**UNIVERSITY LOANED NORMAL URANIUM SLUG
DISPOSITION STUDY - UNIVERSITY SURVEY RESPONSES
(U)**

by G. W. Becker, Jr.

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September 1, 1992

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1.0 INTRODUCTION

During the 1950's and 1960's, the Atomic Energy Commission loaned rejected natural uranium slugs from the Savannah River Site to United States universities for use in subcritical assemblies. Currently, there are sixty-two universities holding 91,798 slugs, containing about 167 metric tons of natural uranium. It was originally planned that the universities would return the material to Fernald when they no longer required it. Fernald has not received slugs since it was shut down in 1988.

The Department of Energy's Office of Weapons and Materials Planning requested that the Planning Support Group develop information to assist them in facilitating the return of the unwanted slugs to one or more of their facilities and develop alternatives for the ultimate disposition of this material. This supplemental report to the University Loaned Normal Uranium Slug Disposition Study¹ documents responses to and summarizes the results of a survey of fifty-eight universities. University contacts and survey responses covering loaned slug descriptions, historical information, radiological data, current status, and plans and schedules are documented.

2.0 SUMMARY

The Department of Energy has 91,798 slugs, containing 167 metric tons of natural uranium, on loan to sixty-two universities. Information concerning this material was requested from fifty-eight universities.

The following summary comes from the 40 universities that responded.

- The slugs consist of reject Mark I, Mark VII-A and Mark VB models consisting of a natural uranium core encased in aluminum cladding. The inventory as listed by the Department of Energy agreed with that of the responding universities, except that one slug was disposed of, nine were lost, seventeen are out of service due to pitting, twenty-five are stuck in fuel tubes, and four have been altered.
- The slugs have been intermittently irradiated by ~ 5 Ci sources in student subcritical assemblies.
- In general, this irradiation has not significantly affected the slugs. The dose from slugs is about the same as natural uranium, surface contamination is below detectable limits. Fission products and transuranics are nil.
- Inactive slugs are stored in wood, cardboard, and steel boxes with vermiculite. Some are stored in subcritical assembly Al lattice tubes. No regulatory problems were reported.

¹ Becker, Jr., G. W., University Loaned Normal Uranium Slug Disposition Study (U), NMP-92-04, August 21, 1992.

- Plans and Schedules: Twenty universities definitely want to return all or a portion of their slugs as soon as possible. Seven may return their slugs. The storage area required to accommodate the amount of university natural uranium slugs to be returned is < 1,000 ft².

3.0 UNIVERSITY BASIC DATA

The 62 universities with loaned slugs are listed on Table 1. This list of universities was compiled from the end of March 1992 Savannah River² and Nuclear Materials Management and Safeguards System³ records. Fifty-eight of these universities were contacted about the

Table 1 Universities with Loaned Slugs

University		Slug No.	Slug Wt. kg
Tuskegee University	AL	2,440	4,212.20
University of Alabama	AL	1,382	2,494.91
University of Arkansas	AR	1,378	2,493.94
University of Arizona	AZ	1,396	2,493.59
Arizona State University	AZ	1,382	2,494.91
University of California, Berkeley	CA	2,603	5,944.43
San Diego State University	CA	1,681	3,034.35
California Polytechnical State University	CA	1,384	2,493.50
Pacific Union College	CA	1,384	2,493.50
University of California, Santa Barbara	CA	1,380	2,491.31
La Sierra University	CA	1,373	2,493.61
Occidental College	CA	1,289	2,498.72
California State Univ., Northridge	CA	1,108	1,986.00
University of Denver, Research Center ✓	CO		2.00
Howard University	DC	1,381	2,493.10
University of Florida	FL	1,522	3,984.56
Georgia Institute of Technology	GA	1,301	2,500.93
Iowa State University	IA	2,162	4,176.30
University of Iowa ✓	IA	2	3.86
University of Idaho	ID	1,384	2,489.73
University of Illinois at Urbana-Champaign	IL	2,772	4,991.69
Valparaiso University	IN	1,425	2,499.88
University of Notre Dame	IN	1,054	1,899.91
University of Kentucky	KY	1,415	2,494.15

✓ Universities not included in survey

2 Savannah River Field Office, Schedule of Normal Uranium on Loan or Lease, March 31, 1992.

3 U. S. Nuclear Materials Management and Safeguards System, Composition of Ending Inventory With Dollar Values For Educational Institutions (U), Report I-21G-HDQ-XAB-QUA(U), March 31, 1992.

Table 1 Universities with Loaned Slugs (continued)

University		Slug No.	Slug Wt. kg
Louisiana State University	LA	1,419	2,496.84
United States Naval Academy	MD	1,396	2,493.59
Maine Maritime Academy	ME	1,386	2,493.33
University of Michigan	MI	1,432	2,498.64
Wayne State University	MI	1,045	1,819.97
University of Missouri, Rolla	MO	1,412	2,540.10
University of Missouri	MO	1,289	2,499.50
Mississippi State University	MS	1,384	2,493.50
University of Nebraska	NB	1,384	2,493.50
University of North Dakota	ND	1,401	2,493.47
Saint Peters College	NJ	1,381	2,493.10
New Jersey Institute of Technology	NJ	1,380	2,490.67
University of New Mexico	NM	1,382	2,494.91
Manhattan College, School of Engineering	NY	2,799	4,988.38
Columbia University	NY	2,762	4,767.48
Polytechnic University	NY	2,570	4,627.00
Cornell University	NY	2,100	3,864.28
State University of New York at Maritime	NY	1,410	2,494.46
United States Military Academy	NY	1,396	2,493.59
United States Merchant Marine Academy	NY	1,384	2,493.50
State University of New York at Buffalo	NY	1,381	2,499.15
Rensselaer Polytechnic Institute	NY	1,299	2,498.88
State University of New York at Stony Brook	NY	61	205.77
Ohio State University	OH	2,271	3,956.93
University of Cincinnati	OH	1,427	2,493.86
Youngstown State University	OH	1,373	2,493.61
University of Oklahoma	OK	1,381	2,494.67
Oregon State University	OR	620	2,050.00
Reed College ✓	OR	1	4.00
Benedict College	SC	1,378	2,493.94
University of Tennessee	TN	4,709	6,356.59
Tennessee Technical University	TN	2,760	4,988.22
Texas A&M University	TX	1,406	2,494.23
Virginia Military Institute	VA	1,532	2,772.25
University of Virginia	VA	1,372	2,491.79
University of Washington ✓	WA	77	92.00
University of Wisconsin	WI	1,289	2,499.50
West Virginia Institute of Technology	WV	751	1,351.00
Total		91,798	166,927

✓ Universities not included in survey

status of their natural uranium slugs. Four universities listed in Table 2 were not contacted because of the small quantity of material in their possession. According to Department of Energy records at Savannah River, the University of Iowa and the University of Washington want to return their slugs.

Table 2: Universities Not Contacted

University		Slug No.	Slug Wt. kg
University of Denver, Research Center	CO		2.00
University of Iowa	IA	2	3.86
Reed College	OR	1	4.00
University of Washington	WA	77	92.00
Total		80	101.86

3.1 UNIVERSITY QUESTIONNAIRE

The following questions were Faxed to the fifty-eight universities,

(1) Please describe the natural uranium on loan to

- e. g., if available, the original model designation (Mark 1, etc.) the number, weight, and dimensions of loaned natural uranium slugs, pieces, etc. The Department of Energy records indicate that *number* slugs, weighing *mass* kg are at *University*;

(2) Please provide historical information

- e. g., When did you receive this material? Has the material been altered (machined, recanned, etc.)? What was it used for? Has it been irradiated? etc

(3) Please provide average and range radiological data for your natural uranium slugs

- e. g., external radiation level (dose rate at 1 ft. in mrem/h), surface contamination (α and β - γ d/m per 100 cm sq. cm), estimated fission product curie content, and estimated transuranic and fission product

(4) Please provide information on the status of this material

- e. g., How is it currently being used? If inactive, how is it packaged and stored? Are there any regulatory (NRC, EPA, State or Local) compliance issues involved with this material?

(5) Please provide information on your plans and schedules for this material

- e. g., Do you wish to keep this material? Do you wish to return this material to the Department of Energy? If you plan on returning the natural uranium to the Department of Energy, what is your proposed schedule?

As of the issuance of this report, forty universities have responded to the questionnaire.

3.2 RESPONSES

University responses to the preceding five questions along with any other materials received from individual universities are in Appendix A. Responses are divided into four groups; (A.1) universities that want to retain slugs, (A.2) universities that want to return slugs as soon as possible, (A.3) universities that may return slugs, and (A.4) universities that want to transfer their slugs to other institutions. The universities in each of these groups is summarized below.

The names, titles, addresses, telephone numbers, and Fax numbers of the fifty-eight university contacts have been attached in Appendix B.

3.2.1 Universities That Want to Retain Slugs

Out of the fifty-eight universities surveyed, forty responded, and nineteen of these said they appreciate the availability and use of this material, and would like to continue utilizing all or a portion of this material in teaching and research at their respective Nuclear Engineering and Engineering Physics Laboratories. The nineteen universities are listed below in Table 3.

Table 3 Universities That Want to Retain Their Slugs

		<u>No.</u>	<u>Kg U</u>
University of Arizona	AZ	1,396	2,493.59
California State Univ., Northridge	CA	1,108	1,986.00
University of California, Santa Barbara	CA	1,380	2,491.31
University of California, Berkeley •	CA	1,909	3,444.99
University of Florida •	FL	1,292	2,496.00
Georgia Institute of Technology	GA	1,301	2,500.93
Iowa State University •	IA	1,560	3,013.43
Louisiana State University	LA	1,419	2,496.84
United States Naval Academy	MD	1,396	2,493.59
University of Missouri	MO	1,289	2,499.50
University of Missouri, Rolla	MO	1,412	2,540.10
University of New Mexico	NM	1,382	2,494.91
United States Military Academy	NY	1,396	2,493.59
University of Cincinnati	OH	1,427	2,493.86
Oregon State University	OR	620	2,050.00
Benedict College	SC	1,378	2,493.94
Tennessee Technical University	TN	2,760	4,988.22
Virginia Military Institute	VA	1,532	2,772.25
University of Wisconsin	WI	1,289	2,499.50
Total		27,246	50,742.55

- These universities want to retain a portion of their slugs, see Table 4

3.2.2 Universities That Want to Return Slugs ASAP

The twenty universities listed in Table 4 stated that they definitely want to return all or a portion of their slugs as soon as possible to the Department of Energy.

