted hazardous waste, in fact, track the high-level waste standards. The regulations require that a petition for a variance from the ban on injection of solvent waste demonstrate, among other things, that "fluid movement conditions are such that the injection fluids will not migrate within 10,000 years." The supposed

---

[2] Kunreuther, H. et al, "Public Attitudes Toward Siting a High-Level Nuclear Waste Repository in Nevada," Risk Analysis, Vol. 10, No. 4, 1990, p. 469.

disparity between the high-level and hazardous waste standards is thus unfounded.

B. Whether Emplacement of Wastes in a Repository Constitutes Underground Injection.

In the draft preamble, EPA concludes that disposal of radioactive waste in a geologic repository does not constitute underground injection. EPA's conclusion is completely unsupportable and totally at odds with the SDWA, EPA's own UIC regulations, and case law. EPA's sole argument is that somehow "well injection" under Subpart C does not cover situations where wastes are emplaced by mechanical means and are not fluid at the time of injection. EPA's only attempt at support for this is an obscure reference to the legislative history of the SDWA for the proposition that Congress focused on injection practices when directing EPA to control underground injection and therefore (somehow) mechanically-emplaced wastes that are not fluids at the time of injection are not subject to Part C of the SDWA. The most charitable thing that can be said about this argument is that it is creative.

Whatever its focus in considering the SDWA, Congress clearly concluded that "[t]he definition of 'underground injection' is intended to be broad enough to cover any contaminant which may be put below ground level and which flows or moves, whether the contaminant is in semi-solid, liquid, sludge, or any other form or state." Congress did not, as it could have, limit the means by which wastes covered by the UIC provisions are "put below

ground level" nor did it, as EPA suggests, indicate that the wastes could not be solids at the time of injection.

Moreover, the definition of "fluids" under EPA's own regulations actually encompasses solids, i.e. a "fluid" is "[any] material...in a semi-solid, liquid, sludge, gas or any other form or state." 40 CFR 146.3 (emphasis added). It must also be noted that DOE intends to dispose of semi-solids and even some free liquids in at least one repository. Thus the draft Preamble (p. 5) acknowledges that at the WIPP facility in New Mexico, DOE will dispose of "contaminated organic and inorganic sludges" and in the 1990 Final Supplemental Environmental Impact Statement on WIPP DOE states that "[m]inor liquid residues remaining in well-drained bottles, cans and other containers are acceptable." See FSEIS, Vol. 2, p. A-7, DOE/EIS-0026-FS. DOE will also clearly dispose of some wastes in gaseous form at repositories, for example the C-14 and Kr-85, in spent fuel cannisters that will be regulated under the 191.12 containment requirements.

EPA's conclusion that mechanical emplacement of wastes somehow is not covered by the UIC provisions is also flawed. EPA's own definition of "well injection" -- which is taken "almost directly from the legislative history accompanying the SDWA" (Draft Preamble p. 57-58) -- encompasses "subsurface emplacement of fluids through a bored, drilled, or driven well..." 40 CFR 146.1 The term "well" means a bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension." Id. There is simply nothing in the

SDWA, its legislative history, or EPA's regulations indicating that mechanical emplacement of wastes falls outside of these definitions.

The First Circuit, confronted by the overwhelming weight of this legislative history and regulatory language, concluded that a "narrow and constrained reading of Part C of the SDWA...would do violence to the intent of Congress" and therefore that emplacement of waste in a repository "would likely constitute an 'underground injection' under the SDWA." In light of this, EPA proceeds at extreme legal peril in adopting the contrary position.

At the same time, we readily acknowledge and very much support the proposal to conform the standards with the SDWA limits despite the decision that emplacement does not constitute injection. We must emphasize, however, that this proposal, if adopted, would not fully satisfy the agency's legal obligations or the public's rights under the SDWA.

### C. How Human Intrusion Should Be Considered In the Standards

In it December 5, 1991 comments, DOE made the very troubling suggestion that EPA separate consideration of human intrusion from the comprehensive analysis required by the containment requirements. As currently designed, the implementing agency would determine compliance with the containment requirements by evaluating the extent to which various events and processes affecting a repository are likely to lead to releases. Such an

evaluation, using the Table 1 release limits, would consider both natural processes and events (e.g., faulting, groundwater flow) and the effects of inadvertent human intrusion.

Essentially, DOE is suggesting that the Table 1 release limits only apply to natural processes and events and that human intrusion be dealt with in a different and more qualitative fashion. DOE has not provided any specific ideas about how this would be implemented.

