CHEM-NUCLEAR SYSTEMS, INC.
220 Stoneridge Drive • Columbia, South Carolina 29210

July 16, 1985
RA-0308-5
NPS-0109-5

WM Record File
WM Project 19
Docket No.
PDR ✓
LPDR
Distribution:
X PERSON
Tim Johnson
(Return to WM, 623-SS)

Mr. Leroy S. Person
Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20910

Dear Mr. Person:

REFERENCE: (a) Telephone conversation, Leroy Person, Tim Johnson (US NRC), and Les Poppe, Jim Staehr (CNSI)

(b) CNSI Topical Report, "CNSI-WF-C-01-NP,10) CFR 61 Waste Form Certification - Cement"

The enclosed information is submitted in response to reference (a) and to clarify or augment reference (b). The information is believed to satisfy the questions and concerns raised by your review of the subject topical and will be included in a final, smooth document which we will entitle revision 1 to reference (b).

Please do not hesitate to contact us for any additional information regarding this information or the subject topical report.

Very truly yours,

CHEM-NUCLEAR SYSTEMS, INC.

L. K. Poppe
Director, Licensing

James P. Staehr
James P. Staehr
General Manager
Nuclear Plant Services

LKP:als

7/12/85

ANSWERS TO U.S.N.R.C. QUESTIONS ON REV 1, CNSI-WF-C-01-NP TITLE 10 CFR 61, WASTE FORM CERTIFICATION--CEMENT

Q3. Will the composition of N-24 or M-5 change?

A3. The composition of these materials will not change. They are common chemicals available throughout the United States and have been in use for years.

To protect the interests of Chem-Nuclear, the chemical composition of M-5 and/or N-24 are not openly disclosed. However, each of these reagents is defined in Chem-Nuclear's research records and are subject to audit by duly authorized agencies.

Q4. With reference to the in-situ encapsulation method:

a) Assuming that no support may be credited to the filters or other media to be encapsulated, will the cement slab support the weight of earth overburden?

b) Is leach test data available for the in-situ formula? Are leach indices for the in-situ formula comparable to other waste formulas?

A4. a) It has been shown that the structural strength incorporated into the current design is sufficient to support the maximum expected loads for the largest container (14-195 Liner). The maximum span for that container is 71 inches of cement with a minimum thickness of 3 1/2 inches, and contains two layers of 3/4" gage 9 steel mesh. This lid is sufficient to support up to 50 ft of 120 lb/ft^3 soil overburden. (See Attachment 1)

b) Leach data obtained for encapulation formula is identical to data for sodium sulfate waste formulation. Such formulation makes up the sulfate process. Data is included for the sulfate waste solidification formula which uses cement, M-5, boric acid and lime for which is data included.

Q8. Clarify the use of the term "random" versus "intentionally," with respect to core sample locations within full-scale billets.

A8. The locations of core drillings were intended to provide representative samples from the solidified billets. Both longitudinal and transverse sections of the billet were examined for uniform mixing and compressive strength. Sample points are always selected at or near the dewater leg, which experience has shown, could be the most stagnant point. Other samples are taken at random to prove homogeneity.

Q9. You state that variations up to 12 percent boric acid up to 66 percent waste loading are stable. Why is data included for 73 percent?

A9. The subject document presents complete certification data for the five generic waste forms identified on page 2. The data for the 73 percent waste loading formula was included as an indication of the effect of formula variations on final product properties. The data for 73 percent waste loading will be removed from the final document.

Q12. The test data state that slight bacterial growth was observed in the ASTM G-22 test. Why was the recommended extraction procedure not performed?

A12. ASTM G-22 states that the "nutrient-salts agar will support growth of the test bacteria when carbon requirements are supplied by susceptible plastic materials"; or in our case, carbon supplied by the solidified test sample.

According to Dr. Gerald Cowley, Assistant Chairman, University of South Carolina Department of Biology, in his letter dated June 18, 1985 (See Attachment 2), it is not uncommon to find slight growth of bacteria in the type of agar used due to its own impurities.

Q13. Please provide all data for leach tests in the recommended format.

A13. The data are supplied in Attachment 3.

Q14. Please provide all data for leach tests of various leachants. Why was sea water not used?

A14. In lieu of performing tests using synthesized sea water as a leachant, CNSI decided to submit data generated in 1981 on a now obsolete formula which used leachants of various pH values. These tests used Cs-137, Co-60, Sr-85, and Ce-144, and showed that varying the pH did not affect the leach rate. Although the Technical Position on Waste Form states that "additional testing using other leachants specified in ANS 16.1 should also be performed," CNSI believed these data would be sufficient to fulfill the intended purpose of testing various leachants, "to confirm the solidification agents' leach resistance in other leachant media."

Presently, Chem-Nuclear has conducted comparative leach and deionized water tests using synthesized sea water on resin bead and boric acid formulas. Higher leach indices were obtained for the sea water leachant in each test.

As a result of these tests, CNSI believes that demineralized water adequately defines a solidification agent's leaching behavior. (See Attachment 4).

Q17. How does the 80 ft^3 solidified sample compare with the actual sizes of products solidified by CNSI? Why was a 10% Na_2SO_4 solution solidified instead of a 25% solution?

A17. a) The rate at which the reaction heat is dissipated can affect the final compressive strength. Due to the low thermal conductivity of cement products, the heat dissipation rate is directly proportional to the ratio of surface area per unit volume.

The selection of the 80 ft^3 container was based on its high heat dissipation rate compared to that of other larger containers. The results of this test have yielded the lowest compressive strength, therefore offering the highest degree of conservatism.

b) Ten percent sodium sulfate concentration was selected for the following reasons:

1) The high temperature required to maintain 25% sodium sulfate in solution is difficult to achieve with testing equipment; particularly, when large volumes are involved. More importantly... CNSI routinely processes 20 and 25% solids content in large liners. The reference to "dangerous exotherms" was made in error, based only on simulation problems during testing, and will be removed from the final document.

ATTACHMENT 1

STRUCTURAL ANALYSIS OF CONCRETE RADWASTE CONTAINER UNDER BURIAL CONDITIONS

SUMMARY

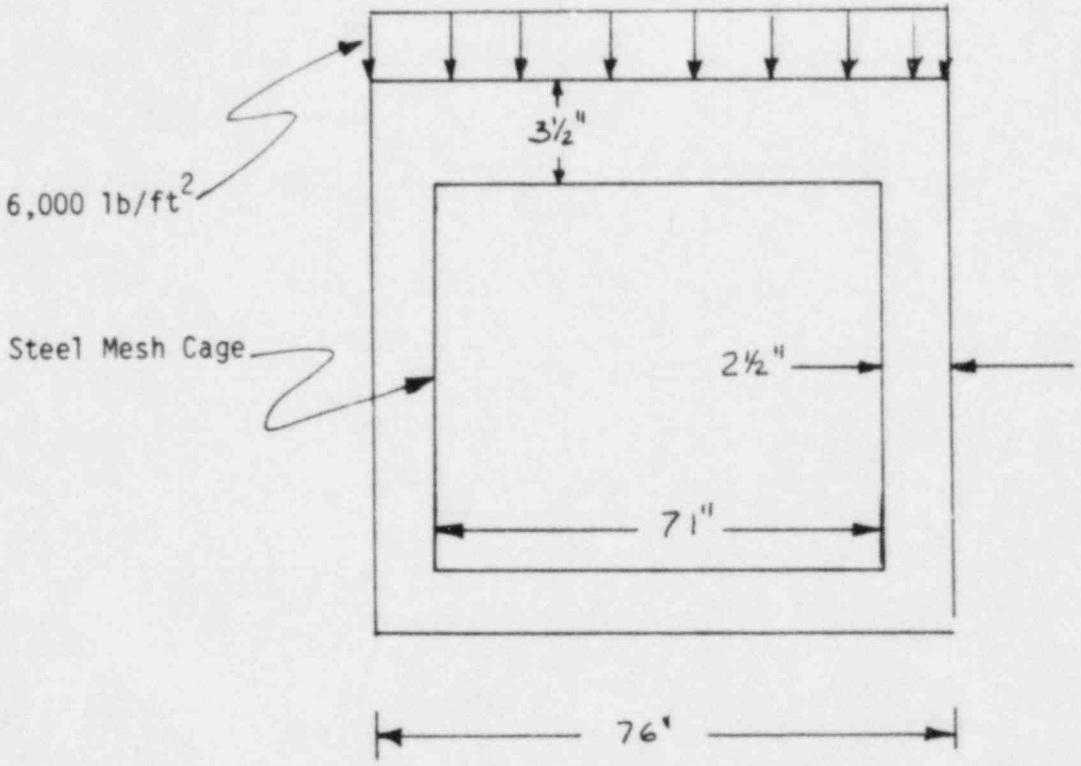
The following is a structural analysis of a concrete container for burial of radwaste. The concrete container is reinforced with a wire mesh in the form of an inner steel cage with a wire mesh lid. The container is used to encapsulate components such as cartridge filters. The following assumptions were used:

- Burial Height . . . . . 50 feet
- Soil Density . . . . . 120 lb/ft^3
- Contents do not support the structure; i.e., container is effectively empty.
- Concrete compressive strength . . . . . 1,500 psi
- Steel allowable stress . . . . . 36,000 psi

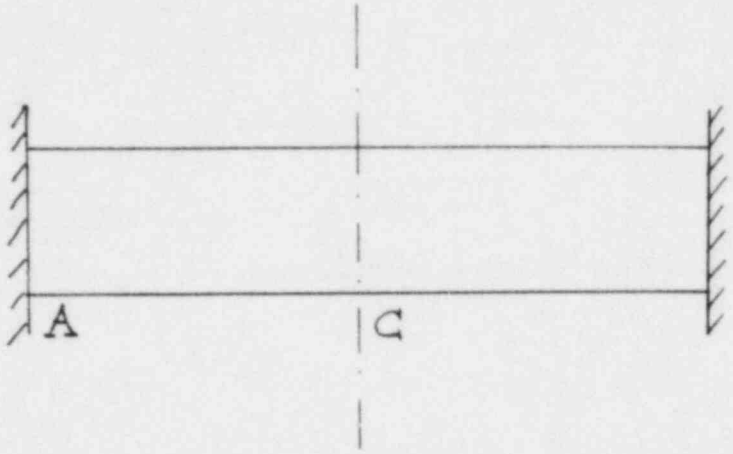
The analysis shows that with a lid thickness of concrete (3.50 inches) and the existing layers of wire, the allowable stresses are not exceeded and the container may be buried for an indefinite period without failure of the lid due to the soil loading.

INTRODUCTION

A sizing analysis of buried concrete liners has been performed to determine a design for the upper closure plate that can withstand a loading of 6,000 lb/ft^2 on its surface. The overall dimensions of the liner are as indicated on the sketch:



An ANSYS finite element analysis indicates that the upper closure plate behaves like a fixed-end circular plate, the bending moment for which may be calculated using analytical expressions available in Formulas for Stress and Strain, by Roark, fifth edition.



Bending moment at center:

$$M_c = \frac{9a^2(1 + V)}{16}$$ (Case 40 (b) page 363)

$$= \frac{\frac{6000}{144} \times 35.5^2 \times (1 + 0.1)}{16}$$

$$= 3,610 \text{ in-lb/in}$$

Bending moment at edge:

$$M_{ra} = -9a^2/8$$

$$= -\frac{6000}{144} \times 35.5^2/8$$

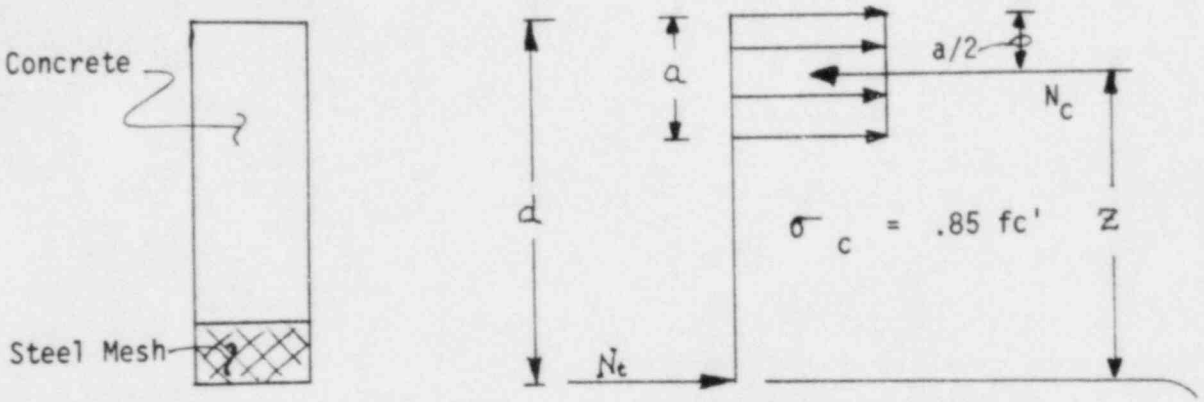
$$= -6,564 \text{ in-lb/in}$$

It can be seen from the expressions of bending moment that at the center the tensile stress occurs at the bottom surface of the plate, whereas at the edge, the top edge experiences tensile stress. Therefore, it is necessary to reinforce the concrete at both top and bottom.

