UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

October 30, 1981

Dear Sirs:

The proposed low-level waste management regulation, 10 CFR 61, includes a waste classification system which defines, based on radionuclide concentrations, the requirements for wastes buried in near-surface disposal facilities. In order to provide to waste generators and vendors guidance on acceptable forms for stabilized wastes, the Nuclear Regulatory Commission (NRC) staff has prepared a draft Branch Technical Position (BTP) on waste form. This draft BTP provides guidance on how the staff would evaluate the acceptability of solidified wastes, high integrity containers, and spent organic ion-exchange resins.

Prior to issuing this BTP, we are requesting comment from those who would have to apply this guidance. We would, therefore, appreciate your review and comment on this draft prior to November 30, 1981.

The guidance for solidified products includes specific test methods and criteria on waste form stability acceptable to the NRC staff. A specific criterion for leachability, however, has not been included. The NRC staff with the technical assistance of Brookhaven National Laboratory is currently evaluating the need and basis for including a minimum acceptable leach rate. These evaluations are scheduled for completion in April 1982. Comments will also be requested on any proposed leach rate criteria prior to including such criteria in the BTP.

The high integrity container design guidance is essentially identical to the draft guidance dated February 25, 1981, which the NRC has made available previously.

The NRC staff is also interested in receiving suggestions in other areas where additional waste form guidance to waste generators would be useful. These suggestions will be considered in preparing this BTP as well as others which may be issued later.

If you have any questions regarding this BTR, please contact either myself at (301) 427-4200 or Mr. Timothy C. Johnson at (301) 427-4160.

Sincerely,

R E Browning

Robert E. Browning, Deputy Director
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Enclosure: Draft BTP

Technical Position Waste Form

A. Introduction

The proposed rule, "Licensing Requirements for Land Disposal of Radioactive Waste," 10 CFR 61, establishes a waste classification system based on the radioisotopic concentrations in the wastes. Class B and C wastes are required to be stabilized. Class A wastes have lower concentrations, are segregated, and do not require stabilization. Structural stability is intended to assure that the waste does not degrade and promote slumping, collapse, or other failure of the cap or cover over the disposal trench and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder since it provides greater assurance that the waste form will be recognizable and nondispersable during its hazardous lifetime. Structural stability of a waste form can be provided by the waste form itself (as with activated stainless steel components), by processing the waste to a stable form (e.g., solidification), or by emplacing the waste in a container or structure that provides stability (e.g., high integrity container).

This technical position on waste form has been developed to provide guidance to waste generators on test methods and criteria for waste forms acceptable to the NRC staff for implementing the 10 CFR 61 waste classification system. This position includes guidance on the processing of wastes into an acceptable, stable waste form and for the design of acceptable high integrity containers.

This technical position applies to all waste generators who solidify wastes or use high integrity containers in order to meet the Class B and C stability requirements in the 10 CFR 61 waste classification system. It is the intent of the NRC staff to add other guidance on waste form in additional technical positions as necessary.

B. Background

Historically, waste form and container considerations were considered of secondary importance to good site selection; the combination of a properly operated site having good geology and hydrology characteristics

were considered the only barriers necessary to isolate low-level radioactive wastes from the environment. Experience in operating low-level waste disposal sites indicates the waste form/container should play a major role in the overall plan of environmental containment.

The proposed rule for near-surface disposal of radioactive wastes, 10 CFR 61, includes requirements which must be met by a waste form to be acceptable for near-surface disposal. The proposed rule includes a waste classification system which divides waste into three general classes: A, B, and C. Certain minimum requirements must be met by all waste deemed disposable by near-surface burial. These minimum requirements involve basic packaging criteria and prohibitions against the disposal of explosive, toxic, or infectious materials.

In addition to the minimum requirements, Class B and C wastes are required to have stability. As defined in the proposed rule, structural stability requires that the waste form maintain its physical dimensions within five percent and its form for at least 150 years under the expected disposal conditions. Structural stability is necessary to prevent slumping, collapse, or other failure that could result if the waste were degraded, which could lead to water infiltration and radionuclide migration. Stability is also considered in the intruder pathways where it is assumed that after the active control period wastes are recognizable and, therefore, inadvertent intrusion is unlikely.

In order to assure that the waste will maintain its stability, the following conditions need to be met:

a. The waste should be a solid form or in a container or structure that provides stability after disposal.

b. The waste should not contain free liquids. That is, the wastes should contain only trace amounts of drainable liquid, and in no case should the volume of free liquid exceed one percent of the waste volume.

c. The waste should be resistant to degradation caused by radiation effects.

d. The waste should be resistant to biodegradation.

e. The waste should remain stable under a constant compressive

load of 50 psi.

f. The waste should remain stable if exposed to moisture or water after disposal.

