

PROJECT ADMINISTRATION DATA SHEET

ORIGINAL  REVISION NO. \_\_\_\_\_

Project No. E-25-689 R6076-OAO GTRC/~~EXX~~ DATE 12/31 / 85

Project Director: G.G. Eichholz School ~~DEB~~ ME NE/HP

Sponsor: E.I. Dupont De Nemours & Company Savannah River Plant  
Aiken, SC 29808-0001

Type Agreement: P.O. No. AX-0720613 Under D.O.E. Prime No. DE-AC09-76SR00001

Award Period: From 11/15/85 To 5/15/86 (Performance) 5/15/86 (Reports)

Sponsor Amount: 12-14-86  
This Change Total to Date

Estimated: \$ \_\_\_\_\_ \$ 24,948.00

Funded: \$ 24,948.00 \$ 24,948.00

Cost Sharing Amount: \$ \_\_\_\_\_ Cost Sharing No: \_\_\_\_\_

Title: Investigation of Leaching Phenomena Under Conditions of Unsaturated Flow

ADMINISTRATIVE DATA

OCA Contact R. Dennis Farmer X4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:

M.W. Grant

Subcontract Administration

Building 773-41A, Room 254

E.I. DuPont De Nemours & Company

Savannah River Plant

Aiken, SC 29808-0001 (803) 725-6211

Defense Priority Rating: DO-E-2 Military Security Classification: \_\_\_\_\_

(or) Company/Industrial Proprietary: \_\_\_\_\_

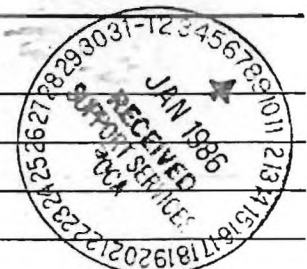
RESTRICTIONS

See Attached \_\_\_\_\_ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of \$500 or 125% of approved proposal budget category.

Equipment: Title vests with Government

COMMENTS:



COPIES TO: SPONSOR'S I. D. NO. 02.240.004.86.002

Project Director  
Research Administrative Network  
Research Property Management  
Accounting

Procurement/GTRI Supply Services  
Research Security Services  
Reports Coordinator (OCA)  
Research Communications (2)

GTRC  
Library  
Project File  
Other Jones/Newton

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 3-13-87

Project No. E-25-689 School/Lab ~~XXX~~ ME

Includes Subproject No.(s) N/A

Project Director(s) G. Eichholz GTRC / ~~XXX~~

Sponsor E.I. DuPont De Nemours & Company Savannah River Plant - Aiken, SC 29808-0001

Title Investigation of Leaching Phenomena Under Conditions of Unsaturated Flow

Effective Completion Date: 12-14-86 (Performance) 12-14-86 (Reports)

Grant/Contract Closeout Actions Remaining:

- None
- Final Invoice or Final Fiscal Report
- Closing Documents
- Final Report of Inventions - Questionnaire sent to P.I.
- Govt. Property Inventory & Related Certificate
- Classified Material Certificate
- Other \_\_\_\_\_

Continues Project No. \_\_\_\_\_ Continued by Project No. \_\_\_\_\_

COPIES TO:

- Project Director
- Research Administrative Network
- Research Property Management
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- Procurement/GTRI Supply Services
- Research Security Services
- ~~Reports Coordinator (OCAL)~~
- Legal Services

Library  
 GTRC  
 Research Communications (2)  
 Project File  
 Other Ina Lashley  
 \_\_\_\_\_  
Angela DuBose  
Russ Embry



E-25-689



# Georgia Institute of Technology

A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA  
SCHOOL OF MECHANICAL ENGINEERING

January 15, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAM  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Waste Disposal Technology Division  
Savannah River Laboratory  
EI Du Pont de Nemours & Co.,  
Aiken, S.C. 29808

## Monthly Progress Report - Project E 25-689

Dear Dr. Grant,

After some administrative delays the contract for this project was finally in place in early December and this report covers the period from inception, effectively November 15, 1985 to date. During this period work has been under way in two areas, migration studies in soil columns to establish migration rates under unsaturated flow conditions and leach investigations, which are just getting under way, on simulated waste in soil columns.

