August 10, 1992

MEMORANDUM FOR: Commissioner Curtiss

FROM: James M. Taylor
Executive Director
for Operations

SUBJECT: QUESTIONS CONCERNING REGULATORY REQUIREMENTS FOR HIGH-LEVEL WASTE REPOSITORY

Your memorandum of July 8, 1992, asked five questions about the regulatory requirements for a high-level waste repository. The following are the staff's answers to those questions.

James M. Taylor
Executive Director
for Operations

cc: The Chairman
Commissioner Rogers
Commissioner Remick
Commissioner dePlanque
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QUESTIONS CONCERNING REGULATORY REQUIREMENTS FOR HLW REPOSITORY

1) EPA's high-level waste standard explicitly limits reliance on active institutional controls to a period not to exceed 100 years. What is the rationale for this approach? How does this approach compare to the approach taken in other regulatory programs that address risks that extend over a long period of time (e.g., low-level waste, uranium mill tailings, hazardous waste)? Is there a similar assumption contained in NRC's 10 CFR 60?

EPA's rationale for limiting reliance on active institutional controls is skepticism about the ability (or willingness) of society to maintain active institutional controls for periods of time longer than about a century. EPA distinguishes between "active" institutional controls, which include monitoring or guarding a site, and longer-lived "passive" institutional controls such as monuments, markers, and land-use records. The NRC's HLW repository regulations similarly anticipate that "passive" controls can be effective in providing long-term protection for a repository site, but do not anticipate long-term reliance on "active" controls.

EPA admits that the specific time limit allowed for reliance on "active" controls is judgmental. However, the time limit imposed by EPA has not been especially contentious during development of EPA's HLW standards. Most observers have accepted the idea that long-term use of "active" institutional controls is not a reliable way to achieve safe waste disposal. For example, while the NRC's final decommissioning rule does not contain specific restrictions on the time period involved for delay in completion of decommissioning, the proposed rule indicates this period should be on the order of 100 years because this is considered a reasonable time period for reliance on institutional control (53 FR 24,018, dated June 27, 1988). In discussing delay in completion of decommissioning, as in the case of SAFSTOR or ENTOMB, and after noting appropriate delay will depend on the type of facility and the contaminant isotopes involved, the Commission said that delay "should be no greater than about 100 years as this is considered a reasonable time period for reliance on institutional control" (citing NUREG/CR-2241, dated January 1982).

The 100-year limit for reliance on active institutional controls emerged, in part, as a consensus position from a series of public workshops on low-level radioactive waste disposal held by NRC in the government can survive [that determines the institutional control period], but how long should they be expected to provide custodial care." The Commission went on to note that "a clear consensus was developed which supported the 100 year limit. The Commission has not seen any compelling reason to change its view on the 100 year limit." (Supplementary Information for Part 61 Final Rule, 47 FR 57,446 dated December 27, 1982.)

EPA appears to have consistently used a 100 year limit on active institutional controls in all standard-setting for radioactive waste disposal. EPA's approach for non-radioactive wastes, however, has differed somewhat with respect to reliance on long-term institutional controls to protect members of the public and the environment. In the hazardous waste program, for example, EPA generally requires the operator of a hazardous waste disposal facility to control and maintain the facility for 30 years following closure (i.e., the post-closure care period). At the conclusion of this period, EPA's standards allow some reliance on continuing institutional controls through permanent deed restrictions. EPA's current guidelines for land disposal of solid wastes (as compared to hazardous wastes) in 40 CFR Part 241 do not address institutional controls. EPA has not addressed the potential for inadvertent human intrusion into hazardous or solid waste after closure. However, control over the disposal facility may be reimposed at a later date under the Comprehensive Environmental Response, Compensation, and Liability Act if the facility causes or threatens a release of hazardous constituents to the environment.

The NRC's repository regulations in 10 CFR Part 60 do not contain an explicit limit on the duration of active institutional control. However, the provision (in Section 60.52) for termination of a repository license indicates that long-term reliance on active institutional controls is not anticipated.