In the following pages the minimum top surface thicknesses of concrete and plain steel wire cloth, which are used to form the closure plate, are evaluated and the following assumptions are used:

- The tensile loads are carried entirely by the steel and the compressive loads are carried entirely by concrete.
- The concrete is loaded to its maximum compressive strength (1500 psi).
- The steel wire cloth is loaded to yield (36,000 psi).

Under these assumptions the stress distribution over a cross-section of unit width is as follows:



(Reference: Reinforced Concrete Fundamentals, by Ferguson, fourth edition, John Wiley)

From above reference, page 44:

$$N_c = 0.85 f_c' \; a \; b = 766.53 \; d$$

$$C_b = \frac{87{,}000}{87{,}000 + fg} \; d = 0.7073 \; d$$

$$a = 0.85 \; c_b = 0.6012 \; d$$

$$Z = d \cdot \frac{a}{z} = 0.6994 \; d$$

$$N_t = A_s \; fg$$

$$M = N_t \; Z = 536.11 \; d^2$$

$$d = \sqrt{\frac{M}{536.11}}$$

Therefore present design, having 3-1/2 inch concrete thickness with 0.075 inch of steel reinforcing, meets the above criteria.

ATTACHMENT 2

DR. GERALD COWLEY LETTER - JUNE 18, 1985
REFERENCE: BACTERIAL GROWTH OBSERVED
IN
BIODEGRADATION TESTING

UNIVERSITY OF SOUTH CAROLINA

COLUMBIA, S. C. 29208

DEPARTMENT OF BIOLOGY

(803) 777-4141

18 June 1985

Mr. David Thorpe
Chem Nuclear Systems
220 Stoneridge Drive
Columbia, SC 29210

Dear David:

Enclosed is an explanation of the bacterial growth in some earlier samples and a summary of results of the last three PV samples.

I hope everything is satisfactory.

Sincerely,

Gerald T. Cowley
Assistant Chairman

GTC:tdp

Enclosure

Explanation of Bacterial Growth on Agar Surfaces

Samples labeled DE/Fe_2O_3, BWR69, and PWR66, reported in 1984 as having bacterial growth on the agar surrounding the samples, were not invaded by bacteria since no bacteria were detected below the surface of the cement samples. Growth on the agar was very sparse and did not exceed the growth on a concurrent culture containing agar, but no cement sample. Staining of the cement surface was only at the point of contact between the agar surface and the cement. A small amount of growth in agar is not uncommon. This growth results from a small amount of organic matter contamination in the agar itself.

Tests on later samples were performed in a liquid, rather than an agar solidified medium. This modified procedure accomplished two things: (1) it avoided the problem of microbial growth resulting from a small amount of organic matter contamination in the agar; (2) it provided for a better wetting of the entire cement surface.

ATTACHMENT 3

LEACH TEST RESULTS
IN
ANS 16.1 FORMAT

BWR 69

	Sr-85		Cs-137	
	1	2	1	2
	8.66	8.17	6.70	6.38
	8.20	8.02	6.44	6.34
	8.64	8.40	6.61	6.39
	9.01	8.11	6.79	6.29 *
	8.87	8.38	6.58 *	6.33
	8.83	8.27	6.58	6.32
	10.41	9.22	6.60	6.32
	8.95	10.19	6.58	6.43
	11.09	12.17	6.73	6.56
	12.52	–	6.92	6.55
	11.28	11.98	7.08	6.57
	–	11.96	7.13	6.62
	11.48	–	7.14	6.70
	12.07	11.02	7.22	6.71
	–		7.22	
AVG	10.00	9.66	6.82	6.47
	(9.8)		(6.6)	

* $\sum a_n/A_0$ greater than 20%

DE/Fe_2O_3

	Sr-85		Cs-137	
	1	2	1	2
	8.71	9.15	7.42	7.48
	8.89	8.99	7.82	7.81
	8.98	9.08	7.91	7.82
	9.21	9.14	7.99	7.92
	9.03	9.11	8.01	7.92
	9.28	9.22	8.14	8.09
	10.41	10.16	8.42	8.23
	10.12	9.90	8.28	8.25
	10.79	10.46	8.67	8.69
	10.80	10.76	9.00	9.08
	10.47	10.59	9.20	9.35
		11.05		9.89
AVG	9.70	9.80	8.26	8.38
	(9.8)		(8.3)	

Resin A

Sr-85		Cs-137	
1	2	1	2
9.61	9.67	7.75	7.77
9.37	9.31	7.15	7.14
8.97	8.94	7.01	6.99
8.60	8.72	7.08	7.05
8.62	8.61	7.12	7.09
8.69	8.71	7.10	7.08
9.78	9.69	7.33	7.09 *
10.03	10.05	7.15 *	7.09
10.21	10.09	7.21	7.12
10.29	9.94	7.22	7.16
10.52	10.43	7.27	7.21
10.86	10.68	7.35	7.28
11.91	11.73	7.40	7.34
11.69	12.48	7.50	7.43
11.55	11.58	7.55	7.51
11.88	-	7.61	7.58
-	-	7.77	7.72
10.04	10.16	7.33	7.27
(10.1)		(7.3)	

* $\Sigma a_n / A_0$ greater than 20%

Powdex B

Sr-85		Cs-137	
1	2	1	2
8.75	8.67	6.88	6.88
8.29	8.06	6.64	6.64
8.26	8.32	6.75	6.87
8.30	8.34	6.72	6.63
8.23	8.15	6.68 *	6.69 *
8.27	8.11	6.70	6.71
9.04	9.53	6.77	6.78
9.29	9.28	6.78	6.80
9.75	10.03	6.81	6.83
9.85	9.87	6.88	6.91
10.42	10.45	6.95	6.99
10.16	10.44	7.04	7.07
10.20	10.05	7.13	7.17
9.81	9.60	7.19	7.24
9.12	9.21	685	6.87
(9.2)		(6.9)	

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe_2O_3 - 1 and 2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgway

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number DE/Fe_2O_3 - 1 and 2

Portion of Waste Incorporated in Mixture 49 Weight %

.74 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

133 g Celite 545, 0.2 g Fe_2O_3 powder, 28.3 g DI water, 50 µl nuclides (A: 395.8 µCi Sc-85, 494.7 µCi Cs-137)

Type and Composition of the Solidification Agent

125 g Agent 01-5, 250 g Portland I cement

Preparation of Specimen add Celite, Fe_2O_3, and DI water. Allow to stand for 24 hours. Add nuclides, Agent 01-5, and cement. Blend and fill 2 - 250 ml plastic cups. Seal and cure at 140°-150°F for about 2½ days. Allow to cool 2 hours before starting test.

Shape and Dimension of Specimen

Sphere, diameter, d (cm) =

Cylinder, diameter, d (cm) =

length, l (cm) =

Parallelepiped, length, l (cm) =

width, w (cm) =

height, h (cm) =

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance gray

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2200
2	< 2.0	2200
3	< 2.0	2200
4	< 2.0	2200
5	< 2.0	2200
6	< 2.0	2200
7	< 2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

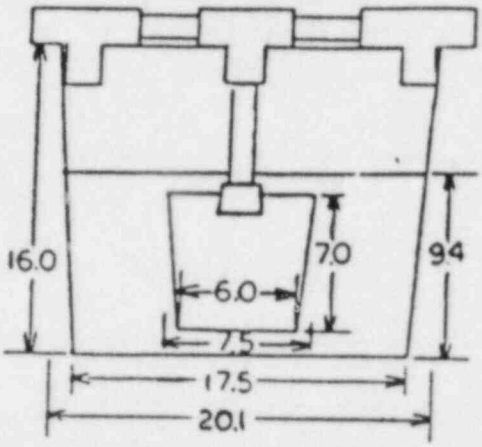
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number NO 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_i, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe_2O_3-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr-85

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 395.8

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	0950 9-19	1150 9-19	$7.20E^{3}$	$7.20E^{3}$	$5.70E^{-4}$	Ø	$5.70E^{-4}$	1.49	$3.76E^{-3}$	$5.23E^{-7}$	$3.76E^{-3}$
2	22±3	1150 9-19	1630 9-19	$1.68E^{4}$	$2.40E^{4}$	$3.83E^{-4}$	Ø	$3.83E^{-4}$	1.00	$2.53E^{-3}$	$1.50E^{-7}$	$6.29E^{-3}$
3	22±3	1630 9-19	0840 9-20	$5.28E^{4}$	$8.22E^{4}$	$5.86E^{-4}$	Ø	$5.86E^{-4}$	1.54	$3.89E^{-3}$	$7.37E^{-8}$	$1.02E^{-2}$
4	22±3	0840 9-20	0835 9-21	$8.01E^{4}$	$1.68E^{5}$	$4.67E^{-4}$	Ø	$4.67E^{-4}$	1.23	$3.11E^{-3}$	$3.61E^{-8}$	$1.33E^{-2}$
5	22±3	0835 9-21	0830 9-22	$8.64E^{4}$	$2.54E^{5}$	$4.36E^{-4}$	Ø	$4.36E^{-4}$	1.14	$2.89E^{-3}$	$3.35E^{-8}$	$1.62E^{-2}$
6	22±3	0830 9-22	0850 9-23	$8.76E^{4}$	$3.42E^{5}$	$2.80E^{-4}$	Ø	$2.80E^{-4}$	$7.39E^{-1}$	$1.87E^{-3}$	$2.13E^{-8}$	$1.81E^{-2}$
7	22±3	0850 9-23	0830 9-30	$6.04E^{5}$	$9.46E^{5}$	$3.41E^{-4}$	Ø	$3.41E^{-4}$	$9.68E^{-1}$	$2.45E^{-3}$	$4.05E^{-9}$	$2.06E^{-2}$
8	22±3	0830 9-30	0845 10-7	$6.06E^{5}$	$1.55E^{6}$	$3.10E^{-4}$	Ø	$3.10E^{-4}$	$9.48E^{-1}$	$2.40E^{-3}$	$3.95E^{-9}$	$2.30E^{-2}$
9	22±3	0845 10-7	0830 10-21	$1.21E^{6}$	$2.76E^{6}$	$1.89E^{-4}$	Ø	$1.89E^{-4}$	$6.72E^{-1}$	$1.70E^{-3}$	$1.40E^{-9}$	$2.47E^{-2}$
10	22±3	0830 10-21	0830 11-11	$1.81E^{6}$	$4.57E^{6}$	$1.70E^{-4}$	Ø	$1.70E^{-4}$	$7.58E^{-1}$	$1.92E^{-3}$	$1.06E^{-9}$	$2.66E^{-2}$
11	22±3	0830 11-11	0830 12-2	$1.81E^{6}$	$6.38E^{6}$	$1.61E^{-4}$	Ø	$1.61E^{-4}$	$9.02E^{-1}$	$2.28E^{-3}$	$1.26E^{-9}$	$2.89E^{-2}$
12												
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x ml x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe_2O_3 - 1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Risseeuw