For the flow experiment and unsaturated a flow system was designed as shown in the attached diagram. Water content is controlled by applying suction to the bottom of each column. Tests are run on three types of soil, including SRP soils, with I-131 and Cs-137 tracers. Using the iodine tracer, a relation has been obtained connecting count rate and water content.

Leach tests have been started using Rexyn ion exchange resin to simulate the waste matrix and both deionized and equilibrated water as the leachant. Elution under saturated and various unsaturated regimes will be compared under steady flow and cyclic flow conditions. We expect to find a transition from dilution and diffusion into an infinitely thick liquid to a film wetting effect on minimum moisture contents.

We still look forward to a visit from you to discuss further details on the project, perhaps in early February. In the meantime we expect to proceed as outlined, with Mr. Petelka and Mr. Park responsible for the leach tests and Mr. Whang and Miss Long for the migration columns.

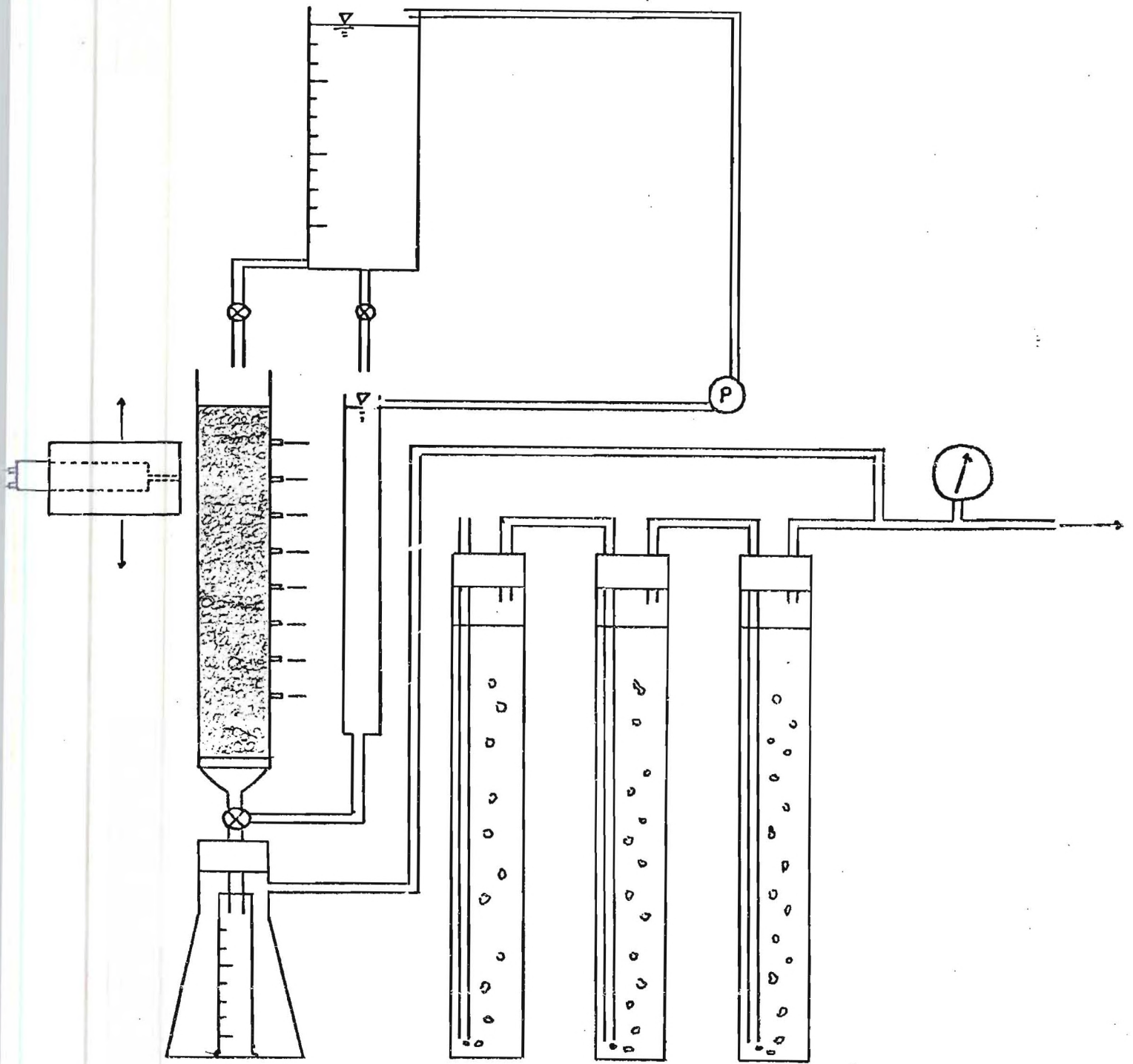
I hope you received the new tape on the 3 D model in good condition and it is implemented satisfactorily on your computer.