2) How does the approach that EPA has taken to human intrusion in its high-level waste standard compare with the approach and/or assumptions employed in other regulatory programs where the potential for human intrusion is a consideration?

The following table illustrates the treatment of human intrusion in regulating disposal of several types of wastes.

Waste	Toxic Life	Institutional Control Period	Intrusion Concern
LLW	Variable; 500+ yr[1]	No More than 100 yr	Intruder Dose (500 mrem)[2]
Mill Tailings	1,000+ yr	In Perpetuity[3]	Not Addressed
HLW	10,000+ yr	100 yr plus Passive Controls	Higher Releases
Hazardous Waste	Variable; Forever[4]	30 yr plus Deed Restrictions	Not Addressed
Solid Waste	Variable; 300+ yr	Not Addressed	Not Addressed

[1]Duration of hazard depends upon radionuclide inventory and concentrations. LLW may be disposed of under 10 CFR Parts 20 and 61. Wastes disposed under 10 CFR Part 20 may decay to background radiation levels within a few years of disposal. Although 10 CFR Part 61 requires performance of intruder protection barriers for at least 500 years, there is no time limit imposed on long-term protection of humans and the environment. Some radionuclides within the waste have half-lives of 10,000 years or more.

[2]Waste concentration limits in 10 CFR Part 61 are based on limiting intruder exposures to no more than 500 mrem for a given set of scenarios.

[3]Perpetual custody of tailings disposal site transferred to the Department of Energy or State, unless the Commission determines otherwise, in accordance with Section 83 of the Atomic Energy Act, as amended; however, both NRC and EPA standards limit reliance on active maintenance in providing long-term control for mill tailings (e.g., radon emissions and long-term stability).

[4]Some hazardous wastes may decay into relatively non-toxic waste through natural processes (e.g., organic degradation); other wastes do not diminish in terms of their toxicity or environmental hazard (e.g., heavy metal wastes).

3) Please provide a comparative table setting forth the annual individual risks associated with [NRC and EPA standards].

Standard	Limit	Annual Ind. Risk[1]
10 CFR 20 (Workers)	5 rem/yr (0.05 Sv/yr)	2E-3[2]
Indoor radon	4 pCi/l (0.1 Bq/l)	4E-4
Background radiation	300 mrem/yr (3 mSv/yr)	2E-4
40 CFR 192 (Mill Tails)	20 pCi/m^2s (0.7 Bq/m^2s) 5 pCi ^{226}Ra/g (0.2 Bq/g)	1E-6 3E-4
10 CFR 20 (Public)	100 mrem/yr (1 mSv/yr)	5E-5[3]
10 CFR 61 (LLW)	25 mrem/yr (0.25 mSv/yr)	1E-5[3]
40 CFR 190 (Uranium fuel cycle)	25 mrem/yr (0.25 mSv/yr)	1E-5
40 CFR 191.03 (Repository Operations)	25 mrem/yr (0.25 mSv/yr)	1E-5
40 CFR 191.15 (HLW ind. prot. std.)	25 mrem/yr (0.25 mSv/yr)	1E-5
40 CFR 61 (NESHAPs)	10 mrem/yr (0.10 mSv/yr)	4E-6
40 CFR 191.16 (Groundwater prot. std.)	4 mrem/yr (0.04 mSv/yr)	2E-6
EPA GW Prot. Strategy	4 mrem/yr (0.04 mSv/yr)	2E-6

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[1]Assumes a risk of 5E-4 per rem (5E-2 per Sievert). With two exceptions, the risks in this table are those allowed for an assumed maximally exposed individual. The exceptions, the reactor safety goal and 40 CFR 191.13, are average risks experienced by the population potentially affected by the facility. Translation from average to maximum individual risks (or vice versa) is not possible without specific demographic information about the exposed population.

[2]Neglects consideration of ALARA radiation protection measures; actual doses are generally well below the dose limit.