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs-137

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 494.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	$\sum_1^n a_j/A_0$
1	22±3	0950 9-19	1130 9-19	7.20E3	7.20E3	3.75E-3	Ø	3.75E-3	8.25	1.67E-2	2.32E-6	1.67E-2
2	22±3	1150 9-19	1630 9-19	~~1.68E4~~ ~~2.04E4~~	~~2.40 4~~ ~~2.76E4~~	1.95E-3	Ø	1.95E-3	4.29	8.67E-3	5.16E-7	2.54E-2
3	22±3	1630 9-19	0640 9-20	5.82E4	8.22E4	3.3E-3	Ø	3.3E-3	7.27	1.47E-2	2.53E-7	4.01E-2
4	22±3	~~0640~~ 0840 9-20	~~0835~~ 0835 9-21	8.61E4	1.68E5	2.83E-3	Ø	2.83E-3	6.24	1.26E-2	1.47E-7	5.27E-2
5	22±3	~~0835~~ 0835 9-21	0830 9-22	8.61E4	2.54E5	2.11E-3	Ø	2.11E-3	4.63	9.36E-3	1.09E-7	6.21E-2
6	22±3	0830 9-22	0850 9-23	9.76E4	3.42E5	1.54E-3	Ø	1.54E-3	3.40	6.87E-3	7.85E-8	6.90E-2
7	22±3	0850 9-23	0830 9-30	6.04E5	9.46E5	5.44E-3	Ø	5.44E-3	11.97	2.42E-2	4.01E-8	9.32E-2
8	22±3	0830 9-30	0845 10-7	6.0E5	1.55E6	4.48E-3	Ø	4.48E-3	9.86	1.99E-2	3.29E-8	1.13E-1
9	22±3	0845 10-7	0830 10-21	1.21E6	2.76E6	4.3E-3	Ø	4.3E-3	9.60	1.94E-2	1.60E-8	1.32E-1
10	22±3	0830 10-21	0830 11-11	1.81E6	4.57E6	3.40E-3	Ø	3.40E-3	7.52	1.52E-2	8.40E-9	1.48E-1
11	22±3	0830 11-11	0830 12-2	1.81E6	6.38E6	2.21E-3	Ø	2.21E-3	4.85	9.80E-3	5.42E-9	1.57E-1
12												
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x ... x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe_2O_3 - 1 and 2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number DE/Fe_2O_3 - 1 and 2

Portion of Waste Incorporated in Mixture 49 Weight %

74 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

133 g Celite 545, 0.2 g Fe_2O_3 powder, 28.3 g DI water, 50 ml nuclides (A: 395.8 μCi Sc-85, 494.7 μCi Cs-137)

Type and Composition of the Solidification Agent

125 g Agent A-5, 250 g Portland I cement

Preparation of Specimen add Celite, Fe_2O_3, and DI water. Allow to stand for 24 hours. Add nuclides, Agent A-5, and cement. Blend and fill 2 - 250 ml plastic cups. Seal and cure at 140°-150°F for about 2½ days. Allow to cool 2 hours before starting test.

Shape and Dimension of Specimen

Sphere, diameter,	d (cm)	=
Cylinder, diameter,	d (cm)	=
	length, l (cm)	=
Parallelepiped,	length, l (cm)	=
	width, w (cm)	=
	height, h (cm)	=

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance gray

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2200
2	< 2.0	2200
3	< 2.0	2200
4	< 2.0	2200
5	< 2.0	2200
6	< 2.0	2200
7	< 2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

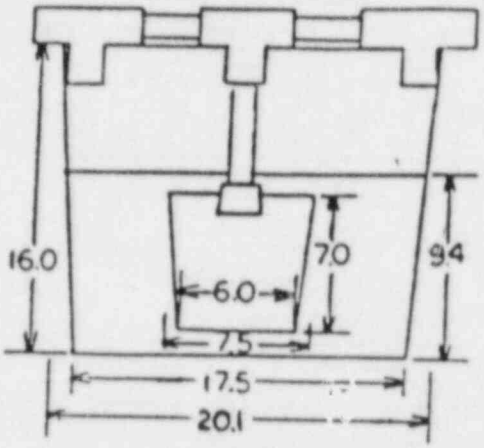
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number NO 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent e_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent e_2, Analytical Procedure, Standard Deviation of Method Same as e_1.

Constituent e_1, Analytical Procedure, Standard Deviation of Method Same as e_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe$_2$O$_3$ - 2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr 85

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 395.8

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	0950 9-19	11:50 9-19	7.20E3	7.20E3	3.44E-4	Ø	3.44E-4	.9	2.27E-3	3.16E-7	2.27E-3
2	22±3	1150 9-19	1630 9-19	1.68E4	2.40E4	3.44E-4	Ø	3.44E-4	.901	2.27E-3	1.35E-7	4.54E-3
3	22±3	1630 9-19	0840 9-20	5.82E4	8.22E4	5.81E-4	Ø	5.81E-4	1.52	3.84E-3	6.60E-8	8.38E-3 ~~1.35E-7~~
4	22±3	0840 9-20	0835 9-21	8.64E4	1.68E5	5.03E-4	Ø	5.03E-4	1.32	3.34E-3	3.87E-8	1.17E-2
5	22±3	0835 9-21	0830 9-22	8.61E4	2.54E5	3.99E-4	Ø	3.99E-4	1.05	2.65E-3	3.08E-8	1.44E-2
6	22±3	0830 9-22	0850 9-23	8.76E4	3.42E5	2.988E-4	Ø	2.988E-4	.789	1.99E-3	2.28E-8	1.64E-2
7	22±3	0850 9-23	0830 9-30	6.04E5	9.46E5	4.51E-4	Ø	4.51E-4	1.28	3.23E-3	5.35E-9	1.96E-2
8	22±3	0830 9-30	0845 10-7	6.06E5	1.55E6	3.99E-4	Ø	3.99E-4	1.22	3.08E-3	5.09E-9	2.27E-2
9	22±3	0845 10-7	0830 10-21	1.21E6	2.76E6	2.73E-4	Ø	2.73E-4	.973	2.46E-3	2.03E-9	2.52E-2
10	22±3	0830 10-21	0830 11-11	1.81E6	4.57E6	1.76E-4	Ø	1.76E-4	.788	1.99E-3	1.10E-9	2.72E-2
11	22±3	0830 11-11	0830 12-2	1.81E6	6.38E6	1.4E-4	Ø	1.4E-4	.789	1.99E-3	1.10E-9	2.92E-2
12	22±3	0830 12-2	0830 1-24-84	4.58E6	1.10E7	9.49E-5	Ø	9.49E-5	.93	2.35E-3	5.13E-10	3.15E-2
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER DE/Fe2 O3 -2
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST PAULA ROWLAND SUSAN RIDGEWAY
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Cs 137
Free Standing Water in Leach Specimen Container: ___ yes ✓ no
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 494.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	$t=\text{Sum}(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n *** (uCi)	a_n/A_o	$[a_n/A_o][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_o 1
1	22±3	0950 9-19	11:50 9-19	7.20E3	7.20E3	3.51E-3	Ø	3.51E-3	7.73	1.56E-2	2.17E-6	1.56E-2
2	22±3	11:50 9-19	16:30 9-19	1.68E4	2.40E4	1.98E-3	Ø	1.98E-3	4.35	8.79E-3	5.23E-7	2.44E-2
3	22±3	1630 9-19	0840 9-20	5.82E4	8.22E4	3.66E-3	Ø	3.66E-3	8.04	1.63E-2	2.79E-7	4.07E-2
4	22±3	0840 9-20	0835 9-22	8.61E4	1.68E5	3.09E-3	Ø	3.09E-3	6.79	~~7.29E-1~~ 1.37E-2	1.59E-7	5.44E-2
5	22±3	0835 9-22	0830 9-22	8.61E4	2.54E5	2.35E-3	Ø	2.35E-3	5.17	1.05E-2	1.21E-7	6.49E-2
6	22±3	0830 9-22	0850 9-23	8.76E4	3.42E5	1.65E-3	Ø	1.65E-3	3.63	7.34E-3	8.38E-8	7.22E-2
7	22±3	0850 9-23	0830 9-30	6.04E5	9.46E5	6.72E-3	Ø	6.72E-3	14.79	2.99E-2	4.95E-8	1.02E-1
8	22±3	0830 9-30	0845 10-7	6.06E5	1.55E6	4.66E-3	Ø	4.66E-3	10.26	2.07E-2	3.42E-8	.123
9	22±3	0845 10-7	0830 10-21	1.21E6	2.76E6	4.24E-3	Ø	4.24E-3	9.32	1.88E-2	1.56E-8	.142
10	22±3	0830 10-21	0830 11-11	1.81E6	4.57E6	3.10E-3	Ø	3.10E-3	6.83	1.38E-2	7.63E-9	.156
11	22±3	0830 11-11	0830 12-2	1.81E6	6.38E6	1.89E-3	Ø	1.89E-3	4.11	8.31E-3	4.59E-9	.164
12	22±3	0830 12-2	0830 1-24-84	4.58E6	1.10E7	2.02E-3	Ø	2.02E-3	4.45	9.00E-3	1.96E-9	.173
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_o. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number BWR 69-1

Portion of Waste Incorporated in Mixture 46 Weight %

69 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste 62.5 g Na_2SO_4, 162 g DI H_2O, .25 ml nuclides (Ru: 549.6 µCi Cs-137, 366.4 g Sr-85, 3776 g Co-60)

Type and Composition of the Solidification Agent 2 g boric acid, 20 g lime, 25 g Agent M-5, 190 g Portland I cement

Preparation of Specimen Heat the DI H_2O and add Na_2SO_4 (130°F). Add nuclides, boric acid, lime, Agent M-5, and cement. Blend and pour into 250 ml plastic cup. Seal and store at 160-170°F for 24 hours.

Shape and Dimension of Specimen

Sphere, diameter, d (cm) =

Cylinder, diameter, d (cm) =

length, l (cm) =

Parallelepiped, length, l (cm) =

width, w (cm) =

height, h (cm) =

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2200
2	< 2.0	2200
3	< 2.0	2200
4	< 2.0	2200
5	< 2.0	2200
6	< 2.0	2200
7	< 2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

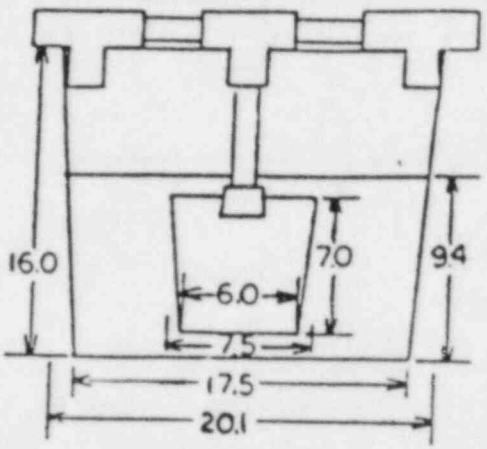
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number NO 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_3, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Pam Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr ~~SR~~-85

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 566.4

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	1100 8-10	1300 8-10	$7.20E^3$	$7.20E^3$	$6.26E^{-4}$	∅	$6.26E^{-4}$	1.47	4.01E-3	5.57E-7	4.01E-3
2	22±3	1300 8-10	1430 8-10	$1.26E^4$	$1.98E^4$	$6.97E^{-4}$	∅	$6.97E^{-4}$	1.63	$4.45E^{-3}$	$3.53E^{-7}$	$8.46E^{-3}$
3	22±3	1430 8-10	0845 8-11	$5.85E^4$	$7.83E^4$	$1.04E^{-3}$	∅	$1.04E^{-3}$ ~~2.04E~~	2.44	$6.66E^{-3}$	$1.14E^{-7}$	$1.54E^{-2}$
4	22±3	0845 8-11	0930 8-12	$8.91E^4$	$1.67E^5$	$6.33E^{-4}$	∅	$6.33E^{-4}$	1.50	$4.09E^{-3}$	$4.59E^{-8}$	$1.92E^{-2}$
5	22±3	0930 8-12	1110 8-13	$9.24E^4$	$2.60E^5$	$5.91E^{-4}$	∅	$5.91E^{-4}$	1.37	$3.74E^{-3}$	$4.05E^{-8}$	$2.30E^{-2}$
6	22±3	1110 8-13	1300 8-14	$9.30E^4$	$3.53E^5$	$4.90E^{-4}$	∅	$4.90E^{-4}$	1.20	$3.28E^{-3}$	$3.52E^{-8}$	$2.62E^{-2}$
7	22±3	1300 8-14	0950 8-17	$2.48E^5$	$6.01E^5$	$1.67E^{-4}$	∅	$1.67E^{-4}$	.418	$1.14E^{-3}$	$4.60E^{-9}$	$2.74E^{-2}$
8	22±3	0950 8-17	0830 8-19	$8.16E^4$	$6.83E^5$	$1.76E^{-4}$	∅	$1.76E^{-4}$	$6.82E^{-1}$	$1.71E^{-3}$	$2.10E^{-8}$ ~~+8~~	$2.92E^{-2}$
9	22±3	0830 8-19	0850 8-24	$4.32E^5$	$1.11E^6$	$5.87E^{-5}$	∅	$5.87E^{-5}$	.240	$6.55E^{-4}$	$1.52E^{-9}$	$2.99E^{-2}$
10	22±3	0830 8-24	0845 9-2	$7.79E^5$	$1.89E^6$	$2.17E^{-5}$	∅	$2.17E^{-5}$	.065	$1.77E^{-4}$	$2.28E^{-10}$	$3.01E^{-2}$
11	22±3	0845 9-2	0900 9-16	$1.21E^6$	$3.09E^6$	$5.84E^{-5}$	∅	$5.84E^{-5}$	.327	$8.92E^{-4}$	$7.38E^{-10}$	$3.10E^{-2}$
12	22±3	0900 9-16	0830 9-30	$1.21E^6$	$4.30E^6$	~~not det.~~	∅	NOT Det.				$3.10E^{-2}$
13	22±3	0830 9-30	0845 10-7	$6.06E^5$	$4.91E^6$	$2.11E^{-6}$	∅	$2.11E^{-6}$	$4.66E^{-2}$	$1.27E^{-4}$	$2.10E^{-10}$	$3.11E^{-2}$
14	22±3	0845 10-7	0830 10-21	$1.21E^6$	$6.12E^6$	$1.16E^{-5}$	∅	$1.16E^{-5}$	$8.82E^{-2}$	$2.41E^{-4}$	$1.94E^{-10}$	$3.13E^{-1}$
15	22±3	0830 10-21	0830 11-11	$1.81E^6$	$7.93E^6$	NOT. DET.	∅	NOT Det.				$3.13E^{-1}$