Yours sincerely

G.G. Eichholz  
Regents' Professor

GGE/sm  
cc: P. Heitmuller (OCA)

Telephone: 404-894-3720 Telex: 542507 GTRIOCAATL Fax: 404-894-3120 (Verify: 404-894-4850)



SCHEMATIC DIAGRAM OF EXPERIMENTAL APPARATUS



# Georgia Institute of Technology

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SCHOOL OF MECHANICAL ENGINEERING

February 14, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAM  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Waste Disposal Technology Division,  
Savannah River Laboratory  
E.I. Du Pont de Nemours & Company  
Aiken, S.C. 29808

Monthly Progress Report - Project E-25-689

Dear Dr. Grant,

During the month work progressed on both tasks, the leach rate determination and the unsaturated - flow migration test. Distribution coefficients,  $K_d$ , are being determined for equilibrated water for SRP soil, using I-131, Cs-137, and Ba - 133 tracers. SRP Soil #3 has been characterized and both particle size distribution and surface area have been measured. Unsaturated flow through the larger columns has been tested and it has been shown that constant flow under unsaturated conditions can be maintained.

The resin beads serving as the simulated waste matrix have been tested for residual water retention and bead characteristics. A new column has been set up for the leach tests and is being tested.

We anticipate completing the major part of the unsaturated - flow migration tests during the coming month.

Please call me if you have any questions regarding this work.

Yours sincerely,

G.G. Eichholz  
Regents' Professor

GGE/sm

cc: P. Heitmuller (OCA)



E-25-689



# Georgia Institute of Technology

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SCHOOL OF MECHANICAL ENGINEERING

March 12, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAM  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
E. I. Du Pont de Nemours & Company  
Aiken, SC 29808

## Monthly Progress Report - Project E25-689

Dear Dr. Grant:

Since your visit last week here helped to update you on our activity in detail, I am sending you this letter mainly for the record. Work has proceeded on both tasks: Migration through unsaturated soil and leach tests with soil-equilibrated water.

Steady unsaturated flow conditions have been maintained in a long column whose hydraulic pressure is monitored by means of tensionmeters at six levels. Cyclic wetting and drying conditions are being produced to obtain the appropriate time constants. It is evident that the effect of an infiltration pulse gets smoothed out at moderate depth already.

$K_d$  measurements for various tracers have been obtained with equilibrated water. The value obtained for barium was unexpectedly low and that test is being repeated.

Leach tests with ion exchange beads have resulted in rather large pH changes below the resin layer with slow recovery. Measurements of effective surface area of the beads have been somewhat ambiguous. For these reasons tests are under way with molecular sieve material as an alternative waste form simulation.