[3]Neglects consideration of ALARA radiation protection measures; actual doses to members of the public from all pathways are generally far below the dose limit.

40 CFR 141 (Drinking Water)	4 mrem/yr (0.04 mSv/yr)[4]	2E-6[5]
	20 pCi ^{226}Ra/l (0.7 Bq/l)[6]	1E-6
	30 pCi U-nat/l (1 Bq/l)[6]	2E-6
	300 pCi ^{222}Rn/l (11 Bq/l)[6]	3E-6
Reactor Safety Goal	0.1 % increase	2E-6 to 5E-7[7]
40 CFR 191.13 (Containment reqmts.)	1,000 deaths/10,000 yr	4E-7[8]
40 CFR 300 (Superfund)	General[9]	1E-6 to 1E-8[10]
	5 pCi ^{226}Ra/g (0.2 Bq/g)[11]	3E-4

[4]Presently limited to 4 mrem/yr whole body or any critical organ for man-made radionuclides that emit beta and gamma; proposed amendment to 40 CFR Part 141 would convert the present limit into 4 mrem/yr effective dose equivalent.

[5]Based on 4 mrem/yr EDE.

[6]Proposed standard (56 FR 33050; July 18, 1991)

[7]An increase of 0.1% in the early fatality risk to an average individual within one mile of the plant site boundary would be a risk of 5E-7 per reactor-year. An increase of 0.1% in the risk of latent cancer fatality to the average individual within ten miles of the plant site boundary would be a risk of 2E-6 per reactor-year.

[8]The average individual risk for 40 CFR 191.13 is inversely proportional to the size of the population within which the allowed 1,000 deaths are assumed to occur. If a small rural community (population 1,000) were to exploit a contaminated aquifer for its drinking water source, the average annual risk would be 1E-4. Alternatively, if releases were diluted in a large river so that a downstream population of 10 million were affected, the average risk would be only 1E-8. The figure in the table (4E-7) assumes a population of 250,000, the approximate size of Las Vegas, NV. For gaseous release of carbon-14, rapid and extensive dilution would cause the entire world population to be affected with the resulting average individual risk being on the order of 1E-11.

[9]Depends upon exposure pathways, radionuclide, total inventory, and site characteristics.

[10]Only includes risk of fatality; could be further reduced by a factor of 2 to account for incidence risk.

[11]As applied at selected Superfund sites with ^{226}Ra contamination (e.g., Montclair, New Jersey; Denver, Colorado).

4) In commenting on EPA's Working Draft 3 high-level waste standard, the agency took the following position:

> "The NRC staff is concerned about EPA's ability to develop a defensible basis of support for its cumulative release standards using technical achievability considerations. . . . For this reason, the NRC staff urges EPA to derive its standards from an evaluation of the acceptability of various risk levels, including those previously determined to be acceptable for uranium fuel cycle facilities, and to consider adding a dose-based alternative to the cumulative release limits of the standards."

In analyzing the pending Energy legislation, the staff expressed the following view:

> "While recent NRC comments on working drafts of EPA standards have expressed concerns about deriving standards based on what is technically achievable, the result appears to be a workable standard. The NRC will continue to urge EPA to provide comparisons with other standards and risks so that the stringency of the standards can be evaluated on an objective basis. However, the apparent achievability of the release limits argues for their reinstatement."

On the surface, these two statements appear difficult to reconcile. Accordingly, I would appreciate further clarification from the staff. Specifically, is it the staff's view that the concerns that have been expressed over the apparent stringency of the EPA high-level waste standard would be addressed if EPA would simply provide us with a comparison of this standard to other environmental standards, or is the staff going beyond that and arguing that such a comparison would serve to demonstrate that EPA's high-level waste standard does not comport with these other standards and, accordingly, should be modified to bring it into line with such standards?

