Enclosure 2

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MEMORANDUM FOR: John T. Greeves, Chief
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FROM: Timothy C. Johnson, Section Leader
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SUBJECT: ASTM MEETING TRIP REPORT

Enclosed is my trip report for the American Society for Testing and Materials (ASTM) Subcommittee C26.07 meetings in New Orleans. On January 14, 1986, a seminar was held on long-term predictive testing of high-level waste packages. On January 15, 1986, I attended a meeting of the Low-Level and TRU Waste Task Group.

If you have any questions, please contact me at x74088.

ORIGINAL SIGNED BY

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ASTM C26.07 SUBCOMMITTEE MEETING REPORT

DATE: January 14-15, 1986

LOCATION: New Orleans, LA

PURPOSE: The purpose of this meeting was to discuss ASTM involvement in the long-term predictive testing of high-level waste packages and to discuss ASTM activities in the low-level waste areas.

PARTICIPANTS:

E. Kuhn, Stone & Webster
R. Blauvelt, MOUND
P. Salter, BWIP
N. Abraham, DOE-HQ
D.McCright, NNWSI
S. Gorpal, ONWI
K. Kim, NRC/RES
H. Bauer, CRP
(approximately 20 others)

DISCUSSION:

A seminar on predictive testing for high-level waste packages was held on January 14, 1986. The ASTM Task Group proposed to prepare a general guideline on predictive testing which would set out basic principals to build confidence in the extrapolation of short-term test data over 1000 to 10,000 year periods. After a general discussion by E. Kuhn, the Task Group Chairman, presentations were made by myself, and P. Salter, D. McCright, S. Gorpal and H. Bauer representing the four HLW projects.

My presentation discussed the basic principles NRC was expecting in extrapolation programs:

1. conservative test data
2. fundamental understanding of degradation mechanisms
3. confirmatory in-situ testing program

A discussion paper on predictive testing (Enclosure 1) was prepared by Materials Section Staff and given to attendees. I voiced support of the ASTM proposal because it offered a forum for developing a wide consensus. Concensus standards also have high credibility before licensing boards.

The discussion by S. Gorpal centered on the use of peer review to justify and document key decisions. It appears that the ONWI-SALT approach is to base predictions on peer panel member preferred models. There was no discussion of the basic principals in the NRC approach.

D. McCright only presented the results of some of his testing programs. This was a recapitulation of data presented at the NNWSI Waste Package Workshop. There was no attempt made to outline the NNWSI approach to extrapolating short-term test data.

Surprisingly, P. Salter was very cool to the idea of ASTM involvement in the development of a predictive testing guideline. It appears that BWIP views the ASTM proposal as a distraction from completing the work currently underway. While N. Abraham from DOE-HQ only said a decision on DOE participation had not been made, it appeared that P. Salter was candidly expressing the sentiment of the entire DOE organization. Obviously, without the DOE support, the ASTM proposal is unlikely to be fully successful.

Because the crystalline repository program is in its infancy, H. Bauer did not address predictive testing philosophy for the CRPO, but did present a schedule for waste package design development:

- initiate program planning	10/1/86
- initiate design planning	07/1/87
- initiate test plan development	10/1/87
- initiate field studies for data acquisition	01/1/88
- borehole data available	06/30/89
- initiate test material/equipment procurement	04/1/89
- initiate waste package testing	10/1/89

On January 15, 1986, I attended the C26.07 Low-Level and TRU Waste Task Group meeting. An agenda for the meeting is in Enclosure 2.

The Task Group is preparing a draft leach testing procedure. This will be a modified ANS 16.1 procedure and is intended to address radioactive, mixed and hazardous wastes. The major difference between the ASTM and ANS procedure is that the ASTM is a 5 day test and the ANS is a 90 day test. I indicated that I preferred a 90 day test in order to have better confidence that the leaching mechanism would remain unchanged over time. The ASTM and ANS procedures assume diffusion is the release mechanism. Some leach test data, however, indicate possible mechanism shifts. These shifts would not be observed in 5 days but would be more likely to be observed at 90 days. The draft standard is scheduled to be presented at the July 1986 meeting.