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Pam Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs 137

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 549.6

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum 1 a_j/A_0
1	22±3	1100 8-10	1300 8-10	$7.20E^{3}$	7.206^{3}	$4.51E^{-3}$	Ø	$4.51E^{-3}$	20.93	$3.81E^{-2}$	$5.29E^{-6}$	$3.81E^{-2}$
2	22±3	1300 8-10	1430 8-10	$1.26E^{4}$	$1.98E^{4}$	$8.51E^{-3}$	Ø	$8.51E^{-3}$	18.71	$3.40E^{-2}$	$2.70E^{-6}$	$7.21E^{-2}$
3	22±3	1630 8-10	0845 8-11	$5.85E^{4}$	7.835^{4}	$1.72E^{-2}$	Ø	$1.72E^{-2}$	37.83	$6.88E^{-2}$	$1.18E^{-6}$	$1.41E^{-1}$
4	22±3	0845 8-11	0930 8-12	$8.91E^{4}$	$1.67E^{5}$	~~1.30E-2 2.864E-2~~	Ø	~~1.30E-2 2.864E-2~~	28.69	$5.22E^{-2}$	$5.86E^{-7}$	1.936^{-1}
5	22±3	0930 8-12	1110 8-13	$9.24E^{4}$	$2.60E^{5}$	1.21E-2	Ø	$1.21G^{-2}$	26.67	$4.85E^{-2}$	$5.25E^{-7}$	2.42 -1 2.24E
6	22±3	1110 8-13	1300 8-14	9.306^{4}	$3.53E^{5}$	$8.83E^{-3}$	Ø	8.836^{-3}	19.44	$3.54E^{-2}$	$3.80E^{-7}$	2.776^{-1}
7	22±3	1300 8-14	0950 8-17	$2.98E^{5}$	$6.01E^{5}$	$1.64E^{-2}$	Ø	$1.64E^{-2}$	36.02	$6.55E^{-2}$	$2.64E^{-7}$	$5.43E^{-1}$
8	22±3	0950 8-17	0830 8-19	$8.16E^{4}$	$6.83E^{5}$	$7.03E^{-3}$	Ø	$7.03E^{-3}$	15.47	$2.81E^{-2}$	$3.45E^{-7}$	$3.71E^{-1}$
9	22±3	0830 8-19	0830 8-24	$4.32E^{5}$	$1.11E^{6}$	$6.11E^{-3}$	Ø	$6.11E^{-3}$	13.46	$2.45E^{-2}$	$5.79E^{-8}$	$5.95E^{-1}$
10	22±3	0830 8-24	0845 9-2	$7.79E^{5}$	$1.88E^{6}$	$3.03E^{-3}$	Ø	$3.03E^{-3}$	6.66	$1.21E^{-2}$	$1.56E^{-8}$	$4.07E^{-1}$
11	22±3	0845 9-2	0900 9-16	$1.21E^{6}$	$3.09E^{6}$	$6.29E^{-3}$	Ø	$6.29E^{-3}$	13.85	$2.52E^{-2}$	$2.08E^{-8}$	4.33 -1 4.42E
12	22±3	0900 9-16	0830 9-30	$1.21E^{6}$	$4.30E^{6}$	$9.46E^{-3}$	Ø	$9.46E^{-3}$	20.80	$3.78E^{-2}$	$3.13E^{-8}$	4.70 -1 4.80E
13	22±3	0830 9-30	0845 10-7	$6.06E^{5}$	$4.91E^{6}$	$5.22E^{-3}$	Ø	$5.22E^{-3}$	11.49	$2.09E^{-2}$	$3.45E^{-8}$	4.91 -1 5.01E
14	22±3	0845 10-7	0830 10-21	$1.21E^{6}$	$6.12E^{6}$	$7.58E^{-3}$	Ø	$7.58E^{-3}$	16.67	$3.02E^{-2}$	$2.51E^{-8}$	5.22 -1 5.32E
15	22±3	0830 10-21	0930 11-11	$1.81E^{6}$	$7.93E^{6}$	$8.37E^{-3}$	Ø	$8.37E^{-3}$	18.36	$3.34E^{-2}$	$1.85E^{-8}$	5.55 -1 5.65E

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgway

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number BWR 69-2

Portion of Waste Incorporated in Mixture 46 Weight %

69 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

62.5 g Na_2SO_4, 160 g DI H_2O, 25 ml nuclide (Ba-133, Cs-137, Co-60, Sr-85) 375.6 g Sr-85)

Type and Composition of the Solidification Agent 2 g boric acid, 20 g lime, 25 g Agiet M-5, 190 g Portland I cement

Preparation of Specimen Heat DI H_2O to 130°F and add Na_2SO_4. Add nuclides, boric acid, lime, Agiet M-5, and cement. Blend and pour into 250 ml plastic cup. Seal and cure at 160°-170°F for 24 hours.

Shape and Dimension of Specimen

Sphere, diameter,	d (cm)	=
Cylinder, diameter,	d (cm)	=
	length, l (cm)	=
Parallelepiped,	length, l (cm)	=
	width, w (cm)	=
	height, h (cm)	=

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2200
2	< 2.0	2200
3	< 2.0	2200
4	< 2.0	2200
5	< 2.0	2200
6	< 2.0	2200
7	< 2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

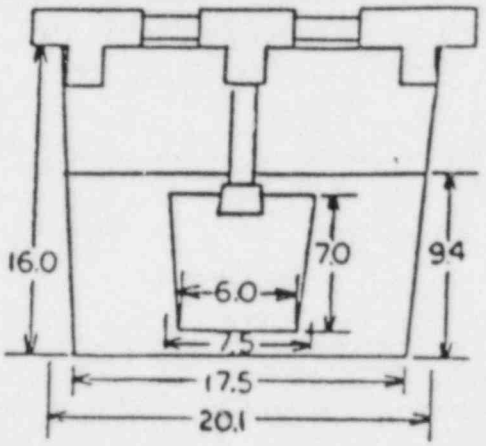
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Tl) detector type number 12SW12-W4 serial number MD 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_1, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-2
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paula Rowland, Susan Ridge, Way
DATE RESULTS REPORTED

Part C. Experimental Data
Constituent Analyzed, a Sr. 85
Free Standing Water in Leach Specimen Container: ___ yes ✓ no
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 375.6

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n *** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	8-17 1135	8-17 1135	7.20E3	7.20E3	1.05E-3	Ø	1.05E-3	2.63	7.00E-3	9.73E-7	7.00E-3
2	22±3	8-17 1155	8-17 1630	1.65E4	2.37E4	1.01E-3	Ø	1.01E-3	2.56	6.82E-3	4.13E-7	1.38E-2
3	22±3	8-17 1630	8-18 0835	5.29E4	8.16E4	1.23E-3	Ø	1.23E-3	3.12 ~~3.72~~	8.31E-3	1.44E-7	2.21E-2
4	22±3	8-18 0835	8-19 0830	8.61E4	1.68E5	1.61E-3	Ø	1.61E-3	4.11	1.09E-2	1.27E-7	3.30E-2
5	22±3	8-19 0830	8-20 1045	9.45E4	2.63E5	9.44E-4	Ø	9.44E-4	2.50	6.66E-3	7.05E-8	3.97E-2
6	22±3	8-20 1045	8-21 0845	7.92E4	3.42E5	7.62E-4	Ø	7.62E-4	2.01 ~~1.68~~	5.35 ~~4.47~~E-3	6.76 ~~5.69~~E-8	4.45 4.41E-2
7	22±3	8-21 0845	8-24 0830	2.58E5	6.00E5	6.54E-4	Ø	6.54E-4	~~4.68~~ 1.2 ~~1.44~~	7.64 3.83E-3	1.82 ~~1.48~~E-8	4.97 4.80E-2
8	22±3	8-24 0830	9-2 0845	7.79E5	1.38E6	4.08E-4	Ø	4.08E-4	1.21	3.22E-3	4.13E-9	5.30 5.12E-2
9	22±3	9-2 0845	9-16 0900	1.21E6	2.59E6	2.43E-5	Ø	2.43E-5	.136	3.62E-4	2.99E-10	5.33 5.16E-2
10	22±3	9-16 0900	9-30 0830	1.21E6	3.80E6	Neg. No.	Ø	Neg. No.	Neg. No.	Neg. No.	Neg. No.	5.33 5.16E-2
11	22±3	9-30 0830	10-7 0845	6.06E5	4.41E6	5.34E-6	Ø	5.34E-6	.035	9.32E-5	1.54E-10	5.34 5.17E-2
12	22±3	10-7 0845	10-21 0830	1.21E6	5.62E6	2.14E-5	Ø	2.14E-5	.107	2.85E-4	2.36E-10	5.37 5.20E-2
13	22±3	10-21 0830	11-18 0850	2.42E6	8.04E6	Neg. No.	Ø	Neg. No.	Neg. No.	Neg. No.	Neg. No.	5.37 5.20E-2
14	22±3	11-18 0850	11-28 0900	8.65E5	8.90E6	1.52E-5	Ø	1.52E-5	.174	4.63E-4	5.35E-10	5.41 5.24E-2
15												

* Date, hour, and minute
** Concentration in leachate, show units.
*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER BWR 69-2
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paula Rowland, Susan Ridgeway
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Cs 137
Free Standing Water in Leach Specimen Container: ___ yes ~~no~~
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_o = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_o = ___
Initial Amount in Specimen, A_o (uCi) [after 30-s rinse] = 563.4

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_o	$[a_n/A_o][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_o 1
1	22±3	0955 8-17	1155 8-17	7.20 E3	7.20 E3	1.42 E-2	Ø	1.42 E-2	31.14	5.53E-2	7.68 E-6	5.53E-2
2	22±3	1155 8-17	1630 8-19	1.65 E4	2.37 E4 ~~1.65E4~~	1.20E-2	Ø	1.20E-2	26.42	4.69 E-2	2.84 E-6	1.02E-1
3	22±3	1630 8-17	0835 8-18	5.79 E4	8.16 E4	2.18E-2	Ø	2.18E-2	48.04	8.53E-2	1.47 E-6	188 E-1
4	22±3	0835 8-18	0830 8-19	8.61 E4	1.68 E5	2.09E-2	Ø	2.09E-2	45.93	8.15E-2	9.47 E-7	2.69 E-1
5	22±3	0830 8-19	10-45 8-20	9.45 E4	2.63 E5	1.16E-2	Ø	1.16E-2	25.42	4.51E-2	4.77 E-7	3.14E-1
6	22±3	1043 8-20	0845 8-21	7.92E4	3.42 E5	1.08E-2	Ø	1.08E-2	23.87	4.24E-2	5.35 E-7	.357
7	22±3	0845 8-21	0830 8-24	2.58 E5	6.00 E5	2.43E-2	Ø	2.43E-2	53.37	9.47E-2	3.67 E-7	.451
8	22±3	0830 8-24	0845 9-2	7.79 E5	1.38 E6	2.96E-2	Ø	2.96E-2	65.04	1.15E-1	1.48 E-7	.566
9	22±3	0845 9-2	0900 9-16	1.21 E6	2.59 E6	1.86E-2 ~~2.33E-2~~	Ø	1.86E-2 ~~2.33E-2~~	40.93	7.26E-2	6.00 E-8	.639
10	22±3	0900 9-16	0830 9-30	1.21 E6	3.80 E6	2.33E-2	Ø	2.33E-2	51.19	9.09E-2	7.51 E-8	.730
11	22±3	0830 9-30	0845 10-7	6.06 E5	4.41 E6	6.56 E-3	Ø	6.56E-3	14.42	2.56E-2	4.22 E-8	.755
12	22±3	0845 10-7	0830 10-21	1.21 E6	5.62 E6	7.40 E-3	Ø	7.40 E-3	16.27	2.89 E-2	2.39 E-8	.784
13	22±3	0830 10-21	0850 11-18	2.42 E6	8.04 E6	9.94 E-3	Ø	9.94 E-3	21.86	3.88 E-2	1.60 E-8	.823
14	22±3	0850 11-18	0900 11-28	8.65 E5	8.90 E6	3.79 E-3	Ø	3.79 E-3	8.35	1.48 E-2	1.71 E-8	.838
15												