Table 4: Universities That Want to Return Slugs ASAP

<u>Definitely want to return slugs</u>		<u>Slugs</u>	<u>Wt. kg</u>
Tuskegee University	AL	2,440	4,212.20
University of Alabama	AL	1,382	2,494.91
California Polytechnical State Univ.	CA	1,384	2,493.50
La Sierra University	CA	1,373	2,493.61
Occidental College	CA	1,289	2,498.72
University of California, Berkeley *	CA	694	2,499.44
San Diego State University	CA	1,681	3,034.35
Howard University	DC	1,381	2,493.10
University of Florida *	FL	230	1,487.00
Iowa State University *	IA	602	1,162.87
University of Iowa †	IA	2	3.86
University of Notre Dame	IN	1,054	1,899.91
Wayne State University ‡	MI	1,045	1,819.97
Saint Peters College	NJ	1,381	2,493.10
Columbia University √	NY	2,762	4,767.48
Cornell University ‡	NY	2,100	3,864.28
Polytechnic University	NY	2,570	4,627.00
United States Merchant Marine Academy √	NY	1,384	2,493.50
University of Oklahoma	OK	1,381	2,494.67
University of Washington †	WA	77	92.00
Total		26,212	49,425.47

* University wants to return a portion of their slugs

† Not contacted, return desired per Department of Energy records

√ No response, return desired per Department of Energy records

‡ No response, return desired per phone contact

3.2.3 Universities That May Return Slugs

Seven of the universities that responded stated that they are exploring the option of returning their slugs due to phaseout of their nuclear program, lack of use of their sub-critical reactor, campus remodeling plans, etc. The decision process is still going on. These seven universities are listed in Table 5.

Table 5 Universities That May Return Slugs

		<u>No.</u>	<u>Kg U</u>
Arizona State University	AZ	1,382	2,494.91
University of Idaho	ID	1,384	2,489.73
Valparaiso University	IN	1,425	2,499.88
University of Michigan	MI	1,432	2,498.64
Mississippi State University	MS	1,384	2,493.50
Rensselaer Polytechnic Institute	NY	1,290	2,495.00
Youngstown State University	OH	1,373	2,493.61
Total		9,670	17,465.27

3.2.4 Universities That Want to Transfer Slugs

Responses from the two universities, listed below in Table 6, stated that they want to transfer their slugs to another university.

Table 6 Universities That Want to Transfer Slugs

		<u>No.</u>	<u>Kg U</u>
Pacific Union College	CA	1,384	2,493.50
University of Virginia	VA	1,372	2,491.79
Total		2,756	4,985.29

APPENDIX

A.1

University of Arizona

RIS CODE	ZAQ
NO. SLUGS	1,396
WT. SLUGS kg	2,493.59

Karl Gross
Assistant Reactor Supervisor
University of Arizona
Room 200, Engineering Building
Tucson AZ 85724
(602) 621 - 2551
Fax (602) 621 - 8096

(1) We have the expected 1396 slugs, weighing 2493.59 kg as described in your letter. The material is contained in approximately 1.2" diameter by 8.3" long aluminum clad cylinders which have hollow center holes approximately 0.4" in diameter. Almost all of the material is presently handled by means of tubing placed through the central hole and flared at the bottom. These tubes allow the assembly of multi-slug "rods" and provide good handles for movement of the material.

(2) Our records indicate that the material was received after October 1960. If more specific dates are needed, we can research our records and probably locate an exact receipt date. The material has not been machined, re-canned or otherwise altered. It has been used in subcritical assemblies filled with distilled water or dry. The extent of the radiological exposure has been while used in this form. Neutron sources are not generally in place in these assemblies, and fission products content in the material should be negligible. I am unaware of any other irradiations performed on the material.

(3) External dose rate and surface contamination were measured today on one of the more commonly utilized slugs and found to be approximately 0.1 mr/hr at one foot, 1.0 mr/hr at one inch for gamma, and 17 mr/hr beta at one inch. The removable surface contamination is below the detectable limits of our usual survey instrument. The majority of the material is presently stored in distilled water and the water remains uncontaminated. The balance of the material is stored dry in a wood storage cabinet that also remains uncontaminated. As noted above, the fission product content is negligible, as well as the transuranic content beyond that which is normal for the unirradiated form. The best estimate of the material content is that it remains substantially as we received it.

(4) The material is routinely used for subcritical assembly experiments in undergraduate and graduate classes. A large, water filled assembly was recently used in research into reactor noise phenomena.

We are unaware of any specific compliance issues involved with the material. It is located in a room adjacent to our nuclear reactor. We are licensed to possess the material, as well as our other materials, by the Arizona Radiation Regulatory Agency via our University Radiation Control Office.

(5) We appreciate the availability and use of this material, and would like to continue to do so. We do plan to eventually return the material to the DOE for disposal or use, however no data has been established or contemplated to do so. To the best of my knowledge, we have no intention of stopping the routine utilization of the material in its present form.

California State Univ., Northridge

RIS CODE	YJC
NO. SLUGS	1,108
WT. SLUGS kg	1,986.0

Dr. Greg W. Dixon
Chairman, Department of Mechanical Engineering
California State Univ., Northridge
18111 Nordhoff Street
Northridge CA 91330
(818) 885 - 2187
Fax (818) 885 - 2140

(1) 1108 Slugs containing 1986.0 Kg of Nat. Uranium. (See attached transfer report and diagram)

(2) Received 4/25/72

Material has not been altered

Used in a graphite moderated subcritical assembly ~1972-83

~24 of irradiation per year with Pu-Be Source

(3) External radiation ~0.09 mrem/hr at 1 Ft. for all slugs

Surface contamination - none detectable for all slugs

Fission product content - nil

(4) Inactive - Stored in shielded & locked vault

State Dept. of Health Services has surveyed storage and found it acceptable.

(5) We wish to keep the material for possible nuclear experimental activities in the future.

U.S. Atomic Energy Commission
NUCLEAR MATERIAL TRANSFER REPORT

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10. Material Type and Description (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100)			Motor Freight Collect SRS 7652			

A. Date Shipped						B. Form No.		C. Signatures of Authorized Official and Date Signed		SHIPPER'S DATA						
Date (MO-DA-YR)						No. (DA-YR)										
08-11-72	4	08-11-72	18	72												
Line No. (20-29)	AEC Project Number and Identification (72-31) E	Material Type (37-33) F	Material Description Code (37-33) G	Compositional Code (34-36) M	Gross Weight (37-33) I	Lbs.	Net Weight (37-33) N	Lbs.	Element Weight (40-50) L	Weight % Isotopes (51-54) W	Isotope Weight (55-65) X	Element (66-70) D	Limits of Error Isotopes (71-75) P			
D21001-10-00	81			362	G	4869	4409		1986							
3 Boxes																
1108 Pcs.																
3,951 Lbs.	Each															

RECEIVED BY DATE

A. Date Received		B. Form No. (75)		C. Signature of Authorized Official and Date Signed						RECEIVER'S DATA			
No. (70-21)	Date (22-23)	To (24)	72										
Sure No. (20-21) 0	AEC Project Number and Identification (22-31) F	Material Type (32-33) F	Material Disposition Code (34-36) G	Owner Code (37) I	Gross weight J	Net Weight K	Element Weight (40-46) L	Weight % Isotope (51-54) M	Isotope Weight (55-63) N	Limits of Error Element (66-70) O	Isotage (71-75) P		
					Shipping weight acceptable								
					Dr. D. W. R. T. H., Physics Dept. RSC								7-24-72

CROSS - SECTION
HOLLOW SLUG
 (Not to Scale)

University of California, Santa Barbara

RIS CODE	YMW
NO. SLUGS	1,380
WT. SLUGS kg	2,491.31

Jim Casto
Radiation Safety Officer
University of California, Santa Barbara
Environmental Health & Safety
Santa Barbara CA 93106
(805) 961-3588
Fax (805) 893 - 8659

- (1) Agree with inventory. Hollow, aluminum clad. None modified.
- (2) Material has not been altered. Used in water-moderated subcritical assembly with 5 Ci Pu-Be source on axis at one end, so irradiation minimal.
- (3) The NU slugs are located in the water-moderated subcritical assembly. Does rates from the surface of this assembly (without the Pu-Be source) are as follows:
 - Measurements with Eberline RO-3C ion chamber indicated 0.5 mR/hr at the side of the assembly and 1.0 mr/hr at the top of the assembly.
 - Measurements with Technical Associates Model 220D Neutron Meter indicated 0.2 mR/hr at the top.
- (4) Most of it is in the subcritical assembly, for experiment in material buckling by flux plotting with miniature He-3 proportional counter, for lab course offered one quarter per year. A few slugs are in storage in wooden boxes in the same lab. No compliance issues.
- (5) We want to keep the material for use in the subcritical assembly experiment. May be converted in 1-2 years into a fast spectrum assembly with no moderator and close spacing. In any event, do not plan to return to DOE in foreseeable future.

University of California, Berkeley

RIS CODE	ZCT
NO. SLUGS	2,603
WT. SLUGS kg	5,944.43

Jack Harrell
Department of Nuclear Engineering
University of California, Berkeley
College of Engineering
Berkeley CA 94720
(510) 642 - 1021
Fax (510) 643 - 9685

(1) Our present inventory of Natural Uranium (NU) aluminum clad elements, consists of 2,603 elements weighing 13,107.5 lbs (5,944.43 Kgm), fall into two categories. Those which we wish to dispose of and those which we wish to retain.

(2) The natural Uranium which we wish to return was received by the University of California in July of 1958. The inventory consists of 694 aluminum clad slugs weighing 7.94 lbs (3.6 Kgm) each totaling 5510.36 lbs (2499 Kgm). This inventory was received from: Mr. V. D. Donihee
General Electric Co.
P. O. Box 100
Richland, WA

(3) This NU has never been modified, irradiated or used. It is presently packaged in a single steel container measuring 41 x 27 x 20 1/4 inches. The container is mounted upon a 47 x 36 x 9 1/4" skid. Activity measures less than 3 mR/hr at surface of container, using a calibrated BICRON mod. RSO-5 survey instrument.

(4) Mr. Thomas Williams of DOE was initially contacted in May of 1988 regarding the return of this inventory. Subsequently, I have been in contact with Mr. William Clark of DOE, Savannah River Operations Office, requesting information as to the appropriate disposal of this material.

(5) The Natural Uranium which we wish to retain was received by the University of California, Berkeley in May of 1988. The inventory consists of 1909 aluminum clad NU slugs weighing 3.98 lbs.(1.8 Kgm) each, totaling 7,596 lbs. (3445 kgm). This inventory was received from:

Mr. James E. McLaughlin
University of California at Los Angeles
405 Hilgard Avenue
Los Angeles, CA

This Uranium is presently being used in a Subcritical Assembly in our teaching lab.

University of Florida

RIS CODE	ZGF
NO. SLUGS	1,522
WT. SLUGS kg	3,984.56

Donald L. Munroe
Radiation Safety Officer
University of Florida
202 Nuclear Science Building
Gainesville FL 32611
(904) 392- 1581
Fax (904) 391 - 3380

(1)

Mark I	2496 kg	21.4 cmL	2.8 cm dia	1292 slugs
Mark VB	1487 kg	21.3 cmL	7 cm outer dia 4.8 cm inner dia	230 slugs

(2) Slugs have not been machined, recanned or irradiated.

