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U. S. NUCLEAR REGULATORY COMMISSION (NRC) DEFINITION OF "ENGINEERED BARRIER" (WMPO ACTION ITEM #86-714)

Enclosed is a presentation made by the NRC at the Waste Package workshop in Columbus, Ohio, that occurred on January 22-24, 1986. The thing that I am concerned about is the focus of the term "engineered barrier" to only those parts that man has control of manufacturing. In the context of a repository, this is absolute nonsense. This position implies that man is incapable of using the rock as it exists in his designs to accomplish a specific objective.

This point became obvious when one considers the engineering of openings in the rock for a repository. If the NRC's logic holds, all I need to consider is the property of the open space; the properties of the rock surrounding the open space need not be considered. We believe that there is a fundamental flaw in the NRC's logic as to the consistency of how to treat the rock as part of an engineered system.

I also believe that our baseline position on the "engineered barrier" is at odds with the NRC position. What do we plan to do about this situation?

Original Signed By
Donald L. Vieth

Donald L. Vieth, Director
Waste Management Project Office

WMPO:DLV-686

Enclosure:
NRC Presentation/Engineered Barriers

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WM Project 11
Docket No.
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NRC Presentation 1/24/85

Enclosure

DOE/NRC SALT WASTE PACKAGE WORKSHOP
January 22-24, 1985
Columbus, Ohio

NRC/WMEG/JCV/01/24/85

WASTE PACKAGE RELIABILITY ANALYSIS

- DOE COMMENTS ON DRAFT GENERIC TECHNICAL POSITION

  R. Stein (DOE) letter to R.W. Browning (NRC) dated February 26, 1985.

- FINAL GENERIC TECHNICAL POSITION ISSUED

  H.J. Miller (NRC) memorandum for J.M. Felton (NRC) on "Federal Register Notice Regarding Availability of Technical Position" [on Waste Package Reliability Analysis] dated December 23, 1985.

- NOTICE OF AVAILABILITY

  "Availability of Final Generic Technical Position in High-Level Waste Program," Federal Register, Vol. 51, No. 3, Monday, January 6, 1986, pp. 460-461.

The Department of Energy's comments have generally been incorporated into the Final Generic Technical Position. However, a significant number of internal NRC comments (Office of Nuclear Regulatory Research) were also incorporated into the Generic Technical Position before it was issued. The Department should review the final document.

SUBSTANTIALLY COMPLETE CONTAINMENT DEFINITION

NRC Staff Report [Meeting Presentation]	E.A. Wick, "How Reliable Does The Waste Package Have To Be?," Proceedings of the Workshop on the Source Term for Radionuclide Migration From High-Level Waste or Spent Nuclear Fuel Under Realistic Repository Conditions, Albequerque, NM, November 13-15, 1984 (Published July 1985).
BNL Letter Report	T.M. Sullivan, Estimates of the Maximum Permissible Fractional Number of High Level Waste Container Failures and Failure Rates That Allow Post Containment Radionuclide Release Criteria to be Met During the Containment Period, Brookhaven National Laboratory Informal Report, October 1985. [Transmitted by T. Sullivan (BNL) letter to E.A. Wick (NRC) dated October 16, 1985.]

These documents assume that it is permissible to release the same amount of radioactivity in the containment period as in the post contaiment period. The Brookhaven calculations were performed on a nuclide specific basis. The calculations indicate that isotopes of americium, carbon, cesium, plutonium, selenium, strontium and technetium are limiting radionuclides during the containment period. Results indicate that only a relatively small number of container failures are acceptable during the containment period.

INDIVIDUAL RADIONUCLIDE RELEASE DATA FOR LICENSING

- The rule exempts certain radionuclides:

  "This requirement [10 CFR 60.113(a)(1)(A)] does not apply to any radionuclide which is release at a rate less than 0.1% of the calculated total release rate limit."

- The EPA Containment Requirements:

  "Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation, based upon performance assessments, that the cumulative release of radionuclides to the accessible environment for 10,000 years after disposal from all significant processes and events that may affect the disposal system shall:

  (1) have a likelihood of less than one chance in 10 of exceeding the quantities calculated according to Table 1 (Appendix A); and

  (2) have a likelihood of less than one chance in 1,000 of exceeding ten times the quantities calculated according to Table 1 (Appendix A)

  40 CFR 191.13

- The EPA Ground Water Protection Requirements:

  "Disposal systems for spent nuclear fuel or high-level or transuranic radioactive wastes shall be designed to provide a reasonable expectation that, for 1,000 years after disposal, undisturbed performance of the disposal system shall not cause the radionuclide concentrations averaged over any year in water withdrawn form any portion of a special source of ground water to exceed:

  (1) 5 picocuries per liter of radium-226 and radium-228;

  (2) 15 picocuries per liter of alpha-emitting radionuclides (including radium-226 and radium-228 but excluding radon); or

  (3) the combined concentrations of radionuclides that emit either beta or gamma radiation that would produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem per year if an individual consumed 2 liters per day of drinking water from such a source of ground water.