Because of the slow nature of unsaturated flow, many of these experiments take time and we are planning a number of tests in parallel. It is obviously desirable to continue this work over the rest of the year as originally planned. A tentative work plan is attached to cover the six-month period past the expiry of the current contract. I will be happy to discuss any details with you to facilitate extension of this contract as I believe the results of this work will be beneficial to SRP in obtaining a realistic assessment of the environmental impact of on-site waste disposal.

Yours truly,

Geoffrey G. Eichholz  
Regents' Professor

GGE:jp





# Georgia Institute of Technology

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SCHOOL OF MECHANICAL ENGINEERING

April 10, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAM  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
E I Du Pont de Nemours & Co.  
Aiken, SC 29808

Monthly Progress Report - Project E25-689

Dear Dr. Grant:

During the past month work has continued, in parallel, on the two major tasks on this project. Tracer tests have been done on SRP soil columns with Ba-133 to observe migration profiles as a function of time under 80% saturation flow conditions. Tests are under way to repeat this for lower moisture contents.

Difficulties have arisen in the leach tests with a simulated waste matrix because the presence of molecular sieve material, chosen as a candidate material, resulted in a significant increase in pH in all waters tested. We are searching for other suitable materials at the moment, to minimize insertion problems, and are considering vermiculite, either raw or baked, and natural zeolites for this purpose.

In view of the impending termination of this contract we hope we can be assured of a timely renewal for another six months to ensure continuity of effort.

I look forward to discussing this work with you at SRL on April 16.

Yours sincerely,

Geoffrey G. Eichholz  
Regents' Professor

GGE:jp

cc: P. Heitmuller (OCA)

# Georgia Institute of Technology

A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA

SCHOOL OF MECHANICAL ENGINEERING

ATLANTA, GEORGIA 30332

May 16, 1986

Mr. Michael W. Grant  
Advanced Waste Disposal Technology Division  
Savannah River Laboratory  
E.I. Du Pont de Nemours & Company  
Aiken, S.C. 29808

Monthly Progress Report - Project E-25-689

Dear Dr. Grant:

In view of the problems encountered in using synthetic zeolite as a simulated waste form, our work is now focused on vermiculite as a waste form, using barium as the tracer. We obtained a quantity of vermiculite and have begun physical testing. The vermiculite was passed through a series of screens to provide the matrix for the continuing tests. Physical properties, including the moisture characteristic curve and the bulk density have been determined. Optical microscopy was used to characterize the particles.

Batch adsorption-desorption tests have been performed on the vermiculite, using cesium and barium tracers and various leachants. It was found that Ba and Cs can be loaded onto vermiculite using deionized water. The amount of tracer adsorbed is slightly affected by the presence of competing ions in solution. The quality of water used during desorption strongly affects the removal of the tracer from the vermiculite. Cesium is very strongly held under all tested conditions and is not suitable for our purposes.

The experimental facility has completed the first operational test, and is functioning as designed. Solution flow control remains problematic. It is expected that the first unsaturated leach tests will commence shortly.

The counting system was interfaced to the personal computer in the lab, allowing for unattended data collection. The system also provides statistical information while saving the data on disk. Sample changing is manual.

On the migration tests, comparative runs have been completed with I-131 and Ba-133 at various suction heads, producing unsaturated conditions. The results are being compared with theory to permit generalization regarding the validity of  $K_d$  factors under these conditions. This week is being incorporated in Mr. Whang's thesis and I am proposing to submit that thesis next month as the interim report on this phase of the project.



Mr. Michael W. Grant  
Page 2  
May 16, 1986

I still hope to hear shortly regarding the extension of the project to allow us to complete the work in hand.

We would appreciate it if you can expedite the renewal contract as officially we have reached the termination date of the current contract.