Mark I slugs are used in a subcritical assembly for Nuclear Engineering classroom demonstrations.
Mark VB have been in storage for 15 years or so.

(3) There is no surface contamination or fission product activity

Mark VB	0.8 mR/hr @ contact
Mark I	0.6 mR/hr. @ contact

(4) See 2 above for use. There are no license or regulatory compliance issues.

(5) Would like to return the Mark VB material and will continue to use the Mark I material. Would like to return Mark VB material within 1 year.

Georgia Institute of Technology

RIS CODE	ZGY
NO. SLUGS	1,301
WT. SLUGS kg	2,500.93

Jerry Taylor
Assistant Radiation Safety Officer
Georgia Institute of Technology
900 Atlantic Drive
Atlanta GA 30332
(404) 894-3605
Fax (404) 853 -9325

- (1) The DOE records indicating 1,301 slugs, weighing 2,500.93 kg is correct.
- (2) The NU slugs were received in October 1973.
The NU slugs have not been altered in any manner and have not been irradiated.
The NU slugs are used for lab classes and some research projects.
- (3)
Box #1 -- 2.3 mrem/hr at 1 ft. --- (<100 dpm/100 sqcm β - γ) (<20 dpm/100 sqcm α)

Box #2 -- 2.5 mrem/hr at 1 ft. --- (<100 dpm/100 sqcm β - γ) (<20 dpm/100 sqcm α)

Box #3 -- 5.0 mrem/hr at 1 ft. --- (<100 dpm/100 sqcm β - γ) (<20 dpm/100 sqcm α)
- (4) The NU slugs are used in neutron lab experiments at Georgia Institute of Technology. The NU slugs have no compliance issues with NRC or the State of Georgia.
- (5) Georgia Institute of Technology would like to keep the 1,301 NU slugs for lab studies. They will be used quarterly for lab classes.

Iowa State University

RIS CODE	ZKB
NO. SLUGS	2,162
WT. SLUGS kg	4,176.3

Dr. R. Danofski
Mechanical Engineering Department
Iowa State University
107 Nuclear Engineering Laboratory
Ames IA 50011
(515) 294 - 5840
Fax (515) 294 - 3261

(1) Number of NU slugs - 2162 Aluminum clad.

Total Weight = 4,176.3 kg

Weight per slug = 1.9317 kg

Dimensions; Length = 8 3/8", Diameter 1 1/8"

Model designation - unknown

(2) Records show that some of the NU slugs were transferred from the University of Iowa on or about March 4, 1980.

The NU slugs held by Iowa State University have not been altered, nor have they been irradiated. While at ISU, the NU slugs have been used in subcritical assembly for the purpose of teaching.

(3) Dose rate at 1 ft. = 0.1mr/hr γ per slug.

Surface contamination = 0 d/m/100 sqcm α , 6.2 d/m/100 sqcm β - γ

Est. fission product curie content is unknown. The NU slugs have only been used in subcritical applications and never irradiated under a neutron flux. The estimated transuranic and fission product content is also not known but is minimum and is due mostly to the spontaneous fission of the uranium isotopes.

(4) The NU is presently used in the subcritical assembly. It is stored in a locked room which is designated by license for the storage of source materials. The NU is used and stored in accordance with Iowa License No. 0014-3-85-SMI.

(5) We would like to keep 1560 NU slugs and return 602 of the NU slugs. We would like to return the 602 slugs as soon as possible. The return of the NU is also dependent on the available funding for shipping, health physics coverages, and shipping container leasing.

Louisiana State University

RIS CODE	ZLS
NO. SLUGS	1,419
WT. SLUGS kg	2,496.84

Dr. L. Max Scott, Radiation Safety Officer
Center for Energy Studies
Louisiana State University
East Fraternity Circle
Baton Rouge LA 70803
(504) 388 - 4400
Fax (504) 388 - 4541

- (1) There are 1419 NU slugs clad in aluminum, weighing 2496.8 kg. Most of these slugs have been loaded into aluminum rods 1" dia. and 4' feet long. The slugs themselves are 1" dia. x 8".
- (2) The slugs were received in ~ 1961 and have not been altered. They are used to form a subcritical assembly for nuclear engineering lab experiments. They are irradiated for a short time (< 1 hr.) approximately once a year with a low intensity neutron source (eg. Cf-252).
- (3) The dose rate at 1 foot from the storage array is 3.4 mrem/hr. There is no significant surface contamination, and only a very small inventory of transuranic and fission products is contained in the clad rods. The dose at one foot from a single slug is 0.2 mr/hr.
- (4) The rods are still being used in laboratory experiments. When not in use they are locked in a storage cabinet. All regulatory requirements have been met for material.
- (5) The subcritical experiments play a central role in the LSU nuclear engineering program. We very much want to retain the material indefinitely.

Nuclear Science Center
LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE
BATON ROUGE · LOUISIANA · 70803-5820
504/388-2163

February 14, 1989

Douglas S. Shull
E G & G Idaho, Incorporated
Post Office Box 1625
Idaho Falls, ID 83415-3126

Dear Mr. Shull:

We have completed DOE Forms 1 and 2 for materials on loan from DOE to the best of our knowledge. Note that the natural uranium slugs are entered on Form 2 along with the CF-252 sources. For your information, I have enclosed an ancient AEC-741 on the uranium and the more modern DOE/NRC-741 on the californium.

Please do not hesitate to contact me if you require further information.

Sincerely,

John C. Courtney
Acting Director, Nuclear Science Center

Enclosures

cc: L. Max Scott, RSO-LSU
(w/enclosures)

U.S. ATOMIC ENERGY COMMISSION

DOCUMENTATION (Only if document is classified Sec 2.0)

NUCLEAR MATERIAL TRANSFER REPORT

Page of Pages Copy of Copies, Series

1. (1) 2. Transfer Code 3. Transfer Series		4. No. of Lines (20-31)	
1. (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100)		5. History of Transaction Complete if Applicable (22)	
6. Name and Address of Shipper		7. Name and Address of Receiver	
U. S. Atomic Energy Commission Savannah River Operations Office P. O. Box A, Aiken, S. C. 29801 Attention: N. H. Seedeck, Jr.		Louisiana State University Baton Rouge, Louisiana Attention:	
8. Shipped for Account of		9. Shipped to Account of	
RIS		RIS ZLS	
10. Date of Transfer of Financial Responsibility		11. Date of Transfer of Financial Responsibility	
9 15 70		9 15 70	
12. Transfer Authority—SMM Draft Number, Reference, or Order Number (34-50)		13. Transfer Authority—SMM Draft Number, Reference, or Order Number (34-50)	
14. Material Type and Description		15. Material Type and Description	
1,419 Aluminum-clad Normal Uranium Slugs (81)		1,419 Aluminum-clad Normal Uranium Slugs (81)	

16. Date Shipped		17. Date Received	
9 15 70		9 15 70	
18. AEC Project Number and Identification (22-31)		19. AEC Project Number and Identification (22-31)	
81		81	
20. Material Type (22-33)		21. Material Type (22-33)	
81		81	
22. Material Description (22-35)		23. Material Description (22-35)	
This transfer is for record purposes only and does not involve a physical transfer of material.		This transfer is for record purposes only and does not involve a physical transfer of material.	
24. Gross Weight (31-34)		25. Gross Weight (31-34)	
2,496.84 kgs		2,496.84 kgs	
26. Net Weight (31-34)		27. Net Weight (31-34)	
2,496.84 kgs		2,496.84 kgs	
28. Element Weight (40-49)		29. Element Weight (40-49)	
2,496.84 kgs		2,496.84 kgs	
30. Isotope Weight (55-55)		31. Isotope Weight (55-55)	
2,496.84 kgs		2,496.84 kgs	
32. Weight % Isotope (51-54)		33. Weight % Isotope (51-54)	
2,496.84 kgs		2,496.84 kgs	
34. Limits of Error		35. Limits of Error	
Element (64-70)		Element (64-70)	
Isotope (71-75)		Isotope (71-75)	

36. Date Received		37. Date Received	
9 15 70		9 15 70	
38. AEC Project Number and Identification (22-31)		39. AEC Project Number and Identification (22-31)	
81		81	
40. Material Type (22-33)		41. Material Type (22-33)	
81		81	
42. Material Description (22-35)		43. Material Description (22-35)	
This transfer is for record purposes only and does not involve a physical transfer of material.		This transfer is for record purposes only and does not involve a physical transfer of material.	
44. Gross Weight (31-34)		45. Gross Weight (31-34)	
2,496.84 kgs		2,496.84 kgs	
46. Net Weight (31-34)		47. Net Weight (31-34)	
2,496.84 kgs		2,496.84 kgs	
48. Element Weight (40-49)		49. Element Weight (40-49)	
2,496.84 kgs		2,496.84 kgs	
50. Isotope Weight (55-55)		51. Isotope Weight (55-55)	
2,496.84 kgs		2,496.84 kgs	
52. Weight % Isotope (51-54)		53. Weight % Isotope (51-54)	
2,496.84 kgs		2,496.84 kgs	
54. Limits of Error		55. Limits of Error	
Element (64-70)		Element (64-70)	
Isotope (71-75)		Isotope (71-75)	

DOE-ID/EG&G IDAHO - NUCLEAR MATERIAL/SOURCE RESPONSE SHEET

FORM 2

Page A.1.8(c)

RIS: ZLS

Page 1 of 1

LOUISIANA STATE UNIVERSITY
CENTER FOR ENERGY STUDIES
BATON ROUGE, LA

MATERIAL DESCRIPTION	SERIAL NUMBER	ELEMENT WEIGHT	ISOTOPE WEIGHT	CURIES	DOE LOAN/GRANT NUMBER	CONTACT & PHONE NUMBER	COMMENTS/DESCRIPTION
Normal Uranium	N/A	2.496.48 (kg)	N/A	1.8	No Record	J. C. Courtney 504/388-2740	1,419 Natural U slugs in aluminum clad. We wish to retain these indefinitely for our subcritical assembly.
Cf-252	SR 101	N/A	0.3 µg		No Record	J. C. Courtney 504/388-2740	Retain indefinitely for instrument calibration
Cf-252	UL 59	N/A	0.15 µg		No Record	J. C. Courtney 504/388-2740	Retain indefinitely for instrument calibration

FUTURE NEEDS:

None at this time.

DOE-ID/EG&G IDAHO - NUCLEAR FUEL RESPONSE SHEET

Form 1

RIS: ZLS

Page 1 of 1

LOUISIANA STATE UNIVERSITY
CENTER FOR ENERGY STUDIES
BATON ROUGE, LA

COMPOSITION OF FUEL MATERIAL TYPE	SERIAL NUMBER	URANIUM (grams)	U-235 (grams)	FUEL ASST. OR LEASE NUMBER	PROJECTED RETURN DATE	CONTACT & PHONE NUMBER	COMMENTS/DESCRIPTION
Normal Uranium							Slugs described on Form 2

FUTURE NEEDS:

None at this time.