A discussion of mixed wastes indicated that there were no ASTM standards developed in this area. The meeting participants agreed that this area is one which should be addressed. However, no specific recommendations were made. In this discussion it was stated that scintillation fluids with non-hazard components were less effective and it was more difficult to homogenize samples than with toluene and xylene based fluids.

The Task Group was attempting to produce a standard procedure for performing a radiation survey of waste packages. This concern arose due to disposal site violations at several facilities where waste generators and disposal site inspectors used different procedures for making the required surveys. The development of this procedures would utilize the work done in ANSI N13.1.2 developed by the Health Physics Society.

Gas generation calculations are required to meet transportation requirements. The Task Group proposed to standardize a calculational technique used by GPU Nuclear. The DOE representatives noted that many actual gas measurements have been made by DOE and that it has been difficult to correlate these measurements with calculational techniques. They attributed this problem to the nature of DOE wastes and the high TRU content. They were, therefore, pessimistic that a standard approach could be developed for these TRU wastes.

The Task Group discussed free liquid testing noting that EPA has a paint filter liquids test and some DOE facilities are using expensive real time radiography units. There was no interest in pursuing this further because the adequacy of these methods has not been determined nor would it be applicable to all container sizes.

C. Domeck of Toledo Edison had been assigned to review the test methods in the Technical Position on Waste Form (TP) to determine the need for radwaste specific tests. No progress, however, had been made. I indicated a need to review this and develop testing procedures directly relevant to radwastes.

The Task Group reported on the status of the MCC-1 static leach test. There were some negative votes in the ASTM balloting which will require resolution and revote. It appears the negative ballots are not due to substantive technical issues.

In other business, it was noted that California was negotiating with U.S. Ecology to operate their LLW site. CNSI had been offered the position but had rejected it because the State would not commit to doing all it could to ensure that a site would be developed. CNSI did not desire to make a substantial financial commitment if the State was not serious in its intent. This occurred after legal action by CNSI to reject the second request for bids from California.

<u>AGREEMENTS AND COMMITMENTS:</u> NA

High-Level Waste Package Licensing Considerations for The Development of Standard Predictive Test Methods

A. Introduction

Programs intended to develop standard test methods to be used for gathering data to support the high-level radioactive waste repository program need to consider the licensing requirements and the technical issues involved with extrapolation of short-term test data to periods of up to 10,000 years. These notes discuss the licensing requirements promulgated by the Nuclear Regulatory Commission (NRC) and the issues the NRC considers important for the development of predictive testing methods.

B. Licensing Requirements

The NRC is charged by the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 and the Nuclear Waste Policy Act of 1982 (NWPA) to develop regulations and license the operation of high-level radioactive waste repositories. The NWPA also assigns the responsibility for development, construction and operation of the repository to the Department of Energy (DOE).

In 1983, NRC promulgated technical regulations for high-level waste repositories, 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories."

These regulations are based on a philosphy that a geologic repository controls the rate of radionuclide release to the accessible environment by means of two major subsystems: (1) the geologic setting; and (2) the engineered system. The geologic setting (site is selected for its geologic, hydrologic, and geochemical attributes that enhance radionuclide isolation.

In order to compensate for the uncertainty in predicting the behavior of geologic systems over long periods of time, the NRC and DOE have adopted a multi-barrier approach. In this approach the staff views the repository to be composed of three major barriers: (1) the waste package, (2) the engineered structure, and (3) the site and its environs. In general, this approach puts emphasis on: (1) engineered containment of radionuclides during the fission product pulse when the hazard is the greatest, and (2) assurance of a controlled release thereafter. This simplifies analysis and reduces uncertainties introduced into the analysis of the total system. During the period of engineered containment of the waste, the site geology should provide sufficient backup to account for those scenarios which may result in loss of engineered containment. Thereafter, the site geology should also have the capacity to retard the movement of the long-lived radionuclides to the accessible environment so that the EPA standard is not exceeded.