Yours sincerely,

Geoffrey G. Eichho<sup>s</sup>  
Regents' Professor~~s~~

GGE:jp

*cc P. Heitman*

E-25-689



# Georgia Institute of Technology

A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA  
SCHOOL OF MECHANICAL ENGINEERING

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAM  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

July 16, 1986

Dr Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
EI DuPont de Nemours & Co.  
Aiken, South Carolina 29808

Re: Monthly Progress Report - Project E25-689

Dear Dr. Grant:

After a hiatus of two months, the renewal contract for this project appears to be in place finally. We have been continuing the work in the interval with some useful results.

I am enclosing the draft version of Mr. Whang's thesis, which will serve as an interim progress report on the first phase of this project. We are continuing column tests with tracers to obtain the remaining points needed in defining migration under unsaturated conditions and expect to conclude those measurements by the end of August.

Tests with labeled vermiculite have indicated that this is an acceptable medium to simulate waste, though some problems arise from it's dimensional variability. Tests are under way with short columns to compare leading under saturated and unsaturated conditions with deionized and soil-equilibrated water. This is expected to constitute the major emphasis for the balance of the project.

Please let me know if you have any comments on the draft thesis or the current program.

Sincerely,

Dr. Geoffrey G. Eichholz

cc: P. Heitmuller



E-25-689



Georgia Institute of Technology  
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA  
NUCLEAR ENGINEERING AND HEALTH PHYSICS PROGRAMS  
SCHOOL OF MECHANICAL ENGINEERING

August 15, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAMS  
CHERRY ENERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Division  
Savannah River Laboratory  
E. I. DuPont de Nemours & Co.  
Aiken, South Carolina 29808

Re: Monthly Progress Report  
Project E25-689

Dear Dr. Grant:

Last month we sent you the draft version of Mr. Whang's thesis as a partial completion report. We would appreciate any comments you may have on this work. After a break due to a rearrangement of our laboratory facilities, work has continued to complete the tracer flow tests on soil column migration under unsaturated flow conditions and we expect to complete that phase of the work by the end of the month.

The vermiculite samples have been hydraulically characterized to serve as leach test samples and we are trying to decide whether it is more practical to work with all-vermiculite columns or vermiculite sandwiched in soil columns for tests under unsaturated conditions. Both approaches may be tried initially, with a decision by the end of August. We expect to complete the leach runs by the end of October.

We would welcome a discussion with you at this stage of the work if you can manage a visit here at this time.

Sincerely,  
A

G. G. Eichholz  
Regents' Professor

GGE/bc

cc: P. Heitmuller



Georgia Institute of Technology  
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NUCLEAR ENGINEERING AND HEALTH PHYSICS PROGRAMS  
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GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

September 22, 1986

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
E.I. DuPont de Nemours & Co.  
Aiken, SC 29808

Re: Monthly Progress Report  
Project E25-689

Dear Dr. Grant:

This past month we conducted the first leach test with a barium tracer, using the small column developed previously. Deionized water equilibrated with vermiculite was used as the leachant. The solution was delivered at 30 ml per day from a syringe pump fabricated in our laboratory, equivalent to a pore velocity of 3.0 cm/d (11 m/yr.) The release rate was found to be  $4.74 \times 10^{-6}$  of the initial activity per ml passing through the system, with a correlation of 0.9976.

This initial test is being followed up by a series of columns operating at different moisture contents. The leachant in the current tests is SRP 3-equilibrated water. One of the columns will be run in the saturated mode to compare the effects of water quality. The remaining columns will be operated at various levels of unsaturation.

In addition, studies were done to check the pH variation of the nominally soil-equilibrated water with contact time and surface area as this will be critical in affecting leaching conditions. Equilibrium was reached in about 12 hrs of contact with pH values ranging from 4.6 to 5.0 for SRP soils used.

All of these tests are continuing and we expect to conclude the experimental work within the next few weeks. Let me know if there are any other areas where we may be able to assist you.

