



UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
[formerly National Bureau of Standards]
Gaithersburg, Maryland 20899

April 13, 1989

Mr. Charles Peterson
Technical Review Branch
Division of High-Level Waste Management
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Re: Monthly Letter Status Report for December 1988 (FIN-A-4171-7)

Dear Mr. Peterson:

Enclosed is the December 1988 monthly progress report for the project
"Evaluation and Compilation of DOE Waste Package Test Data"
(FIN-A-4171-7). The financial information is attached to this letter.

Sincerely,

Charles G. Interrante
Program Manager
Corrosion Group
Metallurgy Division

Enclosures

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Monthly Letter Report for December 1988

Published April 1989

(FIN-A-4171-7)

Performing Organization: National Institute for Standards and Technology (NIST)
Gaithersburg, MD 20899

Sponsor: Nuclear Regulatory Commission (NRC)
Office of Nuclear Materials Safety and Safeguards
Washington, DC 20555

TASK 1 -- REVIEW OF WASTE PACKAGE DATA BASE

STATUS OF DATABASE

	<u>Current Month</u>	<u>Previous Month</u>
Number of citations	1025	1020
Number of completed reviews	78	
Number of reviews in progress	15	

Status of Recently Listed Reviewable Documents

Reviewable documents are classified as follows: papers currently being reviewed (Category 1), review when time permits (Category 2) and file with cross reference(s) to related report(s) (Category 3).

NNWSI

- 7 NNWSI reports currently under review (Category 1).
- 19 NNWSI reports to review when time permits (Category 2).
- 0 NNWSI reports to file with cross reference(s) to other reports (Category 3).
- 4 NNWSI reports identified and not yet categorized.
- 12 NNWSI reports received and not yet categorized.

GLASS -- VITRIFIED WASTE FORM

- 2 Reports currently under review (Category 1).
- 4 Reports to review when time permits (Category 2).
- 0 Reports to file with cross reference(s) to other reports (Category 3).
- 0 Reports identified and not yet categorized.

Database searches for the month of December 1988 include the Compendex Plus and Engineered Materials Abstracts. Examples of the search conducted for each of these databases are in this report.

STATUS OF REVIEWS OF NNWSI REPORTS

NNWSI -- Reports recently identified for review

Preliminary container design considerations are discussed in [Gregg, 1983]. Engineering drawings with external dimensions for the containers that will hold defense high-level waste, commercial high level waste, and spent fuel, are shown.

A procedure for determining the amount of containment credit given to the cladding is described in Wilson, 1983. A discussion of the containment criteria, and mechanisms of radionuclide release set the limits for the test plan that will include modeling and laboratory tests.

Modeling of hydrothermal flow in tuff is described in Busheck, 1988. Heat distribution data resulting from this model are shown as a function of time, distance, and moisture content. Accurate data from the borehole tests is needed for improvement of the model.

The possible rapid transport of radioactive gases from nuclear waste containers into the environment is a serious concern, Knapp, 1987 describes a preliminary mathematical model that examines the transport properties of ^{14}C in a tuff environment. Indications are that diffusion and dispersion processes are not as important as advective processes [Knapp, 1987].

1. Gregg, D. W. and O'Neal, W. C., "Initial Specifications for Nuclear Waste Package External Dimensions and Materials," UCID-19926, September 1983.

2. Wilson, C. N., "Test Plan for Spent Fuel Cladding Containment Credit Tests," HEDL-TC-2353-2, November 1983.
3. Buscheck, T. A. and Nitao, J. J., "Preliminary Scoping Calculations of Hydrothermal Flow in Variably Saturated, Fractured, Welded Tuff During the Engineered Barrier Design Tests at the Yucca Mountain Exploratory Shaft Test Site," UCID-21571, November 1988.
4. Knapp, R. B., "An Approximate Calculation of Advective Gas Phase Transport of ^{14}C at Yucca Mountain, Nevada," UCRL-97805, December 1987.