* Date, hour, and minute
** Concentration in leachate, show units.
*** a_n = corrected concentration x V_t x factor to convert to same units a A_o. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number Resin A-1 and 2

Portion of Waste Incorporated in Mixture 53 Weight %

69 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste
300 g MR 3 (new) mixed bed bead resin (Dow), 200 g 10% Na_2SO_4, 50 ml ave. lides (Re: 438.7 uCi Cs-137, 438.7 uCi Sr-85, 352.8 uCi [illegible])

Type and Composition of the Solidification Agent 150 g Agent M5, 300 g Portland I cement

Preparation of Specimen Add 200 g 10% Na_2SO_4 to dry resin. Allow to stand overnight. Drain off 50 ml of liquid and add 50 ml of [illegible]. Add Agent M-5 and cement. Blend and pour into 2 - 250 ml plastic cups. Seal and cure at 150°F for 2½ days.

Shape and Dimension of Specimen

Sphere, diameter, d (cm) =

Cylinder, diameter, d (cm) =

length, l (cm) =

Parallelepiped, length, l (cm) =

width, w (cm) =

height, h (cm) =

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	<2.0	2200
2	<2.0	2200
3	<2.0	2200
4	<2.0	2200
5	<2.0	2200
6	<2.0	2200
7	<2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

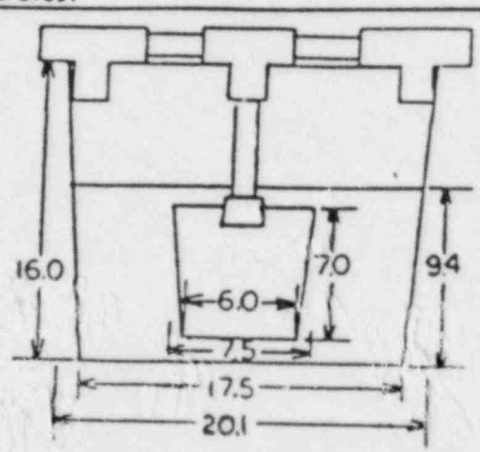
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Tl) detector type number 12SW12-W4 serial number NO 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent e_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent e_2, Analytical Procedure, Standard Deviation of Method Same as e_1.

Constituent e_1, Analytical Procedure, Standard Deviation of Method Same as e_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-1
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paul A Rowland, Susan Ridge WAY
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Sr 85
Free Standing Water in Leach Specimen Container: ___ yes ✓ no
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 438.77

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n *** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	0935 7-11	1135 7-11	7.20E3	7.20E3	2.11E-4	Ø	2.11E-4	.59	1.34E-3	1.86E-7	1.34E-3
2	22±3	1135 7-11	1645 7-11	1.86E4	2.58E4	2.46E-4	Ø	2.46E-4	.692	1.58E-3	8.49E-8	2.92E-3
3	22±3	1645 7-11	0900 7-12	5.85E4	8.43E4	6.68E-4	Ø	6.68E-4	1.88	4.29E-3	7.33E-8	7.21E-3
4	22±3	0900 7-12	0910 7-13	8.70E4	1.71E5	9.73E-4	Ø	9.73E-4	2.74	6.25E-3	7.18E-8	1.35E-2
5	22±3	0910 7-13	0835 7-14	8.43E4	2.55E5	7.02E-4	Ø	7.02E-4	1.98	4.51E-3	5.35E-8	1.80E-2
6	22±3	0835 7-14	0935 7-15	9.00E4	3.45E5	5.77E-4	Ø	5.77E-4	1.64	3.74E-3	4.16E-8	2.17E-2
7	22±3	0935 7-15	0915 7-18	2.58E5	6.03E5	3.81E-4	Ø	3.81E-4	1.08	2.46E-3	9.53E-9	2.42E-2
8	22±3	0915 7-18	0915 7-21	2.59E5	8.62E5	2.28E-4	Ø	2.28E-4	.648	1.48E-3	5.71E-9	2.57E-2
9	22±3	0915 7-21	0910 7-25	3.45E5	1.21E6	1.95E-4	Ø	1.95E-4	.587	1.34E-3	3.88E-9	2.70E-2
10	22±3	0910 7-25	1015 7-29	3.50E5	1.56E6	1.51E-4	Ø	1.51E-4	.468	1.07E-3	3.06E-9	2.81E-2
11	22±3	1015 7-29	1100 8-4	5.21E5	2.08E6	1.42E-4	Ø	1.42E-4	.469	1.07E-3	2.05E-9	2.91E-2
12	22±3	1100 8-4	0930 8-12	6.86E5	2.76E6	1.01E-4	Ø	1.01E-4	.365	8.32E-4	1.21E-9	3.00E-2
13	22±3	0930 8-12	0830 8-19	6.01E5	3.37E6	2.16E-5	Ø	2.16E-5	.0836	1.91E-4	3.18E-10	3.02E-2
14	22±3	0830 8-19	0845 9-2	1.21E6	4.58E6	4.29E-6	Ø	4.29E-6	.193	4.40E-4	3.64E-10	3.06E-2
15	22±3	0845 9-2	0900 9-16	1.21E6	5.79E6	3.52E-5	Ø	3.52E-5	.197	4.49E-4	3.71E-10	3.10E-2

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-1
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST PAULA RELMAN, SUSAN RIDGEWAY
DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr. 85

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
16 ✓	22±3	0900 9-16	0845 10-7	1.81E6	9.60E6	2.70E-5	∅	2.70E-5	.177	4.03E-4	2.23E-10	3.14E-2
17 ✓	22±3	0845 10-7	1540 12-2	4.86E6	1.25E7	Neg. No.	∅	Neg. No.	Neg. No.	Neg. No.	Neg. No.	Neg. No.
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-1
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paula Rowland, Susan Ridgeway
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Cs 137
Free Standing Water in Leach Specimen Container: ___ yes ✓ no
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	0935 7-11	11:35 7-11	7.20E3	7.20E3	2.26E-3	Ø	2.26E-3	4.98	1.14E-2	1.58E-6	1.14E-2
2	22±3	11:35 7-11	16:45 7-11	1.86E4	2.58E4	4.05E-3	Ø	4.05E-3	8.91	2.03E-2	1.09E-6	3.17E-2
3	22±3	16:45 7-11	0900 7-12	5.85E4	8.43E4	8.18E-3	Ø	8.18E-3	17.99	4.10E-2	7.01E-7	7.27E-2
4	22±3	0900 7-12	0910 7-13	8.70E4	1.71E5	7.18E-3	Ø	7.18E-3	15.79	3.60E-2	4.14E-7	1.09E-1
5	22±3	0910 7-13	0835 7-14	8.43E4	2.55E5	5.08E-3	Ø	5.08E-3	11.18	2.55E-2	3.02E-7	.134
6	22±3	0835 7-14	0935 7-15	9.00E4	3.45E5	4.69E-3	Ø	4.69E-3	10.32	2.35E-2	2.61E-7	.158
7	22±3	0935 7-15	0915 7-18	2.58E5	6.03E5	8.18E-3	Ø	8.18E-3	18.0	4.10E-2	1.59E-7	.199
8	22±3	0915 7-18	0915 7-21	2.59E5	8.62E5	6.30E-3	Ø	6.30E-3	13.86	3.16E-2	1.22E-7	.230
9	22±3	0915 7-21	0910 7-25	3.45E5	1.21E6	5.69E-3	Ø	5.69E-3	12.51	2.85E-2	8.26E-8	.259
10	22±3	0910 7-25	1015 7-29	3.50E5	1.56E6	4.25E-3	Ø	4.25E-3	9.34	2.13E-2	6.09E-8	.280
11	22±3	10:15 7-29	1100 8-4	5.21E5	2.08E6	4.31E-3	Ø	4.31E-3	9.48	2.16E-2	4.15E-8	.302
12	22±3	1100 8-4	0930 8-12	6.86E5	2.76E6	2.89E-3	Ø	2.89E-3	6.36	1.45E-2	2.11E-8	.316
13	22±3	0930 8-12	0830 8-19	6.01E5	3.37E6	1.93E-3	Ø	1.93E-3	4.25	9.69E-3	1.61E-8	.326
14	22±3	0830 8-19	0845 9-2	1.21E6	4.58E6	2.20E-3	Ø	2.20E-3	4.83	1.10E-2	9.09E-9	.337
15	22±3	0845 9-2	0900 9-16	1.21E6	5.79E6	3.79E-3	Ø	3.79E-3	8.33	1.90E-2	3.28E-9	.356

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs 137

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_o = _____

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_o = _____

Initial Amount in Specimen, A_o (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t-Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_o	$[a_n/A_o][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_o 1
16 ✓	22±3	0900 9-16	0845 10-7	1.81E6	7.60E6	3.88E-3	Ø	3.88E-3	8.53	1.94E-2	1.07E-8	.375
17	22±3	0845 10-7	1540 12-2	4.86E6	1.25E7	4.30E-3	Ø	4.30E-3	9.49	2.16E-2	4.44E-9	.397
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9												
10												
11												
12												
13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_o. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Rosin A

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan R. Tower

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number Rosin A-1 and 2

Portion of Waste Incorporated in Mixture 53 Weight %

69 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

300 g MR 3 (conc) mixed bed bead resin (Dow), 200 g 10% Na_2SO_4, 50 ml dewatering (Ba: 438.7 uCi Cs: 137, 438.7 uCi Sr: 85, 3.2 uCi Ce 144)

Type and Composition of the Solidification Agent 150 g Aqua Mix, 300 g Portland I cement

Preparation of Specimen Add 200 g 10% Na_2SO_4 to dry resin, allow to stand overnight. Drain off 50 ml of liquid and add 50 ml of dewatering. Add Aqua Mix and cement, blend and pour into 2 - 250 ml plastic capped vials and cure at 150°F for 2 days.