United States Naval Academy

RIS CODE	YBF
NO. SLUGS	1,396
WT. SLUGS kg	2,493.59

Dr. Martin E. Nelson, Marine Engineering
Department of Naval Arch., Oceanography and Marine Engineering
United States Naval Academy
590 Holloway Road
Annapolis MD 21402 - 5042
(301) 267 - 3871
Fax (301) 267 - 2591

- (1) 1396 Canned slugs. Each slug weighs 3.938 lbs. Total weight: 5497.45 lbs. (2493.59 kgs). Each slug has dimensions of 8.25" (height) and 1.2" diameter.
- (2) Received material January 1960. No machining or alteration has occurred to NU. Slugs have been used as fuel for sub-critical reactors (SCR) since 1960. Therefore, fuel has been irradiated. Reactor moderator is ordinary water.
- (3) Does at surface of SCR ~ 1 mrem/hr. Semi-annual α,β swipes indicate no surface contamination around SCR ($<.005 \mu \text{Ci}$). Fission product curie content unknown, but fuel has been subjected to thermal neutron flux (ϕ) of 100,000 n/(sqcm-sec) since 1960.
- (4) Fuel in Subcritical reactor.
No regulatory issues involved at this time.
- (5) Yes, USNA wishes to keep the NU as it's used in teaching/research.

University of Missouri

RIS CODE	ZNK
NO. SLUGS	1,289
WT. SLUGS kg	2,499.5

Professor William H. Miller
Nuclear Engineering
University of Missouri
333 Engineering Building West
Columbia MO 65211
(314) - 882 - 4211
Fax (314) 882 - 6360

(1) The University of Missouri originally received 1289 pieces of canned, normal uranium slugs.

(2) This material was received on 6/6/92. Of these 1289 slugs, 1285 have been used as part of a subcritical training reactor. These have received short irradiations using a Cf-252 source. The remaining four slugs have been used to fabricate a filtered neutron beam for the University of Missouri Research Reactor. One of these four slugs has been cut to provide the proper filter length. These filter slugs have been exposed to higher levels of neutron flux, with a maximum fluence of approximately 10 to the 19th power, neutrons/sqcm.

(3) External radiation levels are approximately 8 mrem/hr on contact and 2.5 mrem/hr at 3 feet for the 1285 slugs that have been used in the subcritical assembly. The four slugs in the filtered beam tube have not been measured for radiological levels. It is difficult to estimate fission product, transuranic, and fission product content, although it should be minimal.

(4) The 1285 slugs used in the subcritical training reactor are currently in storage due to the building of a new engineering complex on campus. Within the past month, the subcritical training reactor has been reassembled and the uranium will be returned to it shortly. The four filter slugs are in storage in a beam tube at the University of Missouri Research Reactor.

(5) We would like to keep this material for both teaching and research purposes.

University of Missouri, Rolla

RIS CODE	ZNL
NO. SLUGS	1,412
WT. SLUGS kg	2,540.1

Albert E Bolon
Chairman, Nuclear Engineering Department
University of Missouri, Rolla
Building C
Rolla MO 65401
(314) 341 - 4236
Fax (314) 341 - 4192

(1)

- A. Model unknown, 1799 gm, each (nominal) 8 3/8" x 1 3/16" dia. with 1/2" dia hole along centerline.
- B. The number of slugs was independently verified by Health Physics Technician, Lisa Stiles, on June 30, 1992. (See the attached.)

The mass is therefore assumed to be correct.

(2)

- A. ca. 1966 or 1967.
- B. The slugs have not been intentionally altered in any way. A few of them (17) have small pits, so have been taken out of service.
- C. The slugs have been in storage most of the time.
- D. The slugs have been used in the subcritical assembly several times.

(3)

- A. 0.35 mrem/hr at 1 ft.
- B. Alpha at background and Beta-Gamma below background (11 dpm) and background was 20 dpm. (See the attached memo.)
- C. Minimal - we haven't sufficient information to be able to calculate.
- D. Minimal - we haven't sufficient information to be able to calculate.

(4)

- A. The slugs are stacked five high in 279 aluminum tubes that are in dry storage in room G4A of Fulton Hall. They are in "ready reserve".
- B. See 4A above.
- C. The material is under the U. S. NRC license no. SNM-247.

(5)

- A. Yes, we would like to keep the NU slugs.
- B. Not at this time.
- C. Sooner or later we will need to return the NU slugs to DOE. Perhaps this will be in ten or fifteen years?

UNIVERSITY OF MISSOURI-ROLLA

Page A.1.11(a)

Environmental Health/Risk Management

Hazardous Materials
Radiation Safety
Safety and Risk Management

215 Altman Hall
Rolla, MO 65401-0249
Telephone (314) 341-4305

MEMO TO: Dr. A. Bolon

FROM: Lisa Stiles, Health Physics Tech *LS*

DATE: July 1, 1992

RE: License No. SNM-247 (Inventory and inspection of
Sub-Critical Assembly, Uranium)

An inventory was conducted on June 30, 1992 of the Sub-Critical Assembly in room G-4A of Fulton Hall. The purpose of the inventory was to verify the quantity of material present at the time of the last inventory. The inventory of all 1412 slugs was verified for a total weight of 2540.1 kg.

The assembly is 8 rows wide and 35 rows long and contains a total of 280 assembly tubes. One of the tubes is empty and the rest of the tubes contain 5 slugs each.

279 tubes with 5 slugs each:	1395 pieces
1 box outside of the assembly contained:	+ 17 pieces

Total Number:	1412 pieces

Note: Tubes 34 and 208 were removed and the contents verified. A marked stick was placed in the other assembly tubes in order to verify the number of slugs.

Member National Safety Council

an equal opportunity institution

UNIVERSITY OF MISSOURI-ROLLA

Page A.1.11(b)

Environmental Health/Risk Management

Hazardous Materials
Radiation Safety
Safety and Risk Management

215 Altman Hall
Rolla, MO 65401-0249
Telephone (314) 341-4305

MEMO TO: Dr. Bolon

FROM: Lisa Stiles, Health Physics Tech *LS*

DATE: July 13, 1992

RE: Natural Uranium slugs

As you requested, a slug from G-4A Fulton Hall was surveyed for radiation dose rate and contamination. On contact, the dose rate was 10.5 mrem/hour and at one foot the rate was 0.35 mrem/hour. Two swipes were taken of the slug with no contamination evident. The results are attached.

Member National Safety Council

an equal opportunity institution

GAS PROPORTIONAL COUNTER

DATE	ROOM	ACCT	SWIPE	//	ALPHA COUNTS										BETA COUNTS									
					Gross	Bkgd	Actual	EFF	Std	MDA	STD	DPM	//	Gross	Bkgd	Actual	EFF	Std	MDA	STD	DPM			
7/09/92	G-4	Fulton	Bolon	S1	//	0	1	0	12	2090	11	Am-241	0	//	20	20	0	35	15690	17	Cl-36	0		
7/09/92	G-4	Fulton	Bolon	S2	//	0	1	0	12	2090	11	Am-241	0	//	24	20	4	35	15690	17	Cl-36	11		

University of New Mexico

RIS CODE	ZPL
NO. SLUGS	1,382
WT. SLUGS kg	2,494.91

Ken Carpenter, Nuclear Engineering Laboratory Supervisor
Department of Chemical and Nuclear Engineering
University of New Mexico
Dept. of Nuclear Engineering
Albuquerque NM 87131
(505) 277 -5431
Fax (505) 277 - 0813

(1) Records are correct.

(2)

1) --

2) Has not been altered

3) Subcritical Assembly

4) Has not been irradiated.

(3) Have not used in five years. Have no data for slugs.

(4) Inactive - Stored in source storage room under cement blocks.

(5) Wish to keep.

Hope to reestablish new subcritical setup with Pulse neutron generator.

United States Military Academy

RIS CODE	YBB
NO. SLUGS	1,396
WT. SLUGS kg	2493.59

LTC Larry Lockett, CHP
 Department of Physics
 United States Military Academy
 Department of U.S. Army
 West Point NY 10996 - 1790
 (914) 938 - 5012
 Fax (914) 938 - 3828

(1) Natural Uranium (NU) on loan to USMA is in the form of 1396 hollow cylindrical slugs (nominal 1 inch diameter by 8 inches length with a 0.5 inch bore). Each slug is totally encased by thin-walled aluminum. Total weight of material is approximately 2495 kg.

Note: Individual slugs are not marked or labeled, however, historical records in this Department identify the material as " ... hollow Savannah River reject fuel slugs Mark VII-A." (Dept. of Electricity, Unit Reg 148-61, 23 Nov 60).

(2) Material was obtained from the Atomic Energy Commission in 1960-1961 for use in a sub-critical assembly manufactured by Universal Nuclear Corporation of Jamaica, NY. The sub-critical assembly (UNC Model AE-12) consists of a five feet high, forty-six inches in diameter, aluminum tank holding approximately 370 gallons of light (deionized) water with 271 nuclear grade aluminum tubes to hold the NU slugs. The tubes can each hold five NU slugs with plexiglass spacers on top and bottom in a hexagonal array with lattice pitch of two inches.

The physical configuration of the material and the slugs have not been altered. During their use in the sub-critical assembly, 1334 of the NU slugs have been irradiated to various neutron flux levels when 5 each 1 curie PuBe neutron sources were placed into tubes within the assembly lattice. The other 62 NU slugs are stored in the original shipping crate and have not been irradiated

The sub-critical assembly has been used in undergraduate education classroom demonstrations and laboratory exercises since its installation. The PuBe neutron sources are routinely stored out of the assembly in a paraffin-filled neutron howitzer, so that NU slugs were irradiated by the PuBe neutron flux only 3-5 weeks per semester.

(3)	<u>Irradiated NU Slug</u>	<u>Slug in Storage</u>
External radiation level (mrem/hr @ 1 foot) per slug	0.06	0.06
Surface contamination	none	none
Fission Product content (Ci)	unknown	unknown
Transuranic content	unknown	unknown

(4) This material is currently used in the water-moderated sub-critical assembly described above. It is licensed to the USMA Physics Department by the US Nuclear Regulatory Commission under License SUD-311, expiring 30 September 1996.

(5) Current plans do not call for any changes to the usage described above.

University of Cincinnati

RIS CODE	ZDP
NO. SLUGS	1427
WT. SLUGS kg	2,493.86

Prof. Joel Weismen
 Nuclear Engineering Laboratory, Director
 University of Cincinnati
 Department of Mechanical, Industrial and Nuclear Engineering
 Cincinnati OH 45221 - 0072
 (513) 556 - 2739
 Fax (513) 556 - 3390

(1) 1427 Slugs (Model Savannah River Mark VII A)

Element weight	945 pieces, 3.787 1G/Slug	7.9 to 8.05 in. long
& size	482 pieces, 3.982 1G/Slug	8.4 to 8.5 in. long
All pieces ~ 1" diameter		

(2)

- A - July 2, 1959
- B - Material has not been altered
- C - Educational use in subcritical reactor only.
- D - PuBe source is placed in core of reactor during lab classes only.