APPENDIX A - TABLE FOR SUBPART B

TABLE 1 - RELEASE LIMITS FOR CONTAINMENT REQUIREMENTS (Cumulative Releases to the Accessible Environment for 10,000 Years After Disposal)

Radionuclide	Release Limit per 1000 MTHM or other unit of waste (see Notes) (curies)
Americium-241 or -243	100
Carbon-14	100
Cesium-135 or -137	1000
Iodine-129	1
Neptunium-237	100
Plutonium-238, -239, -240, or -242	100
Radium-226	100
Strontium-90	1000
Technetium-99	10000
Thorium-230 or -232	10
Tin-126	1000
Uranium-233, -234, -235, -236, or -238	100
Any other alpha-emitting radionuclide with a half-life greater than 20 years	100
Any other radionuclide with a half-life greater than 20 years that does not emit alpha particles	1000

ENGINEERED BARRIER SYSTEM BOUNDARY DEFINITION

The rule, 10 CFR 60.113(a)(1)(B), states:

> "The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000..."

In order to clarify the intent of this portion of the rule, one must describe the physical location where the release rate is to be evaluated. The rule, 10 CFR 60.2, defines both the engineered barrier system and the underground facility:

> "...'Engineered Barrier System' means the waste package and underground facility."
>
> "'Underground Facility' means the underground structure, including openings and backfill materials, but excluding shafts, boreholes, and their seals."

This definition of the engineered barrier system is in keeping with the Nuclear Waste Policy Act of 1982 (Public Law 97-425 - January 7, 1983), which states:

> "The term 'engineered barriers' means manmade components of a disposal system designed to prevent the release of radionuclides into the geologic medium involved. Such term includes the high-level radioactive waste form, high-level radioactive waste canisters, and other materials placed over and around such cannisters."

It is the position of the NRC staff that this defines the engineered barrier system boundary as the limit of excavation in the underground facility. Performance assessments for the engineered barrier system should consider any materials (e.g., backfill) or voids within the underground facility. Performance assessments should <u>not</u> consider shaft seals, effects of the disturbed zone, or any engineered treatment of the disturbed zone except as they may affect input parameters that effect the engineered barrier system.

APPLICATION OF 10 CFR PART 61 METHODOLOGY TO HIGH LEVEL WASTE

Reference: "Staff Evaluation Report related to the Topical Report covering the FL-50/EA-50 High Integrity Container manufactured by Nuclear Packaging, Inc. (Docket No. WM-45)," U.S. Nuclear Regulatory Commission Report, October 1985.

Because of the 300 year period involved, the 10 CFR Part 60 and 10 CFR Part 61 criteria appear similar:

> "Containment of HLW within the waste packages will be substantially complete for a period . . . not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository."
>
> 10 CFR Part 60.113(a)(1)(A)

> "The high integrity container design should have as a design goal a minimum lifetime of 300 years. The high integrity container should be designed to maintain its structural integrity over this period."
>
> Section C.4.b.
> Final Technical Position on Waste Form
> Rev. 0, U.S.NRC, May 1983.

> "To the extent practical Class B and C waste forms should maintain gross physical properties and identity over a 300 year period."
>
> Section B. Background
> Final Technical Position on Waste Form
> Rev. 0, USNRC, May 1983.

Conclusions:

1. The 10 CFR 60 and 10 CFR 61 criteria are significantly different. That is, 10 CFR 60 requires substantially complete containment (essentially no leaks) where staff's interpretation of 10 CFR 61 suggests structural integrity, gross physical properties and identity be maintained (leaks are permitted) over the 300 year period.

2. Although similarities are expected between the methodology used in the FL-50 High Integrity Container Report (to extrapolate data over long periods of time) and the methodology to be used in a 10 CFR 60 application, differences between the 10 CFR 60 and 10 CFR 61 criteria are also expected to have a significant impact on the rigor with which the methodology is applied.

2.2 ENGINEERED BARRIERS
Postclosure

Subparts are: 2.2.1 WASTE PACKAGE
2.2.2 REPOSITORY ENGINEERED BARRIERS
2.2.3 SHAFT AND BOREHOLE SEALS

DEFINITION:

Any material or structure that prevents or substantially delays movement of fluids or radionuclides. This material or structure will generally be engineered, but may include a portion of the host rock. | Revision 1

FUNCTIONAL REQUIREMENTS:

1. To control the release of radionuclides into the geologic setting.

PERFORMANCE CRITERIA:

1. a. Assuming anticipated processes and events, the release rate of any radionuclide from the engineered barrier system, excluding shaft and borehole seals, following the containment period shall not exceed 1 part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure or such other fraction of the inventory as may be approved or specified by the Commission; provided, that this requirement does not apply to any radionuclide which is released at a rate less than 0.1 percent of the calculated total release rate limit. The calculated total release rate limit shall be taken to be one part in 100,000 per year of the inventory of radioactive waste, originally emplaced in the underground facility, that remains after 1,000 years of radioactive decay (10 CFR 60.113(a)(1)(ii)(B)).

   b. Shaft boreholes and their seals shall be designed to ensure that release of radioactive materials to the accessible environment following permanent closure conforms to such generally applicable environmental standards for radioactivity as may have been established by the EPA with respect to both anticipated processes and events and unanticipated processes and events (10 CFR 60.112).

CONSTRAINTS:

A. The engineered barrier system must be designed such that other components of the repository such as shafts and drifts do not eventually become ground-water flow paths and do not promote the release of radionuclides to the accessible environment.

2.2 ENGINEERED BARRIERS (continued)

B. Where the host rock is incorporated into the definition of engineered barrier system for purposes of meeting the release rate criterion, it will be necessary to demonstrate the ability to characterize the host rock under anticipated conditions and to predict performance over the period of performance (10,000 years) in order to support a finding of reasonable assurance of compliance by the NRC. This may necessitate inclusion of coupled effects testing in the Site Characterization Plan and the Exploratory Shaft Test Plan. | Revision 1