A large portion of the waste produced in the nuclear industry is in a form which is either liquid or readily dispersible (e.g., small particles such as resins, filter sludge, etc.) and requires processing to achieve an acceptable solid, monolithic form for burial. In order to assure that the solidification process will consistently produce a product which is acceptable for disposal, a process control program should be used. General requirements for a process control program are provided in the NRC Standard Review Plan 11.4, "Solid Waste Management Systems," (NUREG-0800) and its accompanying Branch Technical Position ETSB 11-3, "Design Guidance for Solid Waste Management Systems Installed in Light-Water-Cooled Nuclear Power Reactor Plants," These documents should also be used as the basis for individual solidification process control programs by other fuel-cycle and by non-fuel-cycle waste generators who would solidify wastes to meet the Class B and C stability requirements. The stability requirements in this technical position should be the basis for qualifying process control programs.

An alternative to processing some waste streams, particularly ion exchange resins and filter sludges, is the use of a high integrity container. The high integrity container would be used to provide the long-term stability required to meet the stability requirements in 10 CFR 61. The design of the high integrity container should be based on its specific intended use in order to assure that the waste contents, as well as interim storage and ultimate disposal environments, will not compromise its integrity over the long-term.

C. Regulatory Position

1. Stability Requirements for Processed (i.e., Solidified) Wastes

a. Waste forms should have compressive strengths of at least 50 psi when tested in accordance with ASTM C39.

b. The waste forms should be exposed to a radiation field equivalent to the maximum level of exposure expected from the proposed wastes to be solidified. Waste forms should be exposed to a minimum of 10^8 Rads. The irradiated product should have a minimum compressive strength of 50 psi.

c. Wastes should be resistant to biodegradation as tested in accordance with ASTM G21 and ASTM G22. No indication of culture growth should be visible.

d. Leach testing should be performed for a minimum of 90 days in accordance with ANS 16.1. Specimen sizes should be consistent with the samples prepared for the compressive strength tests. A minimum of three specimens should be tested for each leachant used. In addition to the demineralized water specified in ANS 16.1, the additional leachants specified in ANS 16.1 should also be tested. After the five day test duration specified in ANS 16.1, sampling and leachant replacement should be performed daily for a total period of fourteen days and weekly thereafter.

e. Waste samples should mantain a compressive strength of a minimum of 50 psi following immersion for a minimum period of 90 days. Immersion testing may be performed in conjunction with the leach testing.

f. Wastes should be resistant to thermal degradation. Waste specimens should maintain a minimum compressive strength of 50 psi following thermal testing in accordance with ASTM B~~355~~ 553.

g. Waste products should have less than one percent free liquids as measured using the method specified in ANS 55.1. Free liquids should have a ph between 4 and 11.

h. If small laboratory size specimens are used for the above testing, test data from sections or cores of the largest anticipated full-scale waste products should be obtained to correlate the characteristics of actual size products with those of laboratory size specimens.

i. Waste specimens from full-scale waste forms should be destructively analyzed to assure that the product produced is homogeneous to the extent that all regions in the product have an acceptable compressive strength of at least 50 psi.

2. Radiation Stability of Organic Ion-Exchange Resins

In order to assure that organic ion exchange resins will not produce adverse radiation degradation effects, resins should not be loaded to bulk specific activities greater than 10 ci/ft^3 (This loading is equivalent to an accumulated dose of 10^8 Rads for Cs^{137} and Sr^{90}). In the

event that the waste generator considers it necessary to load resins higher than 10 ci/ft^3, it should be demonstrated that the specific resin will not undergo radiation degradation at the proposed higher loading. The test method should adequately simulate the chemical and radiologic conditions expected.

3. High Integrity Container Design Criteria

a. High integrity containers should be designed with a minimum lifetime of 300 years to provide 10 half-lives of decay for Cs-137 and Sr-90.

b. The high integrity container design should consider the corrosive effects of both the waste contents and the burial ground environment.

c. The high integrity container should be designed to have sufficient mechanical strength to withstand a load placed directly on the top surface of the container equivalent to 35 feet of material having a density of 120 lbs/ft^3.

d. The high integrity container should be designed to withstand the routine loads from disposal site operations, such as trench compaction procedures.

e. For polymeric materials, design mechanical strengths should be extrapolated from creep test data.

f. The design should consider the thermal loads from processing, storage, transportation, and burial.

g. The high integrity container design should consider the radiation stability of the proposed container materials as well as the radiation degradation effects of the wastes.

h. The high integrity container design should consider the biodegradation properties of the container material and any biodegradation effects of the wastes.

i. The high integrity container should be capable of meeting the requirements for a Type A package as specified in 49 CFR 173.398(b). The free drop test may be performed in accordance with 10 CFR 71 Appendix A.

j. The high integrity container and the associated lifting devices should be designed to withstand the forces applied during lifting operations. As a minimum the container should be designed to withstand a 3g vertical lifting load.

k. The container should avoid the collection or retention of water on its top surfaces.

D. Implementation

This technical position reflects the current NRC staff position on acceptable means for meeting the disposal site stability requirements for processed wastes and for containers which would provide structural stability. Therefore, except in those cases in which the waste generator proposes an acceptable alternative method for complying with the stability requirements of 10 CFR 61, the criteria described herein will be used in the evaluation of waste forms acceptable for disposal at near-surface disposal facilities.