Yours sincerely,

Geoffrey Eichholz  
Regents' Professor

GE:jp  
cc: P. Heitmuller (OCA)



E-25-689



# Georgia Institute of Technology

A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA  
NUCLEAR ENGINEERING AND HEALTH PHYSICS PROGRAMS  
SCHOOL OF MECHANICAL ENGINEERING

October 17, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAMS  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
E. I. Du Pont de Nemours & Company  
Aiken, S.C. 29808

## Monthly Progress Report - Project E 25-689

Dear Dr. Grant:

After completion of baseline tests under saturated conditions, we have completed the first leach runs under unsaturated conditions, using vermiculite as the simulated waste material.

The initial release rate for the saturated column under saturated conditions was 5.1 times the rate found when deionized water was the leachant, probably due to ion exchange processes.

The test were performed using the small columns developed previously; SRP#3 equilibrated water was used as the leachant. The solution was delivered at 16.3 ml per day, equivalent to a pore velocity of from 1.7 cm/day in the saturated column to 3.5 cm/day in the least saturated column.

These test are being augmented by another series of four columns one saturated, but with a different pore velocity than the last, and three operating at different moisture contents. SRP#3 equilibrated water will continue to be the leachant in the current tests.

Ancillary tasks underway include a check on possible entrainment of activity by colloids and an analytic determination of water quality.

I am sorry, I did not have a chance to see you last week. I did see Ed Albenecius briefly and hope we can collaborate on a tritium migration project.

Please call me if you have any questions.

Yours sincerely,

Geoffrey G. Eichholz  
Regents' Professor

GGE:jp

cc: P. Heitmuller (OCA)

E-25-689



Georgia Institute of Technology  
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA  
NUCLEAR ENGINEERING AND HEALTH PHYSICS PROGRAMS  
SCHOOL OF MECHANICAL ENGINEERING

November 14, 1986

Please reply to:

NUCLEAR ENGINEERING AND  
HEALTH PHYSICS PROGRAMS  
CHERRY EMERSON BUILDING  
GEORGIA INST. OF TECH.  
ATLANTA, GEORGIA 30332 U.S.A.

Dr. Michael W. Grant  
Advanced Waste Disposal Technology Div.  
Savannah River Laboratory  
E. I. DuPont de Nemours & Co.  
Aiken, S. C. 29808

Monthly Progress Report - Project E25-689

Dear Dr. Grant,

During the past month we concluded the unsaturated leach tests using vermiculite under saturated and unsaturated conditions. The range of water content studied was from complete saturation to 40 percent saturation. SRP#3 equilibrated water was used as the leachant. The variation of release due to changes in the pore water velocity was also examined. For the velocity range used in the unsaturated study, the velocity effects were found to be negligible.

The release rate dependence upon water quality is currently being reexamined. The early data was found to be inconsistent with the recently acquired water quality data.

Ancillary tasks underway include a more detailed characterization of the vermiculite, including its cation exchange capacity.

The past month, the water (SRP 3) used for the teaching experiment was characterized using an ICP and also using a conductivity test. A preliminary water characterization test was run using prepared standards that measured 1000 times greater than the molar concentration of calcium, potassium, sodium, magnesium and strontium. These standards were diluted by a 1/1000 and the water quality was recharacterized. The concentrations were found to be on the order  $10^{-5}$  to  $10^{-8}$  molar, in two separate runs. These results were confirmed by conductivity tests.



Dr. Michael W. Grant  
Page 2

We expect to complete the test work shortly and are evaluating our results. The principal data will be summarized in Frank Petelka's thesis which is in preparation.

We will begin preparation of our final report during the next few weeks and hope to get the draft report in shape before the termination of the project in mid-December.

Yours sincerely,

G. G. Eichholz  
Regents' Professor,

GGE/jr

cc: P. Heitmuller (OCA)