Shape and Dimension of Specimen

Sphere, diameter,	d (cm)	=
Cylinder, diameter,	d (cm)	=
	length, l (cm)	=
Parallelepiped,	length, l (cm)	=
	width, w (cm)	=
	height, h (cm)	=

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2250
2	< 2.0	2200
3	< 2.0	2250
4	< 2.0	2250
5	< 2.0	2250
6	< 2.0	2250
7	< 2.0	2250

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

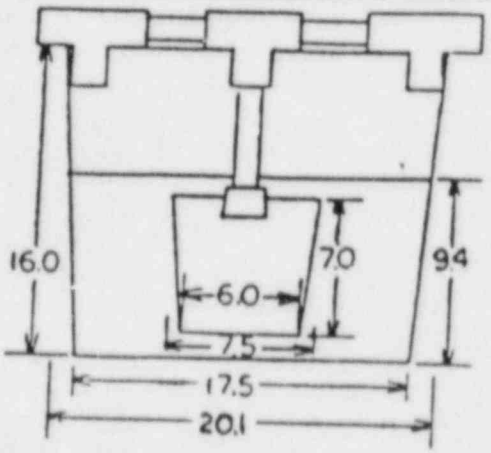
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number MD 220 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_i, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-2
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paula Rowland Susan Ridgway
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Sr-85
Free Standing Water in Leach Specimen Container: ___ yes ✓ no
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 488.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	0933 7-11	1135 7-11	$7.20E^{3}$	$7.20E^{3}$	$1.95E^{-4}$	Ø	$1.95E^{-4}$	$5.48E^{-1}$	$1.25E^{-3}$	$1.73E^{-7}$	$1.25E^{-3}$
2	22±3	1135 7-11	1445 7-11	$1.86E^{4}$	$2.58E^{4}$	$2.65E^{-4}$	Ø	$2.65E^{-4}$	$7.45E^{-1}$	$1.70E^{-3}$	$9.12E^{-8}$	$1.70E^{-3}$
3	22±3	1445 7-11	0900 7-12	$5.85E^{4}$	$8.43E^{4}$	$6.92E^{-4}$	Ø	$6.92E^{-4}$	1.95	$4.44E^{-3}$	$7.59E^{-8}$	$6.14E^{-3}$
4	22±3	0900 7-12	0910 7-13	$8.70E^{4}$	$1.71E^{5}$	$8.52E^{-4}$	Ø	$8.52E^{-4}$	2.4	$5.47E^{-3}$	$6.28E^{-8}$	$1.16E^{-2}$
5	22±3	0910 7-13	0835 7-14	$8.43E^{4}$	$2.56E^{5}$	$7.09E^{-4}$	Ø	$7.09E^{-4}$	2.0	$4.55E^{-3}$	$5.48E^{-8}$	$1.62E^{-2}$
6	22±3	0835 7-14	0935 7-15	$9.00E^{4}$	$3.46E^{5}$	$5.67E^{-4}$	Ø	$5.67E^{-4}$	1.61	$3.67E^{-3}$	$4.08E^{-8}$	$1.98E^{-2}$
7	22±3	0935 7-15	0915 7-18	$2.58E^{5}$	$6.04E^{5}$	$4.18E^{-4}$	Ø	$4.18E^{-4}$	1.19	$2.71E^{-3}$	$1.05E^{-8}$	$2.26E^{-2}$
8	22±3	0915 7-18	0915 7-21	$2.59E^{5}$	$8.63E^{5}$	$2.22E^{-4}$	Ø	$2.22E^{-4}$	$6.33E^{-1}$	$1.44E^{-3}$	$5.57E^{-9}$	$2.40E^{-2}$
9	22±3	0915 7-21	0910 7-25	$3.45E^{5}$	$1.21E^{6}$	$2.26E^{-4}$	Ø	$2.26E^{-4}$	$6.79E^{-1}$	$1.55E^{-3}$	$4.49E^{-9}$	$2.55E^{-2}$
10	22±3	0910 7-26	1015 7-29	$3.50E^{5}$	$1.56E^{6}$	$2.24E^{-4}$	Ø	$2.26E^{-4}$	$7.01E^{-1}$	$1.60E^{-3}$	$4.57E^{-9}$	$2.71E^{-2}$
11	22±3	1015 7-29	1100 8-4	$5.21E^{5}$	$2.08E^{6}$	$1.58E^{-4}$	Ø	$1.58E^{-4}$	$5.23E^{-1}$	$1.19E^{-3}$	$2.29E^{-9}$	$2.85E^{-2}$
12	22±3	1100 8-4	0930 8-12	$6.86E^{5}$	$2.77E^{6}$	$1.24E^{-4}$	Ø	$1.24E^{-4}$	.446	$1.02E^{-3}$	$1.48E^{-9}$	$2.94E^{-2}$
13	22±3	0930 8-12	0830 8-19	$6.01E^{5}$	$3.37E^{6}$	$2.65E^{-5}$	Ø	$2.65E^{-5}$	$1.03E^{-1}$	$2.35E^{-4}$	$3.91E^{-10}$	$2.96E^{-2}$
14	22±3	0830 8-19	0845 9-2	$1.21E^{6}$	$4.58E^{6}$	$1.72E^{-5}$	Ø	$1.72E^{-5}$	$7.74E^{-2}$	$1.76E^{-4}$	$1.46E^{-10}$	$2.98E^{-2}$
15	22±3	0845 9-2	0900 9-16	$1.21E^{6}$	$5.79E^{6}$	$3.42E^{-5}$	Ø	$3.42E^{-5}$	.191	$4.35E^{-4}$	$3.60E^{-10}$	$3.02E^{-2}$

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr-85

Free Standing Water in Leach Specimen Container: ___ yes no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_o = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_o = ___

Initial Amount in Specimen, A_o (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	$t=\text{Sum}\ (dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_o	$[a_n/A_o][1/(dt)_n]$ (fraction/s)	$\text{Sum}\ a_j/A_o$ for j = 1 to n
16	22±3	0900 6-16	0845 10-7	$1.81E^{6}$	$7.60E^{6}$	Neg No	ϕ	Neg No	Neg No	Neg No	Neg No	Neg No
17	22±3	0845 10-7	1540 12-2	$4.86E^{6}$	$1.25E^{7}$	Neg No	ϕ	Neg No	Neg No	Neg No	Neg No	Neg No
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11												
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13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_o. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin - A-2

LABORATORY WHERE TESTS PERFORMED CWSI

ANALYST Paula Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs 137

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	$t = \text{Sum}\ (dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n *** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	$\text{Sum}_1^n\ a_j/A_0$
1	22±3	0935 7-11	1135 7-11	$7.20E^{3}$	$7.20E^{3}$	$2.22E^{-3}$	Ø	$2.22E^{-3}$	4.89	$1.11E^{-2}$	$1.55E^{-6}$	$1.11E^{-2}$
2	22±3	1135 7-11	0645 7-11	$1.86E^{4}$	$2.58E^{4}$	$4.06E^{-3}$	Ø	$4.06E^{-3}$	8.94	$2.04E^{-2}$	$1.10E^{-6}$	$3.15E^{-2}$
3	22±3	1645 7-11	0900 7-12	$5.85E^{4}$	$8.43E^{4}$	$8.33E^{-3}$	Ø	$8.33E^{-3}$	18.32	$4.18E^{-2}$	$7.14E^{-7}$	$7.33E^{-2}$
4	22±3	0900 7-12	0910 7-13	$8.70E^{4}$	$1.71E^{5}$	$7.39E^{-3}$	Ø	$7.39E^{-3}$	16.26	$3.71E^{-2}$	$4.26E^{-7}$	$1.10E^{-1}$
5	22±3	0910 7-13	0935 7-14	$8.43E^{4}$	$2.56E^{5}$	$5.26E^{-3}$	Ø	$5.26E^{-3}$	11.57	$2.64E^{-2}$	$3.13E^{-7}$	$1.37E^{-1}$
6	22±3	0935 7-14	0935 7-15	$9.00E^{4}$	$3.46E^{5}$	$4.76E^{-3}$	Ø	$4.76E^{-3}$	10.47	$2.39E^{-2}$	$2.65E^{-7}$	$1.61E^{-1}$
7	22±3	0935 7-15	0915 7-18	$2.58E^{5}$	$6.04E^{5}$	$9.31E^{-3}$	Ø	$9.31E^{-3}$	20.49	$4.67E^{-2}$	$1.81E^{-7}$	$2.07E^{-1}$
8	22±3	0915 7-18	0915 7-21	$2.59E^{5}$	$8.63E^{5}$	$7.22E^{-3}$	Ø	$7.22E^{-3}$	15.87	$3.62E^{-2}$	$1.40E^{-7}$	$2.43E^{-1}$
9	22±3	0915 7-21	0910 7-25	$3.45E^{5}$	$1.21E^{6}$	$6.70E^{-3}$	Ø	$6.70E^{-3}$	14.75	$3.36E^{-2}$	$9.75E^{-8}$	$2.77E^{-1}$
10	22±3	0910 7-25	1015 7-29	$3.50E^{5}$	$1.56E^{6}$	$4.24E^{-3}$	Ø	$4.24E^{-3}$	9.32	$2.12E^{-2}$	$6.07E^{-8}$	$2.98E^{-1}$
11	22±3	1015 7-29	1100 8-4	$5.21E^{5}$	$2.08E^{6}$	$4.22E^{-3}$	Ø	$4.22E^{-3}$	9.29	$2.12E^{-2}$	$4.06E^{-8}$	$3.20E^{-1}$
12	22±3	1100 8-4	0930 8-12	$6.86E^{5}$	$2.77E^{6}$	$3.67E^{-3}$	Ø	$3.67E^{-3}$	8.08	$1.84E^{-2}$	$2.69E^{-8}$	$3.38E^{-1}$
13	22±3	0930 8-12	0830 8-19	$6.01E^{5}$	$3.37E^{6}$	$2.01E^{-3}$	Ø	$2.01E^{-3}$	4.43	$1.01E^{-2}$	$1.69E^{-8}$	$3.48E^{-1}$
14	22±3	0830 8-19	0845 9-2	$1.21E^{6}$	$4.58E^{6}$	$1.72E^{-5}$	Ø	$1.72E^{-5}$	5.66	$1.29E^{-2}$	$1.07E^{-8}$	$3.61E^{-1}$
15	22±3	0845 9-2	0900 9-16	$1.21E^{6}$	$5.79E^{6}$	$1.75E^{-3}$	Ø	$1.75E^{-3}$	3.84	$8.75E^{-3}$	$7.23E^{-9}$	$3.70E^{-1}$

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_t x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Resin A-2

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland Susan Ridgway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs137

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 438.7

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	$t=\text{Sum}\ (dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	$\text{Sum}_1^n a_j/A_0$
16	21±3	0900 9-16	0845 10-7	$1.81E^6$	$7.60E^6$	$8.94E^{-3}$	0	$8.94E^{-3}$	8.69	$1.98E^{-2}$	$1.09E^{-8}$	$3.89E^{-1}$
17	22±3	0845 10-7	1540 12-2	$4.86E^6$	$1.25E^7$	$5.40E^{-3}$	0	$5.40E^{-3}$	11.92	$2.72E^{-2}$	$5.59E^{-9}$	$4.17E^{-1}$
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8												
9												
10												
11												
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13												
14												
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powder B

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Bridges

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number Powder B - Load 2

Portion of Waste Incorporated in Mixture 37 Weight %

65.5 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

333 g Powder, 25.3 g Ecosorb, 24.0 g anion Powder, 72.0 g cation Powder, 2.7 g Solka floc, 2.7 g Na_2SO_4, 366.7 g D_2O H_2O, 50 ml nuclides (^{60}Co: 524 μCi/ml; ^{137}Cs: 37, 347.4 μCi/ml)

Type and Composition of the Solidification Agent 167 g Agent 00S, 333 g Portland I cement

Preparation of Specimen Mix Powder, Ecosorb anion and cation Powder, Solka floc, Na_2SO_4 and water. Allow to stand overnight and drain 1274 g liquid and nuclides, Agent 00S, and cement. Blend and pour into 2-250 ml plastic cups. Seal and cure at 140°-150°F for 2½ days.