NNWSI --

Category 1 -- Reports currently being reviewed

1. HEDL-TME 85-22, "Results from Cycles 1 and 2 of NNWSI Series 2 Spent Fuel Dissolution Tests," May 1987.
2. UCRL-21019, SAN-662,-027, "Recent Results from NNWSI Spent Fuel Leaching/Dissolution Tests," April 1987.
3. UCRL-21013, "Summary of Results from the Series 2 and Series 3 NNWSI Bare Fuel Dissolution Tests," November 1987.
4. UCRL-95961, "Copper Corrosion in Irradiated Environments. The Influence of H_2O_2 on the Electrochemistry of Copper Dissolution in HCl Electrolyte," December 1986.
5. UCID-20450, "Concept of Waste Package Environment Tests in the Yucca Mountain Exploratory Shaft," May 1985.
6. Ringas, C. and Robinson, F., "Corrosion of Stainless Steel by Sulfate-Reducing Bacteria - Total Immersion Test Results," NACE, Corrosion, Vol. 44(9), September 1988.
7. ANL-88-14, Abrajano, T. A., Bates, J. K., Gerding, T. J. and Ebert, W. L., "The Reaction of Glass During Gamma Irradiation in a Saturated Tuff Environment, Part 3: Long-Term Experiments at 1×10^4 rad/hr," February 1988.

Category 1 (continued) - Status of Reviews not yet sent to NRC and WERB

Document No.	Assigned to Reviewer	First Draft Completed	Lead Worker	Program Manager
HEDL-TME 85-22	<u>11/22/88</u>	_____	_____	_____
UCRL-21019	<u>12/06/88</u>	_____	_____	_____
UCRL-21013	<u>06/21/88</u>	_____	_____	_____
UCRL-95961	<u>07/14/88</u>	_____	_____	_____
UCID-20450	<u>11/14/88</u>	_____	_____	_____
ANL-88-14	<u>12/22/88</u>	_____	_____	_____
Ringas, 1988	<u>*</u>	_____	_____	_____

*Document to be reassigned.

Category 2 -- Review as time permits

1. UCRL-95962, "Hydrogen Speciation in Hydrated Layers on Nuclear Waste Glass," January 1987.
2. UCRL-94658, "Integrated Testing of the SRL-165 Glass Waste Form," December 1986.
3. UCRL-91258, "Leaching Savannah River Plant Nuclear Waste Glass in a Saturated Tuff Environment," November 1984.
4. ANL-84-81, "NNWSI Phase II Materials Interaction Test Procedures and Preliminary Results," January 1985.
5. HEDL-7540, "Technical Test Description of Activities to Determine the Potential for Spent Fuel Oxidation in a Tuff Repository," June 1985.
6. HEDL-SA-3627, "Predicting Spent Fuel Oxidation States in a Tuff Repository," April 1987.
7. UCRL-15976, SANL-522-006, "Microstructural Characteristics of PWR Spent Fuel Relative to its Leaching Behavior", April 1985.
8. UCRL-96702, "Geochemical Simulation of Reaction Between Spent Fuel Waste Form and J-13 Water at 25°C and 90°C," November 1987.
9. UCRL-53702, "Spent Fuel Test - Climax: An Evaluation of the Technical Feasibility of Geologic Storage of Spent Nuclear Fuel in Granite," March 1986.

10. UCID-21274, "Plan for Integrated Testing for NNWSI Non EQ3/6 Data Base Portion," May 1987.
11. UCRL-94721, "Leaching of Actinide-Doped Nuclear Waste Glass in a Tuff-Dominated System," UCRL-94721, January 1987.
12. UCRL-90044, "Waste Package for a Repository Located in Tuff," November 1983.
13. UCRL-89475, "Post Emplacement Environment of Waste Packages," November 1983.
14. WHC-EP-0107, "Measurement of the Oxidation of Spent Fuel Between 140° and 225°C by Thermogravimetric Analysis," September 1988.
15. UCRL-93735, "Estimates of Radionuclide Release from Glass Waste Forms in a Tuff Repository and the Effects on Regulatory Compliance," April 1986.
16. UCRL-15801, "NNWSI Waste Form Testing at Argonne National Laboratory," March 1986.
17. UCRL-94664, "Zeolitization of Glassy Topopah Spring Tuff Under Hydrothermal Conditions," December 1986.
18. UCID-21100, "Thermomechanical Calculations Pertaining to Experiments in the Yucca Mountain Exploratory Shaft," April 1987.
19. UCRL-89477, "The NNWSI Waste Form Testing Program," November 1983.

Category 3 -- File and cross reference

None this month.