We strongly object to DOE's approach. The release limits in Table 1 were meant to correspond to a risk objective of no more than 1000 fatal cancers over 10,000 years. Adopting DOE's approach would mean that EPA has decided to allow extra fatal cancers above what the agency deemed appropriate in 1985. And by analyzing human intrusion in a qualitative fashion, EPA would essentially be writing a standard with no limits on permissible risk. This is particularly troubling because EPA's own generic repository analyses in support of 40 CFR 191 indicated that human intrusion will often be the most important cause of radionuclide releases from repositories.

At least one of DOE's motivations is quite clear: the consequences of human intrusion at WIPP appear to violate the containment requirements. Apparently, DOE's preferred solution is to weaken the standards. Instead, the Department should incorporate a more robust barrier system and/or modify the existing waste form. In fact, a DOE task force is apparently investigating just such changes. If implemented, they could not

only bring the facility into compliance with the containment requirements but also make WIPP a safer repository which, in the end, is what this exercise is supposed to be about.

Thus we believe that it is critical that human intrusion remain an integral part of the analysis of compliance with the containment requirements. In fact, we believe that the guidance in Appendix C on the frequency and severity of human intrusion should be codified in the containment requirements. To the extent that the assumptions about borehole frequency and other matters are not appropriate for a particular site, the implementing agency should seek alternative provisions under 191.17.

The guidance on inadvertent human intrusion in Appendix C suggests that intrusions that could result in major disruptions to a repository would stem from "widespread societal loss of knowledge regarding radioactive wastes..." However, recent work on inadvertent human intrusion suggests that even where societal knowledge is not lost there may be massive off-site activities in the vicinity of a repository (explosions, water withdrawals etc.) that could inadvertently affect the integrity of waste containment. These should be considered in any analysis of human intrusion.

## III. ADDITIONAL COMMENTS

Below we provide specific additional comments on the draft regulations.

## Subpart A -- Management and Storage Standards

191.01 (Definitions)

(o) "Ecologically vital ground water": This definition is unnecessarily limited. First, it is not clear why the definition is restricted to "Congressionally designated Federal Lands...." Under the Federal Land Policy and Management Act, the Secretary of the Interior may also designate federal lands for ecological protection on a temporary basis. Additionally, the President has, without statutory authorization or Congressional approval, designated lands for a range of purposes including ecological protection.[3]

Second, the definition of ecologically vital ground water should be expanded to include water located on non-federal land. DOE has considered many sites for radioactive waste disposal on non-federal lands. Some of these may contain ground water supplying an ecosystem which is managed by governmental or non-governmental entities for the purpose of ecological protection.

191.02 Applicability

Section 191.02(2) limits the applicability of the Subpart A standards to management and storage at a DOE disposal facility. DOE management and storage facilities not associated with a

---

[3] See Getches, "Managing Public Lands: The Authority of the President to Withdraw Lands," 22 Nat. Resources J. 279 (1982).

disposal facility would apparently be exempt. We strongly object to this provision. Spent fuel, high-level, and transuranic waste storage facilities at the Savannah River Site, Idaho National Engineering Laboratory, Rocky Flats, Hanford and other locations could operate free from these critical standards. This creates a double standard between NRC-licensed management and storage facilities not associated with a disposal facility -- which apparently <u>are</u> covered by the standards -- and similar DOE facilities which would be exempt. EPA has advanced no technical or legal rationale for this distinction. It is particularly troubling in light of concerns about potential threats to human health and the environment at a number of DOE storage facilities, among them the infamous Hanford tanks. EPA must eliminate this exemption or face a likely legal challenge.

## Subpart B -- Disposal Standards

### 191.11 <u>Applicability</u>

We are very concerned about the provision in this section which exempts "disposal that occurred before August 15, 1985" (the date the final standards were first issued). It is not at all clear what existing wastes this provision would exempt given varying definitions of disposal and varying intentions about the fate of specific wastes both at the time they were deposited and subsequently.

The provision is not only unclear but also unnecessary. To the extent that application of the disposal standards to wastes already deposited is inappropriate or problematic, then section 191.17 of the proposed standards allows the Administrator to substitute alternative provisions. This is the appropriate approach to existing wastes. The proposed provision would add unnecessary confusion and may lead to litigation.