Shape and Dimension of Specimen

Sphere, diameter,	d (cm)	=
Cylinder, diameter,	d (cm)	=
	length, l (cm)	=
Parallelepiped,	length, l (cm)	=
	width, w (cm)	=
	height, h (cm)	=

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	< 2.0	2200
2	< 2.0	2200
3	< 2.0	2200
4	< 2.0	2200
5	< 2.0	2200
6	< 2.0	2200
7	< 2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

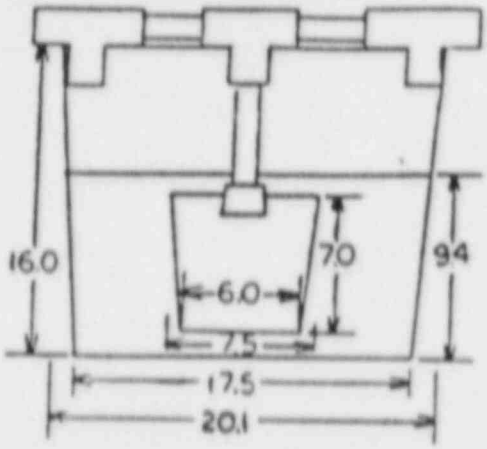
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an autostatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number MD 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_i, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powdex B1

LABORATORY WHERE TESTS PERFORMED CWSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Sr 85

Free Standing Water in Leach Specimen Container: ___ yes ✓ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = _____

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) N/A; Radioactivity (uCi) = ___; and % of A_0 = _____

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 347.4

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	1045 8-29	1245 8-29	$7.20E^{3}$	$7.20E^{3}$	$4.35E^{-4}$	Ø	$4.35E^{-4}$	1.25	$3.60E^{-3}$	$5.00E^{-7}$	$3.60E^{-3}$
2	22±3	1245 8-29	1645 8-29	$1.44E^{4}$	$2.16E^{4}$	$7.0E^{-4}$	Ø	$7.06E^{-4}$	1.55	$4.46E^{-3}$	$3.10E^{-7}$	$8.06E^{-3}$
3	22±3	1645 8-29	0530 8-30	$5.47E^{4}$	$7.83E^{4}$	$1.19E^{-3}$	Ø	$1.19E^{-3}$	3.43	$9.87E^{-3}$	$1.74E^{-7}$	$1.43E^{-2}$
4	22±3	0530 8-30	0540 8-31	$8.70E^{4}$	$1.65E^{5}$	$1.08E^{-3}$	Ø	$1.05E^{-3}$	3.13	$9.01E^{-3}$	$1.04E^{-7}$	$2.33E^{-2}$
5	22±3	0540 8-31	0900 9-1	$8.76E^{4}$	$2.53E^{5}$	$8.83E^{-4}$	Ø	$8.55E^{-4}$	2.58	$7.43E^{-3}$	$8.48E^{-8}$	$3.08E^{-2}$
6	22±3	0900 9-1	0645 9-2	$8.55E^{4}$	$3.38E^{5}$	$6.51E^{-4}$	Ø	$6.51E^{-4}$	2.03	$5.84E^{-3}$	$6.83E^{-8}$	$3.66E^{-2}$
7	22±3	0645 9-2	0855 9-6	$3.41E^{5}$	$6.84E^{5}$	$5.46E^{-4}$	Ø	$5.40E^{-4}$	2.61	$7.51E^{-3}$	$2.17E^{-8}$	$4.41E^{-2}$
8	22±3	0855 9-6	0830 9-9	$2.55E^{5}$	$9.42E^{5}$	$1.13E^{-10}$	Ø	$1.13E^{-10}$	3.61	$1.04E^{-2}$	$4.03E^{-8}$	$5.45E^{-2}$
9	22±3	0830 9-9	0640 9-14	$4.33E^{5}$	$1.35E^{6}$	$2.57E^{-4}$	Ø	$2.57E^{-4}$	$9.43E^{-1}$	$2.71E^{-3}$	$6.27E^{-9}$	$5.72E^{-2}$
10	22±3	0640 9-14	0550 9-23	$7.78E^{5}$	$2.13E^{6}$	$3.32E^{-4}$	Ø	$3.32E^{-4}$	1.23	$3.54E^{-3}$	$4.55E^{-9}$	$6.08E^{-2}$
11	22±3	0550 9-23	0845 10-4	$9.50E^{5}$	$3.10E^{6}$	$1.51E^{-4}$	Ø	$1.51E^{-4}$	$6.33E^{-1}$	$1.82E^{-3}$	$1.92E^{-9}$	$5.36E^{-3}$
12	22±3	0845 10-4	0830 10-21	$1.47E^{6}$	$4.57E^{6}$	$2.19E^{-4}$	Ø	$2.19E^{-4}$	1.1	$3.17E^{-3}$	$2.15E^{-9}$	$8.53E^{-3}$
13	22±3	0830 10-21	0630 11-11	$1.81E^{6}$	$6.38E^{6}$	$1.7E^{-4}$	Ø	$1.70E^{-4}$	1.08	$3.11E^{-3}$	$1.72E^{-9}$	$1.16E^{-2}$
14	22±3	0630 11-11	0900 11-28	$1.47E^{6}$	$7.85E^{6}$	$1.59E^{-4}$	Ø	$1.59E^{-4}$	1.2	$3.45E^{-3}$	$2.35E^{-9}$	$1.51E^{-2}$
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powdex B-1

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs 137

Free Standing Water in Leach Specimen Container: ___ yes ~~no~~

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 521.1

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	$t=\sum(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	1045 8-29	1245 8-29	7.20E3	7.20E3	7.33E-3	Ø	7.33E-3	16.14	3.10E-2	4.30E-6	3.10E-2
2	22±3	1245 8-29	1645 8-29	1.44E4	2.16E4	7.12E-3	Ø	7.12E-3	15.66	3.01E-2	2.09E-6	6.10E-2
3	22±3	1645 8-29	0830 8-30	5.67E4	7.83E4	1.33E-2	Ø	1.33E-2	29.31	5.62E-2	9.92E-7	.117
4	22±3	0830 8-30	0840 8-31	8.70E4	1.65E5	1.32E-2	Ø	1.32E-2	29.06	5.58E-2	6.41E-7	.173
5	22±3	0840 8-31	0900 9-1	8.76E4	2.53E5	9.49E-3	Ø	9.49E-3	20.89	4.01E-2	4.58E-7	.213
6	22±3	0600 9-1	0845 9-2	8.55E4	3.38E5	6.31E-3	Ø	6.31E-3	13.87	2.66E-2	3.11E-7	.240
7	22±3	0845 9-2	0855 9-6	3.46E5	6.84E5	1.56E-2	Ø	1.56E-2	34.27	6.58E-2	1.90E-7	.306
8	22±3	0855 9-6	0830 9-9	2.59E5	9.42E5	1.05E-2	Ø	1.05E-2	23.03	4.42E-2	1.71E-7	.350
9	22±3	0830 9-9	0840 9-14	4.33E5	1.38E6	1.17E-2	Ø	1.17E-2	25.80	4.95E-2	1.14E-7	.399
10	22±3	0640 9-14	0850 9-23	7.78E5	2.15E6	~~1.48E-2~~ 3.32E-4	Ø	~~2.19E-2~~ 3.32E-4	~~26.20~~ 7.30E-1	5.03E-2	6.46E-8	.449
11	22±3	0850 9-23	0645 10-4	9.50E5	3.10E6	9.11E-3	Ø	9.11E-3	20.04	3.85E-2	4.05E-8	.488
12	22±3	0645 10-4	0830 10-21	1.47E6	4.57E6	9.03E-3	Ø	9.03E-3	19.87	3.81E-2	2.59E-8	.526
13	22±3	0830 10-21	0830 11-11	1.81E6	6.38E6	5.65E-3	Ø	5.65E-3	12.43	2.39E-2	1.32E-8	.550
14	22±3	0830 11-11	0900 11-28	1.47E6	7.85E6	2.77E-3	Ø	2.77E-3	6.08	1.17E-2	7.94E-9	.562
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powder B

LABORATORY WHERE TESTS PERFORMED CNSI

ANALYST Paula Rowlett, Susan Rodriguez

DATE RESULTS REPORTED

Part A. Description of Leach Specimen

Specimen Id. Number Powder B - 1 and 2

Portion of Waste Incorporated in Mixture 37 Weight %

68.5 Volume %

(Based on initial volumes)

Type of Waste, Chemical and Radioisotopic Composition, and Specific Activity of the Waste

33.3 g Ecodex, 25.3 g Ecosorb, 24.0 g anion Powder, 72.0 g cation Powder, 2.7 g Solka floc, 2.7 g Na_2SO_4, 366.7 g DI H_2O, 50 ml nuclides (Ave 524 μCi Cs-137, 347.4 μCi Sr-85)

Type and Composition of the Solidification Agent 167 g Agent MS, 333 g Portland I cement

Preparation of Specimen Mix Ecodex, Ecosorb, anion and cation Powder, Solka floc, Na_2SO_4, and water. Allow to stand overnight and drain 127.4 g liquid. Add nuclides, Agent MS and cement. Blend and pour into 2 - 250 ml plastic cups. Seal and cure at 140°-150°F for 32 days.

Shape and Dimension of Specimen

Sphere, diameter, d (cm) =

Cylinder, diameter, d (cm) =

length, l (cm) =

Parallelepiped, length, l (cm) =

width, w (cm) =

height, h (cm) =

Other Shape Truncated cone

Dimensions Top diameter = 7.5 cm, bottom diameter = 6.0 cm, height = 7.0 cm

Initial Weight of Specimen, W (g) =

Volume of Specimen *, V (cm^3) = 251

Surface area of Specimen, S* (cm^2) = 220

Storage Conditions Stored in a sealed plastic cup during cure and cooling period. After cooling, sample was removed and immediately placed in the leaching vessel.

Appearance

Description of Leachant

Leach Interval (n)	Electrical Conductivity (umho/cm)	Volume, V_L (ml)
1	<2.0	2200
2	<2.0	2200
3	<2.0	2200
4	<2.0	2200
5	<2.0	2200
6	<2.0	2200
7	<2.0	2200

* Calculated from dimensions of specimen.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER

LABORATORY WHERE TESTS PERFORMED CNSI

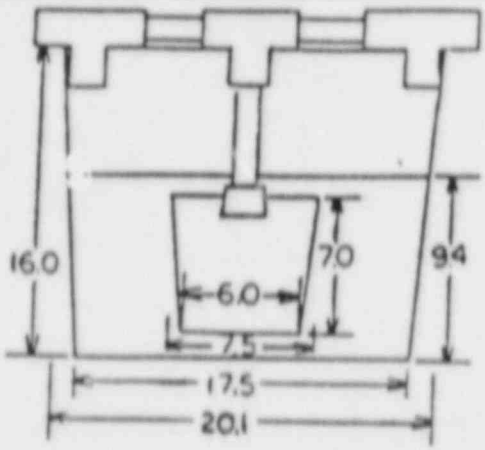
ANALYST Paula Rowland, Susan Ridgeway

DATE RESULTS REPORTED

Part B. Description of Leach Test Procedure

Specimen Preparation * (Same as Part A)

Diagram of Leach Apparatus:



Leachate Sampling Procedure Sample was removed from the leaching vessel and immediately placed in another leach vessel. The sample was not rinsed between periods. The leachate is stirred and a known volume withdrawn using an automatic pipette with disposable tips. The leachate sample is then pipetted into a numbered borosilicate vial. DI water is then added to bring the total volume to 15 ml.

Analytical Techniques:

Counting Instrument Identification and Calibration A Harshaw 3 x 3 NaI(Th) detector type number 12SW12-W4 serial number MD 328 calibrated using a NBS traceable standard of Cs-137, Co-60, and Sn-113.

Constituent a_1, Analytical Procedure, Standard Deviation of Method EG&G Ortec Model 7100 multi-channel analyzer

Constituent a_2, Analytical Procedure, Standard Deviation of Method Same as a_1.

Constituent a_i, Analytical Procedure, Standard Deviation of Method Same as a_1.

* If different from "Preparation of Specimen" in Part A.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powdex B-2
LABORATORY WHERE TESTS PERFORMED CNSI
ANALYST Paula Rowland, Susan Ridgeway
DATE RESULTS REPORTED
Part C. Experimental Data
Constituent Analyzed, a Sr. 85
Free Standing Water in Leach Specimen Container: ___ yes ~~no~~
If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___
Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.
Volume (ml) = N/A; Radioactivity (uCi) = ___; and % of A_0 = ___
Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 347.4

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_i/A_0 i
1	22±3	1045 8-29	1245 8-29	7.20E3	7.20E3	4.87E-4	Ø	4.87E-4	1.38	3.97E-3	5.51E-7	3.97E-3
2	22±3	1245 8-29	1645 8-29	1.44E4	2.16E4	7.04E-4	Ø	7.04E-4	2.03	5.84E-3	4.06E-7	9.81E-3
3	22±3	1645 8-29	0830 8-30	5.67E4	7.83E4	1.12E-3	Ø	1.12E-3	3.22	9.27E-3	1.63E-7	1.91E-2
4	22±3	0830 8-30	0840 8-31	8.70E4	1.65E5	1.03E-3	Ø	1.03E-3	3.00	8.64E-3	9.93E-8	.0277
5	22±3	0840 8-31	0900 9-1	8.76E4	2.53E5	9.74E-4	Ø	9.74E-4	2.85	8.20E-3	9.36E-8	.0359
6	22±3	0900 9-1	0845 9-2	8.55E4	3.38E5	8.18E-4	Ø	8.18E-4	2.43	6.99E-3	8.18E-8	.0429
7	22±3	0845 9-2	0855 9-6	3.46E5	6.84E5	4.78E-4	Ø	4.78E-4	1.48	4.26E-3	1.23E-8	.0472
8	22±3	0855 9-6	0830 9-9	2.58E5	9.42E5	5.25E-4	Ø	5.25E-4	1.16	3.34E-3	1.29E-8	.0505
9	22±3	0830 9-9	0840 9-14	4.33E5	1.38E6	1.86E-4	Ø	1.86E-4	.683	1.97E-3	4.55E-9	.0525
10	22±3	0840 9-14	0850 9-23	9.78E5	2.15E6	3.23E-4	Ø	3.23E-4	1.20	3.45E-3	4.43E-9	.0559
11	22±3	0850 9-23	0845 10-4	9.90E5	3.10E6	1.47E-4	Ø	1.47E-4	.613	1.76E-3	1.85E-9	.0577
12	22±3	0845 10-4	0830 10-21	1.47E6	4.57E6	1.58E-4	Ø	1.58E-4	.795	2.29E-3	1.56E-9	.060
13	22±3	0830 10-21	0830 11-11	1.81E6	6.38E6	2.08E-4	Ø	2.08E-4	1.29	3.71E-3	2.05E-9	.0637
14	22±3	0830 10-11	0900 11-28	1.47E6	7.85E6	2.04E-4	Ø	2.04E-4	1.53	4.40E-3	2.99E-9	.0681
15												

* Date, hour, and minute
** Concentration in leachate, show units.
*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

LEACH TEST RESULTS

LEACH TEST IDENTIFICATION NUMBER Powder B-2

LABORATORY WHERE TESTS PERFORMED CWSI

ANALYST Paula Rowland, Sugar Ridge way

DATE RESULTS REPORTED

Part C. Experimental Data

Constituent Analyzed, a Cs 137

Free Standing Water in Leach Specimen Container: ___ yes ~~X~~ no

If yes, Volume (ml) = ___; Radioactivity (uCi) = ___; and % of A_0 = ___

Specimen Rinse Before Initiation of Leaching: Do not include with results in the table below.