(3)

- A - Dose rate at 1 ft. from reactor vessel sidewall ($\beta\gamma$) < 1mr/hr, (n) < 1mr/hr
 - B - Surface contamination < 100 d/m per 100 sqcm
 - C - Curie content
 - D - Transurania/Fission Product & Content
- } *Content that of normal Uranium. System never operated at any significant flux.*

(4)

- A - Used in numerous experiments in undergraduate and graduate level laboratory classes.
- B - Kept in a light water moderated subcritical reactor. Reactor is drained of water during those periods when it is unused.
- C - We are in compliance with regulatory bodies.

(5) Yes we wish to keep this material for use in our laboratory classes.

Oregon State University

RIS CODE	ZRH
NO. SLUGS	620
WT. SLUGS kg	2,050

Rainer Farmer
Radiation Safety Officer
Oregon State University
Radiation Center
Corvallis OR 97331
(503) - 757 - 2227
Fax (503) 737 - 0480

(1) Department of Energy records are correct.

(2) Received Nov. 9, 1965.

Material has not been altered or irradiated.

600 slugs are in a sub-critical graphite facility which is used for physical experiments.

20 slugs are in storage.

(3) N/A - as per original Nat. U.

(4) Use: -- See #2

No regulatory issues involved with this material.

(5) We wish to keep this material.

Benedict College

RIS CODE	XOK
NO. SLUGS	1378
WT. SLUGS kg	2493.94

Dr. Walter I. Hahn, Professor Physics/Engineering
Department of Biological and Physical Sciences
Benedict College
Harden and Blanding Streets
Columbia SC 29204
(803) 253 - 5274
Fax (803) 253 - 5085

- (1) Rad number 1378 slugs. Total 5760.04 kg.
- (2) Received on July 25, 1983 from Safety Service Division and Physics Department of University of South Carolina. The material has not been used because adequate room for subcritical reactor has not been assigned.
- (3) Nominal weight: Natural Uranium 5500 lbs., natural Thorium-232 10 lbs.
External radiation level - 2 mrem/hr at 1 ft.
No surface contamination
U-235-0.038 C, Th-232 - 0.0005 C, U-238 0.83C
- (4) Currently it is not used. It is stored in a special laboratory.* No regulatory compliance issue.

*It is enclosed in an area shielded with 1 ft. concrete bricks. The room is locked with a special key. This laboratory space is off limits.
- (5) As soon as campus shortage of space is solved, the subcritical reactor will be set-up. We will keep the material.

Tennessee Technical University

RIS CODE	ZVM
NO. SLUGS	2760
WT. SLUGS kg	4988.22

Dr. Nicholas G. Demas, Prof.
Electrical Engineering Department
Tennessee Technical University
P. O. Box 5004
Cookeville TN 38505
(615) 372 - 3185
Fax (615) 372 - 6172

(1) Uranium metal slugs clad in Aluminum

(2)

- (1) Received in 1964
- (2) Used in subcritical assembly for educational purposes
- (3) Have not been significantly irradiated

(3)

- (1) Surface Contamination: none
- (2) Fission product curie content, TRU, and fission product content: none

(4) Used in subcritical assembly for educational purposes

(5) Want to Keep.

Virginia Military Institute

RIS CODE	ZXG
NO. SLUGS	1532
WT. SLUGS kg	2772.25

Dr. Phillip B. Peters, Radiation Safety Officer
Department of Physics
Virginia Military Institute
Department of Physics
Lexington VA 24450
(703) - 464 - 7225
Fax (703) 464 - 7169

- (1) This agrees with our records.
- (2) Received - February, 1961
Material has not been altered.
Used in a subcritical nuclear assembly for student experiments.
It has been irradiated with neutrons by our neutron generator.
- (3) Slugs are housed in fuel rods (5 or 6 per rod). Do not have access to the requested radiological data. The dose rate in the vicinity (several ft) of the group of fuel rods, when standing against the wall in the nuclear lab, is less than 5 mrem/h.
- (4) The subcritical is presently not in use, as we are awaiting a replacement neutron generator. The slugs are housed in the fuel rods which are still in the subcritical assembly.
- (5) We do plan to keep and use the material in the future.

University of Wisconsin

RIS CODE	ZZA
NO. SLUGS	1289
WT. SLUGS kg	2499.5

Richard J. Cashwell, Director Nuclear Reactor Laboratory
Mechanical Engineering Department
University of Wisconsin
Nuclear Reactor Laboratory, Mechanical Engineering Bldg.
Madison WI 53706
(608) 262 - 3392
Fax (608) 262 - 6707

- (1) SRP solid slugs; 1.00-1.15 inch diameter, 8.25-8.50 inch long, 4.27 lb U per slug. Al clad.
- (2) Received 3/23/59. Used as fuel in "pickle barrel" subcritical assembly. Irradiated only by insertion of neutron sources into array, so negligible fission product or Pu production.
- (3) Negligible fission product and plutonium. Not contaminated. Dose rate same as original from uranium content.
- (4) Currently used in experiment in laboratory course offered each semester - still in subcritical assembly
No compliance issues involved.
- (5) We have no plans to return this material at present. Unless the Laboratory course is modified significantly, the experiment will continue to be used.

APPENDIX

A.2

University of Alabama

RIS CODE	ZAG
NO. SLUGS	1,382
WT. SLUGS kg	2,494.91

Dr. William W. Walker
Radiation Safety Officer
University of Alabama
Box 870330
Tuscaloosa AL 35487 - 0330
(205) - 348 - 3489
Fax (205) 348 - 5051

- (1) DOE records are correct. The University of Alabama has 1382 aluminum-jacketed slugs, weighing 2494.91 kg [Each slug is 8.375 in. long and 1.1875 in diameter, weighing about 1.8 kg.]
- (2) Our records indicate the material was received in October 1961. It has not been altered. It was used in a subcritical training reactor. It has been irradiated occasionally by a 5 Curie PuBe neutron source during student lab experiments.
- (3) In its present configuration in the subcritical reactor, the dose rate at one foot is 0.25 mrem/h. No surface contamination has been detected. We are unable to provide an estimate of fission product or transuranic content.
- (4) It is inactive, but still stored in the subcritical reactor. The slugs are inside aluminum tubes, 5 slugs per tube. There are no regulatory compliance issues involved with this material.
- (5) We do NOT wish to keep this material. We began requesting DOE to accept this material about three years ago, and we will return it as soon as DOE will accept it.

Tuskegee University

RIS CODE	ZWH
NO. SLUGS	2,440
WT. SLUGS kg	4,212.2

Dr. Phil Loretan
Radiation Safety Officer
Tuskegee University
Carver Research Foundation
Tuskegee AL 36088
(205) 727 - 8458
Fax (205) 727 - 7626

- (1) There are 2440 aluminum clad, natural uranium slugs weighing 4212 kg. Each slug is the form of a right circular cylinder (annulus) with an outer diameter of 1 3/16-in., inner diameter 1/2-in. and a length of 8 3/4-in.
- (2) One thousand three hundred and eighty eight (1388) of these slugs (2322 kg) were on loan to Tuskegee University (then Tuskegee Institute) prior to 1965 (first Alabama State license application was July 31, 1964) for use in a light water moderated subcritical assembly. One thousand and fifty-two (1052) slugs were added to these in 1970 (Alabama license application on Sept. 25, 1970) for use in a graphite moderated subcritical reactor. They were irradiated with neutrons from at most five, 1 Curie PuBe neutron sources (each approximately 2,000,000 n/sec) for, at most several days every six months up through 1980. They have not been irradiated since then.
- (3) Dose rate at 1 ft from many natural uranium slugs sitting in a storage box = 4.5 mrem/h. Dose rate at 1 ft. from one slug = 0.2 mrem/h. There is no surface contamination on the Al clad slugs as spot checked with smear swipes using an UMC PC-3 proportional counter for both α and β - γ contamination. We are not able to ascertain fission product nor transuranic content but both should be small.
- (4) All the natural uranium slugs have been stored for the past ten years but they have not yet been packaged for transportation. They are licensed at Tuskegee University under Alabama State license No. Sm-224 which is held by the Radiation Safety Committee for the University. This would not restrict our returning the slugs to DOE.
- (5) We wish to return these slugs to DOE and have been trying to do so for the last ten years. However, we would like assistance with transportation to the destination. With assistance, we would return them immediately.

Occidental College

RIS CODE	ZQW
NO. SLUGS	1,289
WT. SLUGS kg	2,498.72

Bruce Steel
Environmental, Safety and Health Officer
Occidental College
1600 Campus Rd.
Los Angeles CA 90041
(213) - 259 - 2933 / 2800
Fax (213) 341 - 4978

(1) See attached.

(2) Unable to supply this info. at this time. Professor involved is away.
Can supply info. upon his return if will be of value (~ 1 month).

(3)

(4)

(5) We would like to return the NU to DOE. We have scheduled (tentatively) the shipment of the Plutonium-Beryllium Neutron sources (5 at 75g total) back to DOE in Los Alamos sometime between Sept. and Dec. 1992 when storage space for this material becomes available. Would like to coordinate the NU return with the Plutonium-Beryllium return if possible.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

RD:EDB:QVP

Dr. Arthur G. Coons, President
Occidental College
1600 Campus Road
Los Angeles 41, California

Dear Dr. Coons:

Reference is made to your proposal submitted to the Atomic Energy Commission dated January 10, 1958 requesting the loan of materials.

I am pleased to inform you that the Commission will loan without charge to Occidental College the following materials:

- (a) Eighty (80) grams of plutonium as five (5) 1-curie plutonium-beryllium neutron sources.
- (b) Twenty-five hundred (2500) kilograms of natural uranium metal as cylindrical slugs, either uncanned or canned in aluminum.

As the number of universities and colleges requesting canned slugs will exceed the monthly output rate of canned reject slugs at Savannah River, you would be delayed several months in obtaining canned uranium slugs. However, the Commission will be able to provide uncanned slugs to you more expediently. These slugs would need to be specially handled, and contained in protective water-proof tubes, properly sealed to assure against contamination or chemical reaction by the uranium.

Uranium metal slowly oxidizes in air at room temperature and will spark when struck with or dropped on a hard object. Personnel handling uranium metal should wear gloves which will protect their hands from the radiation emitted.

Dr. Arthur G. Coons

- 2 -

Statements that you would provide the necessary safety measures, the protective containment of the slugs, and the necessary monitoring procedures to detect harmful contamination would be required in your application for a license to possess uncanned natural uranium metal slugs.

In returning this acceptance please indicate your preference for either uncanned or canned slugs.

As you know, you cannot acquire possession of such materials until you have been issued the correct license. Copies of the pertinent regulations covering these licenses are enclosed.

Please acknowledge acceptance of this loan of materials, including the conditions enclosed as an appendix to this letter, by signing in the space provided below and returning the original copy of this letter. You may retain the appendix for your file.