OTHER REPORTS ON VITRIFIED WASTE FORM --

Category 1 -- Reports currently being reviewed

Chapter 4, "Dissolution of Specific Radionuclides," has been assigned and no draft has been received to date.

1. PNL-5157, "Final Report of the Defense High-Level Waste Leaching Mechanisms Program," August 1984.
2. DP-MS-87-157, "Prediction of Glass Durability as a Function of Glass Composition and Test Conditions: Thermodynamics and Kinetics", a paper proposed for Presentation at the Conference on Advances in the Fusion of Glass, Alfred, NY, June 14-17, 1988.

Status of Reviews not yet sent to NRC and WERB

Document No.	Assigned to Reviewer	First Draft Completed	Lead Worker	Program Manager
PNL-5157 Chapter 4	<u>6/20/88</u>	_____	_____	_____
DP-MS-87-157	_____	_____	<u>12/20/88</u>	_____

Category 2 -- Review as time permits

1. "Large Scale Leach Testing of DWPF Canister Sections," Proceedings of the Materials Research Society Symposium, "Scientific Basis for Nuclear Waste Management X," December 1986.
2. "Waste Glass Leaching: Chemistry and Kinetics," Proceedings of the Materials Research Society Symposium, "Scientific Basis for Nuclear Waste Management X," December 1986.
3. PNL-6353, "Comprehensive Data Base of High-Level Nuclear Waste Glasses: September 1987 Status Report: Volume 2, Additional Appendices," December 1987.
4. DOE/NE/44139--34, "Preliminary Results of Durability Testing with Borosilicate Glass Composition," January 1987.

Category 3 -- File and cross reference

None this month.

TASK 3 -- LABORATORY TESTING

- A. Title of Study: Evaluation of Methods for Detection of Stress Corrosion Crack Propagation in Fracture Mechanics Samples.
Principal Investigator: Charles Interrante

It is observed that the branch-crack formation in two specimens (ST2v and ST5v), which had Rockwell C hardness values equal to about 37 and 23, respectively, were attributable, at least in part, to the sharp v-shaped notches that they contained. The root radius of the 45-degree notch that was machined into the sides of these specimens was of the order of 0.007 inches. In earlier unpublished studies by R. Heady and C. Interrante it tentatively concluded that a larger radius of 0.025 was less likely to cause branch cracking, and the above observations of branch crack formation tend to support this conclusion. Thus, two other specimens (ST6v to ST11v) were sent to the shop to be remachined using a cutter with an 0.025-inch root radius.

Tasks to complete prior to the next test include (1) purchasing a replacement tank of hydrogen sulfide and (2) programming required for computations associated with the comparison of detected acoustic energy and strain energy released in the test. The successful test of specimen ST5v prompted selected changes in the program used for collection of data during the test. In addition, with the advent of a data file on specimen ST5v, which contained valid data, it now becomes desirable to create programs that are needed for analyses of the amount of energy and the crack extension that are associated with a single event of crack extension in this test specimen. After a fully successful test is conducted a plan will be made for any future tests of similar or other not so similar tests.

B. Title of Study: Effect of Resistivity and Transport on Corrosion of Waste Package Materials.

Principal Investigator: Edward Escalante

The improvement in control of the environment in the second series of experiments has resulted in data that is more reproducible. The results of oxygen transport measurements show that particle size is not as important as particle shape. For spherical particles, the ratio of pore volume to particle volume is constant and is independent of particle size. If large and small particles are mixed, then the relative pore volume decreases. Similarly, if the shapes of the particles allow tighter packing, then the relative pore volume is reduced. A smaller relative pore volume results in a decrease in the rate of oxygen transport. The effect of these factors is being examined in this second set of experiments, and the improved reproducibility of the data makes it easier to compare the data for sand of one size particles with that for another size.

C. Title of Study: Pitting Corrosion of Steel Used for Nuclear Waste Storage.

Principal Investigator: Anna C. Fraker

Studies of literature and additional data and specimen analysis in preparation for writing a paper continue. The report that was submitted to NRC earlier will be put in the form of an NIST Internal Report.