Volume (ml) = n/a; Radioactivity (uCi) = ___; and % of A_0 = ___

Initial Amount in Specimen, A_0 (uCi) [after 30-s rinse] = 5214

Interval (n)	Temp. (°C)	Time & Date* In	Time & Date* Out	$(dt)_n$ (s)	t=Sum $(dt)_n$ (s)	As Analyzed (uCi/cc)	Blank (uCi/cc)	Corrected Conc. (uCi/cc)	a_n*** (uCi)	a_n/A_0	$[a_n/A_0][1/(dt)_n]$ (fraction/s)	n Sum a_j/A_0 1
1	22±3	1045 8-29	1245 8-29	7.20E3	7.20E3	7.3E-3	Ø	7.3E-3	16.08	3.05E-2	4.29E-6	3.09E-2
2	22±3	1245 8-29	1645 8-29	1.44E4	2.16E4	7.10E-3	Ø	7.10E-3	15.61	3.00E-2	2.08E-6	6.09E-2
3	22±3	1645 8-29	0830 8-30	5.67E4	7.83E4	1.16E-2	Ø	1.16E-2	25.56	4.91E-2	8.66E-7	.110
4	22±3	0830 8-30	0840 8-31	8.70E4	1.65E5	1.48E-2	Ø	1.46E-2	32.20	6.18E-2	7.10E-7	.172
5	22±3	0840 8-31	0900 9-1	8.76E4	2.53 E5	9.34E-3	Ø	9.34E-3	20.54	3.94E-2	4.50E-7	.211
6	22±3	0900 9-1	0845 9-2	8.55E4	3.38E5	6.46E-3	Ø	6.46E-3	14.22	2.73E-2	3.19E-7	.238
7	20±3	0845 9-2	0855 9-6	3.46E5	6.84E5	1.55E-2	Ø	1.55E-2	34.11	6.55E-2	1.89E-7	.304
8	20±3	0858 9-6	0830 9-9	2.59E5	9.43E5	9.26E-3	Ø	9.26E-3	20.37	3.91E-2	1.52E-7	.343
9	20±3	0830 9-9	0840 9-23	4.33E5	1.38E6	1.12E-2	Ø	1.12E-2	24.68	4.74E-2	1.09E-7	.390
10	20±3	0840 9-23	0850 9-23	7.78E5	2.15E6	1.06E-2	Ø	1.06E-2	23.28	4.47E-2	5.75E-8	.435
11	20±3	0850 9-23	0845 10-4	9.50E5	3.10E6	8.76E-3	Ø	8.76E-3	19.28	3.70E-2	3.89E-8	.472
12	20±3	0845 9-4	0830 10-21	1.47E6	4.57E6	8.48E-3	Ø	8.48E-3	18.66	3.58E-2	2.44E-8	.508
13	20±3	0830 10-21	0830 11-11	1.81E6	6.38E6	5.49E-3	Ø	5.49E-3	12.08	2.32E-2	1.28E-8	.531
14	20±3	0830 11-11	0900 11-28	1.47E6	7.85E6	2.22E-3	Ø	2.22E-3	4.90	9.40E-3	6.39E-9	.540
15												

* Date, hour, and minute

** Concentration in leachate, show units.

*** a_n = corrected concentration x V_i x factor to convert to same units a A_0. The value of a_n must include any radioactivity rinsed from the specimen and the leach apparatus at the end of the renewal period.

ATTACHMENT 4

COMPARISON

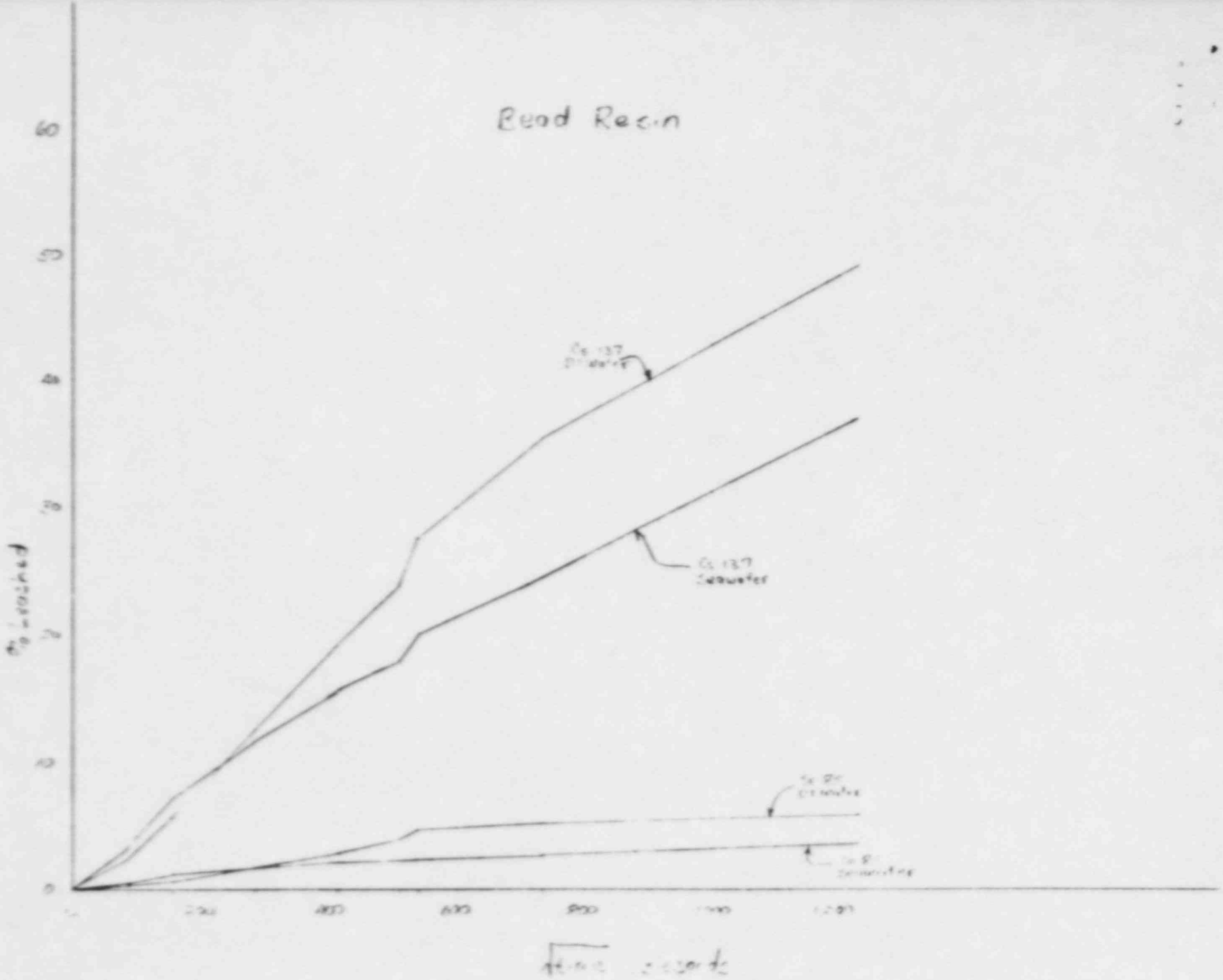
OF

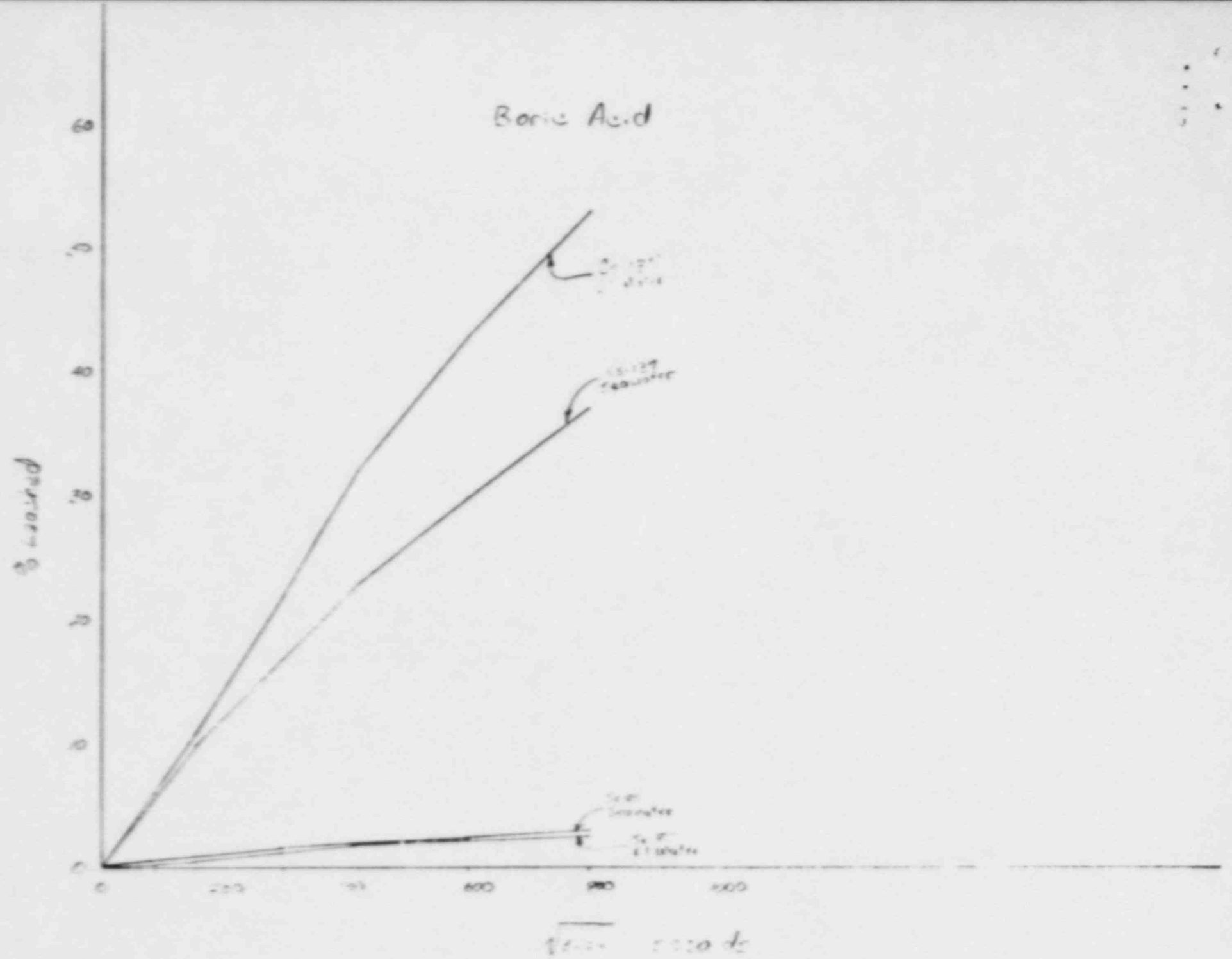
LEACH TEST RESULTS

BETWEEN

SYNTHESIZED SEA WATER / DEIONIZED WATER

Bead Resin




Boric Acid