Sincerely yours,

W. Kenneth Davis, Director
Division of Reactor Development

Enclosures:

- (1) Conditions of loan
- (2) License regulations

Accepted by:

(Duly Authorized Officer - Signature)

(Name - Typed)

(Title)

(Institution)

(Date)

2. SHIPPED TO (RECEIVER):

Name E. L. du Pont de Nemours & Co.
Address Alken, South Carolina

4. SHIPPED FOR ACCOUNT OF LICENSEE:

Name Occidental College
Address 1600 Campus Road, Los Angeles, Calif.
License No. GSA-3965

7. SS MATERIAL (Check)

- ☒ Normal Uranium
☐ Depleted Uranium
☐ Enriched Uranium
☐ Plutonium
☐ Thorium
☐ U-233
☐

8. MATERIAL DESCRIPTION

1289 canned normal uranium
solid slugs

9. DISPATCH DATA

- a. Bill of Lading No. 20150
b. Carrier Wilson truck
c. Routing
d. Car No. and Initials
e. Sealed Net(s)
f. Date Shipped 10/24/58
g. Date Withdrawn

5. RECEIVED FOR ACCOUNT OF LICENSEE:

Name V. L. Bollman
Address 1600 Campus Road, L. A., Calif.
License No. GSA 3965

3. TRANSFER SERIES

a. FROM SDA
b. TO CSA
c. TO 3965

6. DOCUMENTATION

a. Page 1 of 1 Pages
b. Copy 4 of 10 Copies
c. Series A

10. Does this transfer result in
initializing or affecting finan-
cial responsibility to the
AEC?
YES ☐ NO ☒

11. LICENSEE PURCHASE
ORDER NUMBER

None

12. DATE MATERIAL
WAS RECEIVED

11/3/58

13. SHIPPER'S MEASUREMENT METHODS

Gross, tare and net weights determined in pounds. Element
weight determined by factor 4.275 lbs/slug for 1239 slugs
and by factor of 4.241 lbs/slug for 50 slugs.

15. BATCH OR LOT NO.	16. CON- TAINER NO.	17. SHIPPER'S WEIGHTS			18. ISOTOPE
		a. GROSS	b. TARE	c. NET	
Seal	1002				
17849	378	1750	83	1667	
17848	378	1746	81	1665	
17852	378	1744	79	1665	
18091	155	746	60	686	
	1289	5986	303	5683	5508.78 lbs.
					2498.72 kgs.

21.

14. RECEIVER'S MEASUREMENT METHODS

weighed 10 slugs taken at random from shipment.
Average weight per slug - 1.997 kgs.
Total count of slugs received - 1289

18. BATCH OR LOT NO.	19. CON- TAINER NO.	20. RECEIVER'S WEIGHTS			21. ISOTOPE
		a. GROSS	b. TARE	c. NET	
17849	PCB.				
17848	378				
17852	378				
18091	155				
	1289			2575 kgs	

22.

11/17/58
DATE

RECEIVER'S SIGNATURE

23.

11/17/58
DATE

SIGNATURE OF LICENSEE IN ITEM 5

10/29/58
DATE

SHIPPER'S SIGNATURE

UNITED STATES
 ATOMIC ENERGY COMMISSION

Page A.2.3(d)

SOURCE MATERIAL LICENSE

Pursuant to the Atomic Energy Act of 1954, and Title 10, Code of Federal Regulations, Chapter 1, Part 40, "Licensing of Source Material," and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, possess and import the source material designated below; to use such material for the purpose(s) and at the place(s) designated below; and to deliver or transfer such material to persons authorized to receive it in accordance with the regulations in said Part. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954 and is subject to all applicable rules, regulations, and orders of the Atomic Energy Commission, now or hereafter in effect, including Title 10, Code of Federal Regulations, Chapter 1, Part 20, "Standards for Protection Against Radiation," and to any conditions specified below.

Licensee 1. Name Occidental College in the City of Los Angeles 2. Address Los Angeles 41, California		3. License No. SUD-506
		4. Expiration Date December 31, 1963
		5. Docket No. LC-2130
6. Source Material Natural uranium	7. Maximum quantity of source material which licensee may possess at any one time under this license Twenty-five hundred (2500) kilograms.	

CONDITIONS

8. Authorized use (Unless otherwise specified, the authorized place of use is the licensee's address stated in Item 2 above.)

Natural uranium in the form of cylindrical slugs canned in aluminum for use in a light water moderated subcritical assembly in accordance with the procedures described in the licensee's application dated January 10, 1958, and supplements dated May 3, 1960, and November 6, 1961.

For the U. S. ATOMIC ENERGY COMMISSION

DEC 12 1961

Date of issuance

Donald A. Nussbaumer

Donald A. Nussbaumer

U.S. GOVERNMENT PRINTING OFFICE: 1961-O-584871

Division of Licensing and Regulation

San Diego State University

RIS CODE	ZTP
NO. SLUGS	1,681
WT. SLUGS kg	3,034.35

Eric Lindstrom
Radiation Safety Officer
San Diego State University
5300 Campanile Drive
San Diego CA 92182 - 0746
(619) - 594 - 6098
Fax (619) 594 - 2854

- (1) SDSU currently possesses 1,681 Mark VIIA natural uranium slugs. Each slug weighs approximately 1.8 kg.
- (2) The university received this material between 6/59 and 9/70. The material has not been altered. It was used as fuel in a sub-critical reactor assembly. The material has not been used in any system involving a sustained nuclear reaction.
- (3) All of the 1,681 slugs are presently contained in the sub-critical assembly (i.e., under water). The measured exposure rate on contact with the assembly is on the order of 1.4 mR/hr. It is estimated that there are no significant amounts of fission products or transuranics contained within the material.
- (4) The material is not presently being used. It is currently stored within a Nuclear-Chicago Model 9000 Subcritical Assembly (used in the past for instructional and research purposes). The only compliance issues are related to material control as mandated in the University's Broad Scope Type A RAM License by the State of California.
- (5) San Diego State University wishes to return this material to the DOE as soon as practicable. Our schedule is dependent on that of the receiving party.

La Sierra University

RIS CODE	ZLB
NO. SLUGS	1,373
WT. SLUGS kg	2,493.61

Dr. Ivan Rouse
Chairman, Physics Department
La Sierra University
4700 Pierce
Riverside CA 92515
(714) 785 - 2137
Fax (714) 785 - 2901

(1) Number and weight same as DOE records
DOE Loan/Grant # = CSA 5928 (1960)
Savannah River hollow slugs
Size = 1.2" by 8.5"

(2) Received about 1960. Has been used in water moderated sub-critical reactor and in a paraffin moderated subcritical reactor. The material has not been altered but it has

(3) I don't have very good info here except that they have been wipe tested every 6 months and have been ok!

(4) The uranium is not currently being used. It is stored in strong wooden boxes weighing 100-200 lbs each. The local safety (university) and fire dept (city) people are concerned about it and would like us to get rid of it.

(5) We do not wish to keep this material and would like to return it to DOE! We would like to return it ASAP!

California Polytechnical State Univ.

RIS CODE	ZCS
NO. SLUGS	1,384
WT. SLUGS kg	2,493.5

David O. Ragsdale, R.E.H.S.
Environmental Specialist
California Polytechnical State Univ.
Environmental Health & Occupational Safety Section
San Luis Obispo CA 94307
(805) 756 - 6662
Fax (805) 756 - 1602

(1) Cal Poly is in possession of 1384 aluminum-clad natural uranium slugs. The total combined element weight for these slugs is 2493.50 kilograms. At the time of shipment, in 1962, these slugs were designated as "Mark VII a Rejects." Each slug is an aluminum clad hollow cylinder. The aluminum jacket on the slugs is between 0.040 inches and 0.043 inches thick. The outer diameter of each slug is between 1.19 inches and 1.21 inches. The diameter of the hollow core of each slug is between 0.49 inches and 0.51 inches. Each slug is between 7.90 inches and 8.50 inches in length. Each slug contains between 3.7 pounds (1.68 kg) and 4.1 pounds (1.86 kg) of natural uranium.

(2) This material was received at the University on September 28, 1962. The slugs have not been altered from their original structure. This material has been used in a sub-critical assembly for research and educational projects. The assembly has been irradiated with plutonium-beryllium sources. Between 1963 and 1979, the plutonium beryllium sources were in the assembly for approximately 3 hours per year. The assembly has not seen any regular use since 1979. A student project was performed using the assembly a few years ago, but the neutron sources have probably been in the assembly a total of less than 8 hours since 1979.

(3) Since the slugs are currently stored in a sub-critical assembly, it is not practical to perform routine leak tests on them for surface contamination. A survey taken on July 16, 1992, showed a dose rate for the entire assembly of 100 micro-rem per hour at the outer edge of the sandbags surrounding the sub-critical assembly. A survey taken in 1988 with the water drained from the tank showed a dose rate of 2.5 milli-rem per hour at the top of the tank. Per my telephone conversation with you, we expect that fission product content will be minimal due to the small amount of irradiation the material has received over the past 30 years.

(4) This material is not currently in use by the University. It is stored in a sub-critical assembly in a secure room. The slugs are assembled into aluminum tubes approximately 5 feet in length, with 5 or 6 slugs in each tube. 271 of these tubes are stored in a water-filled aluminum tank, equipped with a recirculating pump and filter. The outer circumference of the tank is lined with sandbags for shielding. Regulatory concerns with this material are limited to including the material on our California State Radioactive Materials License and on our Hazardous Materials Business Plan which must be submitted to our County Health Department.

(5) The University would like to pursue returning this material to D.O.E. We would like information and assistance from D.O.E. regarding the proper and legal packaging and transportation of the material to a D.O.E. designated site. Since California generators are likely to be barred from disposing of low-level radioactive wastes after December 31, 1992, we would be interested in returning this material to D.O.E. by November, 1992. This will allow the University to dispose of any activated residues remaining after removal of the NU slugs by December 31.

University of California, Berkeley

RIS CODE	ZCT
NO. SLUGS	2,603
WT. SLUGS kg	5,944.43

Jack Harrell
Department of Nuclear Engineering
University of California, Berkeley
College of Engineering
Berkeley CA 94720
(510) 642 - 1021
Fax (510) 643 - 9685

(1) Our present inventory of Natural Uranium (NU) aluminum clad elements, consists of 2,603 elements weighing 13,107.5 lbs (5,944.43 Kgm), fall into two categories. Those which we wish to dispose of and those which we wish to retain.

(2) The natural Uranium which we wish to return was received by the University of California in July of 1958. The inventory consists of 694 aluminum clad slugs weighing 7.94 lbs (3.6 Kgm) each totaling 5510.36 lbs (2499 Kgm). This inventory was received from: Mr. V. D. Donihee
General Electric Co.
P. O. Box 100
Richland, WA

(3) This NU has never been modified, irradiated or used. It is presently packaged in a single steel container measuring 41 x 27 x 20 1/4 inches. The container is mounted upon a 47 x 36 x 9 1/4" skid. Activity measures less than 3 mR/hr at surface of container, using a calibrated BICRON mod. RSO-5 survey instrument.