D. Title of Study: Corrosion Behavior of Zircaloy Nuclear Fuel Cladding.
Principal Investigator: Anna C. Fraker

The test that started on Nov. 28, 1988 was continued. This test involves exposing Zircaloy-2 to a 10-times concentration of J-13 water at 95°C and a pH of 8.25. Cyclic polarization measurements were made at a slower scan rate (0.1 mv/sec instead of 5 mv/sec) to investigate effects of scan rate on the hysteresis loop observed. No difference was observed as a result of the slower scan rate in this this test. This indicates that the pH of J-13 water or some of the ions in the solution may be responsible for the hysteresis and for a susceptibility to localized corrosion. The corrosion potential for the specimen at the time of this test was -0.150 V. Since the protection potential is more positive than the corrosion potential, pitting would not be expected to occur at the corrosion potential. This slower scan cyclic polarization test will be repeated with a different specimen. Slower scan

rates can provide a more accurate assessment of passivity. Results of the slower scan showed a breakdown potential of +0.700 V and a protection potential of -0.125 V.

The open circuit potentials (V vs. S.C.E.) for this specimen versus time are given in Table 1. These measurements will be repeated with specimens that have not been disturbed by cyclic polarization measurements. These data indicate that the Zircaloy-2 is passivating with increasing time. With time, the open-circuit potential became less negative. There was an increase in open-circuit potential on Dec. 5, and then the potential continued to move in the positive direction. This excursion could have been due to local attack or to experimental problems.

Table 1. Open-circuit potential for Zircaloy-2 in J-13 water at 95°C

<u>O. C. Pot. (V vs. SCE)</u>	<u>Time, hour and/or date</u>
- 0.573	Afternoon, 11/28/88
- 0.250	9:00 a.m., 11/29/88
- 0.438	6:20 p.m., 11/29/88
- 0.123	11:30 a.m., 11/30/88
- 0.151	12/2/88
- 0.321	12/5/88
- 0.236	12/7/88
- 0.201	12/12/88
- 0.195	12/20/88
- 0.172	12/21/88

It was noted on Dec. 21, 1988 that the specimen no longer had a good electrical connection, and the test was discontinued. Earlier measurements of the change in electrode potential with time showed a change from an initial potential of -0.362 V to +0.204 V after 24 hours at 21°C. Additional specimens will be prepared to monitor the potential versus time in J13 at 95°C and under other conditions.

SDIO08, UD 8811, SER. DD001

File(s) searched:

File 8:COMPENDEX PLUS - 70-88/NOV COPR. ENGINEERING INFO
INC. 1988)

Sets selected:

Set	Items	Description
1	1	WASTE()PACKAGE?
2	2	CANISTER?
3	250	CORROSION
4	46	LEACHING
5	352	GLASS
6	6	VITRIFICATION
7	640	CORROSION OR LEACHING OR GLASS OR VITRIFICATION
8	1783	METAL?
9	876	STEEL?
10	9	ZIRCALOY
11	173	TITANIUM
12	372	COPPER
13	2511	METAL? OR STEEL? OR ZIRCALOY OR TITANIUM OR COPPER
14	9	ZIRCALOY?
15	2511	S13-S14/OR
16	2	HIGH()LEVEL()WASTE?
17	27	RADIOACTIVE()WASTE?
18	7	NUCLEAR()WASTE?
19	0	(1OR2) AND (S7 AND S15) AND (S16 OR S17 OR S18)
20	0	(S1 OR S2) AND (S7 AND S15)
21	0	S20 AND (S16 OR S17 OR S18)
22	0	S21/1984-1988
23	0	S22/1986-1988
24	0	ANNA FRAKER BLDG. 223 RM. B244 X6009

Prints requested ('*' indicates user print cancellation) :

Date Time Description
24dec 08:06EST PR S21/5/ALL (no items to PRINT)

Total items to be printed: 0

SDI293, UD 8901, SER. DD023

File(s) searched:

File 293:Engineered Materials Abs 86-89/Jan
(Copr. 1988 ASM INTERNATIONAL)

Sets selected:

Set	Items	Description
1	0	HIGH()LEVEL()WASTE? ? OR RADIOACTIVE()WASTE? OR NUCLEAR()WASTE?
2	442	STEEL? ? OR ZIRCALOY? ? OR TITANIUM? ? OR COPPER
3	0	S1*S2
4	0	ANNA FRAKER, 223, B-254, X6009

Prints requested ('*' indicates user print cancellation) :

Date	Time	Description
29dec	21:17EST	PR 3/5/1-25 (no items to PRINT)

Total items to be printed: 0