The 10 CFR Part 60 regulation includes specific criteria for waste packages and the engineered barrier system which are discussed below.

Post Closure Requirements (Part 60.113)

In Paragraph 60.113 of Subpart E - Technical Criteria, the performance objectives for waste packages (and the engineered barrier system in general) are presented. The NRC's two basic post-closure requirements are presented in this section. The first requirement has to do with "substantially complete containment" of HLW within the waste packages. The second performance objective has to do with the "one part in 100,000 per year" total release rate. Both of these requirements are explained below:

1. Substantially Complete Containment for 300-1000 Years

Paragraph 60.113(a)(1)(ii)(A) states the following:

"Containment of HLW within the waste packages will be substantially complete for a period to be determined by the Commission... provided that such period shall not be less than 300 years nor more than 1,000 years after permanent closure of the geologic repository."

The operative key words in the cited paragraph are "substantially complete." At this time the NRC has not provided a quantitative definition of substantially complete containment. NRC staff would, however, look favorably on either or both of the following two approaches if DOE chose to pursue them:

(a) Utilize very conservative designs for which essentially no leakage is expected during the containment period. The more conservative the design, the easier is the task of providing reasonable assurance that containment will be achieved;

(b) Demonstrate that during the 300-1000 year containment period the radionuclide release rate from the waste packages (on a radionuclide-specific basis) will not exceed the total number of curies allowed to be released per year in the post-containment period from the engineered barrier system. The number of curies which could be released per year is 10^{-5} of the inventory present at 1000 years after closure.

The NRC staff believes that the DOE is permitted needed flexibility in the design of the waste package. DOE can thus assign to each waste package component the design objectives needed to meet the performance objectives for the waste package. For example, with regard to the retardation of groundwater penetration of the waste package and release and concomitant migration of radionuclides outward through the various waste package components, DOE has the option of assigning (assuming the availability of adequate supporting data) time periods for the delay of flow through the packing, penetration of the container, leaching of the waste form, and so on. Thus, the 300 to 1000 year containment requirement may be satisfied through a series of sequential time steps associated with a specific package component function. In addition, a reliability analysis could be used to demonstrate reasonable assurance by producing a probability distribution for the time of containment (and rate of release of radionuclides thereafter).

2. <u>One Part in 100,000 Release Criterion</u>

Paragraph 60.113(a)(1)(ii)(B) states the following:

The release rate of any radionuclide from the engineered barrier system (EBS) following the containment period shall not exceed one 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% 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 1000 years of radioactive decay. The above cited criterion allows radionuclides which have very low inventories to be exempt from the one part in 100,000 annual release rate limit.

<u>Criteria for the Waste Package and Its Components (Part 60.135)</u>

Part 60.135 contains the main body of design criteria for the waste package. The first portions of this section (Paragraphs 60.135(a)(1)

and 60.135(a)(2) provide general guidance concerning the need for the waste package to have chemical, physical and nuclear properties that do not compromise the function of the waste package. A list of required design considerations is also provided and includes the following: solubility, oxidation/reduction reactions, corrosion, hydriding, gas generation, thermal effects, mechanical strength, mechanical stress, radiolysis, radiation damage, radionuclide retardation, leaching, fire and explosion hazards, thermal loads and synergistic interactions.

Paragraph (b) of Part 60.135 contains the specific criteria for HLW package design. There are four basic categories of design criteria for the waste package: (1) Explosive, pyrophoric, and chemically reactive materials; (2) Free liquids; (3) Handling, and (4) Unique identification. The specified criteria are based upon engineering considerations that will contribute toward meeting the performance objectives for containment and controlled release.

Paragraph (c) of Part 60.135 deals with waste form criteria. There are three:

(1) Solidification. "All radioactive wastes (emplaced in the underground facility) shall be in solid form and placed in sealed containers."