(4) Mr. Thomas Williams of DOE was initially contacted in May of 1988 regarding the return of this inventory. Subsequently, I have been in contact with Mr. William Clark of DOE, Savannah River Operations Office, requesting information as to the appropriate disposal of this material.

(5) The Natural Uranium which we wish to retain was received by the University of California, Berkeley in May of 1988. The inventory consists of 1909 aluminum clad NU slugs weighing 3.98 lbs.(1.8 Kgm) each, totaling 7,596 lbs. (3445 kgm). This inventory was received from:

Mr. James E. McLaughlin
University of California at Los Angeles
405 Hilgard Avenue
Los Angeles, CA

This Uranium is presently being used in a Subcritical Assembly in our teaching lab.

Howard University

RIS CODE	ZJG
NO. SLUGS	1,381
WT. SLUGS kg	2,493.1

Dr. Emanuel Glakpe
Professor of Mechanical Engineering
Howard University
L. K. Downing Hall, School of Eng., 2300 6th St NW
Washington DC 20059
(202) - 806 - 6600
Fax (202) 462 - 1080

- (1) The DOE records are correct. See attached for dimensions.
- (2) Material was shipped to Howard University May 22, 1962. The material has not been altered. It was used for subcritical experiments for under graduate and graduate instruction. Material has not been used since Jan. 1981.
- (3) Less than 5mR/hr.
- (4) Material is currently in storage. Boxes have been manufactured to ship material to a DOE facility. Material is under NRC license, to expire October 31, 1993.
- (5) Yes, we wish to return material to DOE as soon as a site has been identified.

University of Florida

RIS CODE	ZGF
NO. SLUGS	1,522
WT. SLUGS kg	3,984.56

Donald L. Munroe
Radiation Safety Officer
University of Florida
202 Nuclear Science Building
Gainesville FL 32611
(904) 392- 1581
Fax (904) 391 - 3380

(1)

Mark I	2496 kg	21.4 cmL	2.8 cm dia	1292 slugs
Mark VB	1487 kg	21.3 cmL	7 cm outer dia 4.8 cm inner dia	230 slugs

(2) Slugs have not been machined, recanned or irradiated.

Mark I slugs are used in a subcritical assembly for Nuclear Engineering classroom demonstrations.
Mark VB have been in storage for 15 years or so.

(3) There is no surface contamination or fission product activity

Mark VB	0.8 mR/hr @ contact
Mark I	0.6 mR/hr. @ contact

(4) See 2 above for use. There are no license or regulatory compliance issues.

(5) Would like to return the Mark VB material and will continue to use the Mark I material. Would like to return Mark VB material within 1 year.

Iowa State University

RIS CODE	ZKB
NO. SLUGS	2,162
WT. SLUGS kg	4,176.3

Dr. R. Danofski
Mechanical Engineering Department
Iowa State University
107 Nuclear Engineering Laboratory
Ames IA 50011
(515) 294 - 5840
Fax (515) 294 - 3261

(1) Number of NU slugs - 2162 Aluminum clad.

Total Weight = 4,176.3 kg

Weight per slug = 1.9317 kg

Dimensions; Length = 8 3/8", Diameter 1 1/8"

Model designation - unknown

(2) Records show that some of the NU slugs were transferred from the University of Iowa on or about March 4, 1980.

The NU slugs held by Iowa State University have not been altered, nor have they been irradiated. While at ISU, the NU slugs have been used in subcritical assembly for the purpose of teaching.

(3) Dose rate at 1 ft. = 0.1mr/hr γ per slug.

Surface contamination = 0 d/m/100 sqcm α , 6.2 d/m/100 sqcm β - γ

Est. fission product curie content is unknown. The NU slugs have only been used in subcritical applications and never irradiated under a neutron flux. The estimated transuranic and fission product content is also not known but is minimum and is due mostly to the spontaneous fission of the uranium isotopes.

(4) The NU is presently used in the subcritical assembly. It is stored in a locked room which is designated by license for the storage of source materials. The NU is used and stored in accordance with Iowa License No. 0014-3-85-SMI.

(5) We would like to keep 1560 NU slugs and return 602 of the NU slugs. We would like to return the 602 slugs as soon as possible. The return of the NU is also dependent on the available funding for shipping, health physics coverages, and shipping container leasing.

University of Notre Dame

RIS CODE	ZQH
NO. SLUGS	1,054
WT. SLUGS kg	1,899.91

Andy G. Welding
Health Physicist
University of Notre Dame
119 Student Health Center
Notre Dame IN 46556
(219) 239 - 5037
Fax (219) 239 - 8794

(1) The University of Notre Dame currently possesses 1,054 slugs labeled MK VII a Rejects, each weighing 3.7 lb. to 4.1 lb., and each with a length of 7.9" to 8.5" and a diameter of 1.19" to 1.21". The total weight is 1899.91 kg (4188.6 lb).

(2) This material was received from E. I. DuPont de Nemours Co., Savannah River Plant, Aiken, SC, on December 31, 1959. It has been used in our Nuclear Engineering Educational Program in conjunction with laboratory experiments conducted with the subcritical graphite exponential. Specific experiments dealt with foil activation, flux measurement, determination of diffusion length, and Fermi Age. This material was canned in aluminum when it was received and has not been altered in any way since that time.

(3) The maximum external radiation for any slug was 1.5 mrem/hr (at one foot using a Wm. B. Johnson GSM-10S Geiger Counter). The greatest amount of measured removable alpha contamination for any one slug was 32 DPM, most slugs had no removable contamination. Greatest beta-gamma contamination measured was 100 DPM; most slugs had none. Estimated fission product content is near zero.

(4) This material is currently inactive. It is packed in vermiculite in cardboard boxes, and is currently located in the basement of our Aerospace Laboratory. The University possesses this material under NRC License Number SUD-197 and Indiana State Department of Health Registration Number R0299. No other compliance issues are involved.

(5) We wish to return this material to DOE as soon as possible.

Saint Peters College

RIS CODE	ZTX
NO. SLUGS	1,381
WT. SLUGS kg	2,493.1

Dr. James J. Grant
Physics Department
Saint Peters College
2641 Kennedy Boulevard
Jersey City NJ 07306
(201) - 915 - 9406
Fax (201) 451 - 0036

- (1) 1381 "Savannah River Slugs" containing 2493 kg of NU.
- (2) The NU was received in the early 1960's. It has not been mechanically altered. The material was used in conjunction with five-one curie PuBe neutron sources in a Nuclear Chicago Training Reactor.
- (3) N/A
- (4) The NU slugs and the PuBe sources are not in use and are being held under storage only licenses. The slugs are stored in the Training Reactor without the neutron sources and without water.
- (5) We have already requested permission to return the material to DOE.

Polytechnic University

RIS CODE	XGL
NO. SLUGS	2,570
WT. SLUGS kg	4,627.0

S. C. Meepagala, Assistant Professor
Physics Department
Polytechnic University
333 Jay Street
Brooklyn NY 11201
(718) 260 - 3195, 3196, or
Fax (718) 260 - 3136

(1)

- (i) Original model - not known
- (ii) No. of slugs - 2570; total weight 4,690 kg (according to our records)
- (iii) Each slug is aluminum clad, cylindrical in shape and of dimensions 8-3/8" (length) x 1-1/4" (diameter).

(2)

- (i) Polytechnic received these in 1973, from New York University (NYU) at the time of the merger of Nuclear Engineering Dept. of NYU with Polytechnic.
- (ii) Material has not been altered; has not been irradiated.
- (iii) Used for pedagogical purposes in Nuclear Engineering classes.

(3)

- (i) dose rate at 1 ft from a slug ~ 0.12 mrem/h
- (i) Surface contaminants - below detectable limits
- (iii) Fission product contents - uncertain.

(4)

- (i) Currently not being used. Last use was ~ 6 years ago.
- (ii) 2376 slugs are placed in a subcritical assembly. 194 slugs are in a wooden box.
- (iii) We have always complied with the City of New York, Bureau of Radiation Control requirements.

(5)

- (i) We wish to return the material to DOE
- (ii) We like to send the material as soon as DOE authorizes the shipment.

- S. C. Meepagala, Polytechnic Univ., 333 Jay Street, Brooklyn, NY, 11201

University of Oklahoma

RIS CODE	ZRA
NO. SLUGS	1381
WT. SLUGS kg	2494.67

Dr. P. Skierkowski
Radiation Safety Officer
University of Oklahoma
905 Asp, Room 112
Norman OK 73019
(405) 325 - 1015
Fax (405) 325 - 7909

(1) Attachment 1 (A-C) is a copy of pages from the license renewal for the subcritical reactor which utilized the natural uranium slugs. It provides some of the below information.

A. The application (Attachment 1-A) states there are 1381 aluminum clad-normal uranium slugs, material type 81. I'm not sure what the "type 81" refers to, either the uranium, the slugs, the aluminum grade or what. The diagram of the slug (Attachment 1-C) also uses the nomenclature MKVIIa Rejects (bottom right corner) as well as describing the dimension limits of the slugs. The "average" weight of our slugs is 1.806 KG (3.97 lb).

(2) The natural uranium material was received from C. W. Post College (Long Island University), Greenvale, NY in January 1974. The material has not been altered and was used in a Nuclear-Chicago Model 9000 Student Sub-critical Training Reactor.

The exact amount of use is not known. I came to the University of Oklahoma in 1982 as the radiation safety officer and can only recall, at most, 3 short uses of the subcritical from 1982 until 1987 when the nuclear engineering program was phased out at this university. We have examined sample slugs by GeLi gamma spectroscopy and see no significant indication of irradiation as would be evidenced by the presence of fission fragments such as Cs-137. All identifiable gamma energy lines are attributable to U-238 daughters.

(3) We have conducted radiation surveys of randomly selected individual slugs. The surface dose rates (gamma and high energy beta) range from 2.5 mR/hr at the end of the cylinder to 20 mR/hr at the surface of the center of the longitudinal side of the same cylinder. The dose rates at one meter from an average slug range from 0.05 to 0.08 mR/hr.

Swipes of the surface of slugs indicate no surface contamination, i.e. the encapsulation is intact. As mentioned in #2 (above), the estimated fission product and transuranic content is minimal.

(4) The material has not been used for at least the past 6 years. It is currently kept in the vertical aluminum tubes (5 per tube) in the grid inside the subcritical tank (see attachment 1-B). The subcritical tank is made of stainless steel and is 60" high with a 48" diameter. Radiation Surveys of the tank with all sources inside indicate a surface reading of approximately 1 mR/hr and a 1 meter rate of approximately 0.4 mR/hr. The material is listed on the University's NRC Broad License and is regulated under the provisions of that license's conditions.