The fundamental principles of radiation protection require that radiological impacts be "as low as reasonably achievable" (ALARA), in addition to meeting an established dose limit. When EPA developed its HLW standards in the 1970s, EPA could have set a risk-based or dose standard, and supplemented that standard with an ALARA requirement to be implemented during licensing. Instead, EPA derived its standards from projections of the waste isolation capabilities of repositories and from the estimated costs of alternative engineered barriers within those repositories. Thus, EPA's HLW standards are an approximation of the level of impacts that would be ALARA for a specific repository. Once compliance with EPA's standards has been demonstrated, there is no need for an additional demonstration that impacts are ALARA.

EPA also compared the population impacts of its standards to the population impacts of unmined uranium ore, other nuclear fuel cycle facilities, natural background radiation levels, and fallout from nuclear weapons testing. However, individual risks were not estimated by EPA, so it was not clear how stringent or lax the EPA standard finally came out to be. As noted in the response to the previous question, the individual risk posed by a repository is strongly dependent on the amount of dilution that would occur prior to human contact with the released material. The NRC staff and others have long urged EPA to compare the subsequent risk levels to other extant standards. Some critics of EPA's standards have also argued that EPA's release standard could be too lax since it allows releases to occur over a short period of time, resulting in high individual exposures. To counter such criticism, EPA added individual protection dose limits to its standards, although those limits are applicable only for "undisturbed performance."

In the case of carbon-14, the discovery has been made that the achievability considerations upon which EPA based the standard covered only saturated sites with low gas phase releases. Some Yucca Mountain analyses now indicate that this unsaturated site could release carbon-14 in excess of or very close to the amount allowed by EPA's standard, demonstrating that the limit is not reasonably achievable. Current analysis indicates that the amount of carbon-14 released, even if it exceeds EPA's standard, would still be well within a reasonable dose limit such as the 10 mrem/yr (0.1 mSv/yr) limit of EPA's National Emission Standards for Hazardous Air Pollutants (NESHAPs). In other words, although the table of release limits in EPA's standard appears to be reasonably achievable for other nuclides, it is not reasonably achievable for carbon-14. In the NRC staff's October 23, 1991, comments to EPA, we recommended consideration of a dose-based alternative to the cumulative release limits of the standard. The staff believes that recommendation is consistent with our comments on the pending Energy legislation. We still urge EPA to provide comparisons with other standards and risks to provide an opportunity for public comment on the stringency and we do not reject the general achievability of the release limits subject, of course, to the consideration of a dose-based alternative such as for carbon-14.

5) What is the technical basis for the subsystem performance criteria set forth in 10 CFR 60.113? Specifically, how do each of these criteria individually, as well as the criteria taken together, relate to protection of the public health and safety? Can these criteria be related to an annual individual risk objective?

The technical basis for the subsystem performance criteria is premised on the "multi-barrier approach"--that barriers can be prescribed that act separately and enhance confidence that wastes will be isolated. In this way, the NRC sought to provide defense-in-depth, in which each of the major elements of the geologic repository had a prescribed minimum performance standard that collectively would assist in arriving at a decision that EPA's high-level waste standard would be met. An extensive analysis was published in 1983 (NUREG-0804) by the NRC to show that satisfying the three subsystem performance criteria would significantly improve confidence that the EPA performance criteria would be met. However, compliance with the subsystem objectives is not sufficient to ensure compliance with EPA's standards for overall system performance. Therefore, an independent demonstration of compliance with EPA's standards is still required, even if NRC's subsystem criteria have been met.

The level of individual risk posed by a release from a repository will be directly proportional to the concentration of released material entering the environment and, therefore, to the rate of release of material from the engineered barrier system. Thus, the lower the release rate from the engineered barrier system, the lower the individual risk in the environment. The waste package containment and groundwater travel time objectives also substantially reduce the level of individual risk during the first several hundred years when high-level wastes are most hazardous. As noted in Footnote 7 of the response to Question 3, the actual level of individual risk associated with a release depends upon the amount of dilution of the release before it reaches an individual. Therefore, the level of risk will be highly site-specific, and it is not possible to relate the subsystem performance objectives to individual risk generically.