191.12 Containment Requirements

NRDC does not support the proposed change in (b) which would explicitly allow DOE as the "implementing agency" to self-certify compliance. DOE self-regulation has produced massive nuclear waste problems that will require tens of billions of dollars to address. We believe that, at a minimum, EPA should review and concur in any DOE determination of compliance. More appropriately, EPA should make the compliance determination in the first instance.

191.13 Assurance Requirements

We object to the exemption of NRC-licensed facilities from the assurance requirements. We believe that EPA's authority under the Atomic Energy Act and Reorganization Plan Number 3 gives the agency the latitude to set assurance requirements applicable to NRC-licensed facilities.

We also object to the EPA decision under 191.13(d) to drop the requirement for "maximum achievable technology." This is the

closest measure EPA has proposed to the ALARA principle which, as we state in our answer to EPA Question #1 supra, should be incorporated into the proposed standard throughout.

Assurance requirements (e) and (f) are also entirely unacceptable. They both appear to be triggered only when an implementing agency is "comparing alternative sites for a disposal system..." Since DOE is not investigating "alternative sites" to WIPP and Yucca Mountain, these critical assurance requirements may not be triggered. This loophole must be eliminated from both (e) and (f). In the case of assurance requirement (e) (the 100,000 year analysis), the most appropriate approach would be to add the provision to the Containment Requirements.

191.14 Individual Protection Requirements

See answers to EPA Questions #1 and #3 supra.

191.15 Demonstration of Capability to Comply

As explained in our comment on 191.12 supra, we do not believe that DOE should self-certify compliance with these standards.

191.16 Emplacement for Experimental Purposes

We do not believe that the standards should allow the emplacement of any wastes for experimental purposes. We have yet to see any convincing evidence that experimental data can be

generated through in situ testing whose value outweighs the risks that the emplaced wastes will not or cannot be retrieved. However, if experimental emplacement is allowed, EPA must require that all wastes are retrieved at the conclusion of the test. Also, EPA must set a limit on waste quantity that represents the minimum amount necessary to conduct the proposed experiment. Additionally, EPA must require in 191.16(1) that the preliminary performance assessment indicates that the facility can meet the overall requirements and in 191.16(3) that there are not only procedures for removal but also a site that will accept the wastes once they are retrieved.

Subpart C -- Groundwater Protection

191.21 Applicability

As discussed in our comments on 191.11, we object to the exemption for wastes disposed of before August 15, 1985.

191.23 Disposal Standards

As discussed in EPA Question 3 supra we support, at a minimum, a 10,000 year duration for the standard (Option B).

Appendix B, Table 1

EPA derived the release limits in Appendix B, Table 1 to insure that there are no more than 1000 deaths per 10,000 years

per repository sized to contain 100,000 MTHM of waste. While this may be comparable to the health risks from the original uranium ore bodies had they remained unmined, we believe a standard that permits ten public deaths per reactor lifetime (approximately 0.33 deaths/Gw-y) is unnecessarily high.[4]

Appendix B, Application of Table 1, Note 2:

Under Note 2(b) NRDC supports Option B as discussed in our answer to EPA Question #5 supra.

Appendix C

We strongly support the use of iterative performance assessments. A one-shot performance assessment prior to waste emplacement is simply inadequate. New and unpredictable circumstances could arise in the course of waste operations at a site which cast serious doubt on the ability of the facility to contain wastes adequately. As EPA has stated:

> [P]erformance assessment can and should be used throughout the entire process of siting, developing, and operating disposal systems. Performance assessment...can be used to periodically confirm that a system is performing as expected. New information should be continuously integrated and models continuously updated to improve the

---

[4] We assume the annual discharge of spent fuel from a 1 Gw reactor is on the order of 33 MTHM, and the reactor lifetime is 30 years. Therefore a, a 1 Gw reactor would discharge 1000 MTHM over its lifetime.

reliability of and confidence in the performance assessments.[5]

In regard to the discussion of iterative performance assessments in Appendix C, we would note that the permissive language of the sentence "The implementing agency should demonstrate that the disposal system complies with Subpart B before any waste is placed in the system for disposal" may conflict with the mandatory language of 191.15 ("The implementing agency shall demonstrate that a disposal system is capable of complying with all the requirements of this Part before any radioactive waste is emplaced in the system").

---

[5] EPA Comments Regarding the National Academy of Science Board on Radioactive Waste Management Paper Entitled "Rethinking High-Level Radioactive Waste Disposal" at 3.