(2) Consolidation. "Particulate waste shall be consolidated (for example, by incorporation into an encapsulated matrix) to limit the availability and generation of particulates."

(3) Combustibles. "All combustible radioactive wastes shall be reduced to a noncombustible form..."

As in the case for the waste package criteria, the design criteria for the waste form are intended to contribute toward meeting the performance objectives for the waste package and the EBS.

<u>Monitoring and Testing Waste Packages (Part 60.143)</u>

Subpart F - Performance Confirmation Program, addresses both geotechnical and waste package performance confirmation requirements. For the waste package it is intended that the monitoring program would continue up to the time of permanent closure of the repository. The waste package monitoring program is also intended to include laboratory experiments that focus on the internal condition of the packages. The laboratory experiments must, to the extent practical, duplicate the environmental conditions experienced by the waste packages within the underground facility.

Environmental Protection Agency (EPA) Regulations (40 CFR Part 191)

The EPA environmental standards for the management and disposal of spent nuclear fuel and high-level and transuranic wastes sets radiation exposure and release limits for a repository. Performance assessments used to show compliance with these requirements may result in more limiting waste package design requirements than the NRC performance objectives in 10 CFR Part 60.113. Testing programs, therefore, will need to consider the data needs to show compliance with EPA environmental standards.

C. Extrapolation of Short-Term Test Data

In order to provide a basis for extrapolating short-term test data to periods of 300 to 10,000 years, we consider that programs must be developed which include:

1. Short-term testing under conservative environmental conditions.

2. A firm understanding of the potential degradation mechanisms.

3. Appropriate performance confirmation testing at the repository for a period up to the time of permanent closure of the repository.

Natural analog studies, validation of models using natural analogs and peer review should also be used to develop confidence in extrapolations.

The short-term testing program would use conservative, accelerated test methods to obtain quantitative data on waste package degradation lifetime and leach rates. We expect that these tests will be performed under conservative test conditions which would bound the anticipated repository environment (temperature, Eh, pH, radiation, chemistry, etc). This test program should include tests of five to ten year duration. These tests should yield data which will provide degradation rates suitable for long-term extrapolation.

The short-term testing must be supported by a fundamental understanding of the potential degradation modes as they relate to the repository environment. For example, evaluations used to support findings that specific localized corrosion modes have minimal impact in a repository should include data showing that the fundamental mechanisms for these modes do not exist in the bounding environmental conditions assumed.

Confirmatory testing would demonstrate over a 30 to 50 year period the adequacy of the assumed bounding environmental conditions, models and waste package degradation rates. This would provide actual data supporting the short-term testing and evaluations.

We consider that the above program combined with conservative implementation of performance assessment models developed in conjunction with the above test data will result in a defensible approach for extrapolation of short-term test data.

D. Important Issues

There are several important issues which should be considered in the development of testing standards related to the high-level waste package and engineered barrier system (EBS). These issues include:

a. Definition of standard environmental test conditions.
b. Development of test methods oriented toward understanding the pertinent degradation mechanisms.
c. Development of accelerated test methods applicable to the materials used in waste package and EBS components.
d. Development and qualification of test methods and instrumentation for in-site confirmatory testing.
e. Reliability evaluations of standard test methods.
f. Appropriate duration of tests.

The resolution of the important issues should be specifically oriented toward the development of a data base which is directly applicable to meeting the regulatory requirements of 10 CFR Part 60.

OMMITTEE C-26
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ASTM C26.07
LOW LEVEL AND TRU WASTE TASK GROUP MEETING
NEW ORLEANS
JANUARY 15, 1986

A G E N D A

* INTRODUCTION
* LEACH MECHANISM TASK GROUP REPORT
* WASTE PACKAGE SURVEY
* GAS GENERATION TASK
* FREE LIQUID TESTING
* MIXED WASTE PROCEDURE
* 10 CFR 61 TBPP TASK GROUP REPORT
* NRC ACTIVITIES
* N 46 TASKS
* OTHER
* ADJOURN