(5) Because the University of Oklahoma no longer has a nuclear engineering program, there is no need for this material and it is our desire to return it to DOE. We can return it very promptly to DOE upon instructions from DOE as to specifics of where, etc.

U.S. NUCLEAR REGULATORY COMMISSION
APPLICATION FOR SOURCE MATERIAL LICENSE

Pursuant to the regulations in Title 10, Code of Federal Regulations, Chapter 1, Part 40, application is hereby made for a license to receive, possess, use, transfer, deliver or import into the United States, source material for the activity or activities described:

1. Check one: ☐ (a) New license ☐ (b) Amendment to License No. _____ ☒ (c) Renewal of License No. <u>SUD-1172</u> ☐ (d) Previous License No. _____		2. NAME OF APPLICANT <u>University of Oklahoma</u> 3. PHYSICAL BUSINESS ADDRESS <u>865 Asp Ave., Room 212, Norman, OK 73019</u>	
4. STATE THE ADDRESS(ES) AT WHICH SOURCE MATERIAL WILL BE POSSESSED OR USED <u>Nuclear Reactor Laboratory</u> <u>University of Oklahoma, 905 Asp Ave., Room 113, Norman, OK 73019</u>			
5. NAME OF PERSON TO BE CONTACTED CONCERNING THIS APPLICATION <u>Johnny James, Nuclear Reactor Supervisor</u>		6. TELEPHONE NO. OF INDIVIDUAL NAMED IN ITEM 5 <u>405/325-5084 or 3386</u>	
7. DESCRIBE PURPOSE FOR WHICH SOURCE MATERIAL WILL BE USED <u>The natural uranium will be used in a Nuclear-Chicago Model 9000 Student Training Reactor. A complete description of this facility is included in Appendix A</u>			
8. STATE THE TYPE OR TYPES, CHEMICAL FORM OR FORMS AND QUANTITIES OF SOURCE MATERIAL YOU PROPOSE TO RECEIVE, POSSESS, USE, OR TRANSFER UNDER THE LICENSE			
(a) TYPE	(b) CHEMICAL FORM	(c) PHYSICAL FORM (Including % U or Th)	(d) MAXIMUM AMOUNT AT ANY ONE TIME (kilograms)
NATURAL URANIUM	1381 Aluminum clad-normal uranium slugs, water	A picture of a fuel pin is enclosed as Appendix B. The composition code is 462	5,499.14 (lbs) ^{AS}
URANIUM ENRICHED IN THE U-235 ISOTOPE	ial type 81		
THORIUM ISOTOPE			
(e) MAXIMUM TOTAL QUANTITY OF SOURCE MATERIAL YOU WILL HAVE ON HAND AT ANY TIME (kilograms) 5500 lbs			
9. DESCRIBE THE CHEMICAL, PHYSICAL, METALLURGICAL, OR NUCLEAR PROCESSES OR PROCESSES IN WHICH THE SOURCE MATERIAL WILL BE USED, INDICATING THE MAXIMUM AMOUNT OF SOURCE MATERIAL PROVIDED IN EACH PROCESS AT ANY ONE TIME, AND PROVIDING A THOROUGH EVALUATION OF THE POTENTIAL RADIATION HAZARDS ASSOCIATED WITH EACH STEP OF THOSE PROCESSES <u>The natural uranium will be used in a Nuclear-Chicago Model 9000 Student Subcritical Training Reactor. Up to a maximum of five curies of Pu-Se will be used as the source. The fuel loading will vary up to a maximum of 5500 lbs of the natural uranium with the fuel pins loaded into 271 vertical aluminum tubes. (continued on attached page 3)</u>			
10. LIST THE NAMES AND ATTACH A RESUME OF THE TECHNICAL QUALIFICATIONS INCLUDING TRAINING AND EXPERIENCE OF APPLICANT'S SUPERVISORY PERSONNEL AND THE PERSON RESPONSIBLE FOR THE RADIATION SAFETY PROGRAM (OR OF APPLICANT IF AN INDIVIDUAL) <u>(continued on attached page 3&4)</u> <u>The Radiological Safety Officer (RSO) shall have a Bachelor's degree in Biological or Physical Science and shall have a minimum of 2 years experience in personnel and environmental radiation monitoring programs at a nuclear facility. Certification as a</u>			
11. DESCRIBE THE EQUIPMENT AND FACILITIES WHICH WILL BE USED TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE OR PROPERTY AND RELATE THE SAME TO THE EQUIPMENT AND FACILITIES TO BE OPERATED. INCLUDE (a) RADIATION DETECTION AND RELATED INSTRUMENTS (including film badges, dosimeters, counters, air sampling, and other survey equipment as appropriate). The description of radiation detection instruments should include the instrument characteristics such as type of radiation detected, window thickness, and the range(s) of each instrument. <u>(see attached page 4)</u>			
12. METHOD, FREQUENCY, AND RECORDS USED FOR CALIBRATION OF INSTRUMENTS LISTED IN (a) ABOVE, INCLUDING AIR SAMPLING EQUIPMENT (for filter, alpha, beta, gamma, and neutron calibration and processing, if applicable) <u>Calibration of survey Instruments</u> <u>(see attached page 5)</u>			

University of Oklahoma
Page 1

Appendix A

Description of the Nuclear-Chicago Model 9000 Student Subcritical Training Reactor

The training reactor is a water moderated, natural uranium assembly. A stainless steel tank, four feet in diameter by five feet high forms the reactor vessel. The tank contains 435 gallons of water that acts as a moderator and shield. Immersed in the water is a lattice-like arrangement of 271 vertical aluminum tubes held in place by two grid plates located near the bottom of the tank. Each tube contains five aluminum jacketed natural uranium rods approximately eight inches long by one inch in diameter. A neutron source such as plutonium mixed with beryllium is placed at the center of the uranium lattice to initiate and maintain the chain reaction. The fission process in the assembly results in a multiplication of the neutron flux from the source by a factor of six to seven.

Tank description

The technical specifications are the following:

- Lattice - Lattice consists of two grid plates which hold and position 271 aluminum tubes arranged in a hexagonal pattern.
- Wall thickness of tubes - 0.035 inches. Tubes designed to hold natural uranium slugs available to schools under the AEC assistance program. Total weight of natural uranium - 5500 lbs.
- Lattice core - Hexagonal, 42.1 inches high, 35 inches maximum diameter.
- Moderator - Light water, 3600 lbs., 435 gallons. Deionizer supplied to maintain purity.
- Reflector - Light water. Minimum thickness 7.35 inches; maximum thickness is 8.43 inches. Essentially an infinite reflector thickness since migration length of neutrons in ordinary water is less than 2.5 inches.
- k_{inf} - 0.960
- k_{eff} - 0.842
- Neutron multiplication - 6.0 - 7.0.
- Flux - Central region flux using five ore-cure plutonium-beryllium sources is approximately 5×10^4 n/cm²/second.
- Reactor vessel - Cylindrical, 40 inches high, 48 inches diameter. Stainless steel, split into two sections 30 inches high by 48 inches in diameter with watertight flange.

ATTACHMENT 1-B

	MAX	MIN
A	1.21"	1.19"
B	0.51"	0.49"
C	8.50"	7.90"
WT. U.	4.1 lb.	3.7 lb.

SEPTEMBER 25, 1953

CROSS - SECTION
HOLLOW SLUG
(Not to Scale)

MR. ELLI's Rejects

ATTACHMENT

APPENDIX

A.3

Arizona State University

RIS CODE	ZAS
NO. SLUGS	1,382
WT. SLUGS kg	2,494.91

Dr. Keith E. Holbert
Nuclear Engineering Science
Arizona State University
College of Engineering & Applied Sciences
Tempe AZ 85287 - 5706
(602) 965 - 8594
Fax (602) 965 - 1719

(1) The NU metal appears to consist of 1382 slugs which are 3.01 cm in diameter (some slugs are apparently hollow with an inside diameter of 1.11 cm) by 21.3 cm tall with an approximate mass of 1900 grams each at a density of 15 gm/cucm

(2) The NU was apparently received in the early 1960's. Approximately 1250 of the unclad slugs have been encased in an aluminum cladding to create 251 fuel rods which are stored in a subcritical reactor assembly manufactured by the Curtis Wright Corporation. This fuel has been used in laboratory experiments related to subcritical reactor behavior since the mid-1970's. The material has undergone periodic irradiation using Pu-Be sources.

(3) There is no estimate available on the transuranic or fission product content. The external dose rate was measured to be 5.2 mrem/hr at the surface and 3 mrem/hr at a distance of 1 ft (dry fuel). Swipe tests on wet slugs indicated the surface contamination as less than 200 Bq per 100 sqcm; however, water samples from the subcritical pool indicate more significant activity.

(4) Material is currently being used in the previously mentioned nuclear lab course which is taught every other semester. There are some NU slugs which apparently have never been irradiated. Fuel is confined to a single laboratory which undergoes periodic inventory and radiological surveys from both university and state officials.

(5) Current plans indicate a phaseout of the nuclear program here at ASU, and therefore, it is conceivable that the fuel may no longer be needed (after ~1 1/2 years). I will have to discuss with the ASU administration whether or not the fuel would be released at that time.

University of Idaho

RIS CODE	ZJL
NO. SLUGS	1,384
WT. SLUGS kg	2,489.73

Vicky Schur
Laboratory Safety Technician
University of Idaho
College of Engineering
Moscow ID 83843
(208) 885 - 6524
Fax (208) 885 - 5969

- (1) UI possesses 2490 kg normal uranium (1385 aluminum clad slugs, 1" diameter x 8" length). The DOE Loan/Grant number is DNET 63/2-1.
- (2) The material was received in or before 1962. The material has not been altered in any way. It has been used in a sub-critical student training reactor Model 9000 for teaching purposes in conjunction with Pu:Be neutron sources. The sources were placed with the uranium slugs 1-2 weeks per year, and otherwise stored separate from the uranium slugs.
- (3) The external radiation dose rate is less than 1 mrem/hr at 1 foot. The slugs are stored in a water bath in the reactor and surface contamination is not expected. The estimated fission product content based on the time the slugs were irradiated is believed to be insignificant.
- (4) The slugs are currently stored in the sub-critical reactor in a water bath, and is not being used. The NRC status of the sub-critical reactor is currently inactive and in storage. NRC approval will be obtained if the sub-critical reactor is activated.
- (5) Due to the lack of use of the sub-critical reactor, and possible campus remodeling plans, UI is exploring options for removal of the sub-critical reactor. One option we are investigating are the procedures and requirements involved with returning the normal uranium to DOE.

Valparaiso University

RIS CODE	ZWZ
NO. SLUGS	1,425
WT. SLUGS kg	2,499.88

Dr. Donald D. Koetke, Chairman
Department of Physics and Astronomy
Valparaiso University
Neils Science Center
Valparaiso IN 46383
(219) 464 - 5377
Fax (505) 665 - 1712

(1) 1425 slugs: UN concentric cylinders w/NU between cylinders (A1): Approx: length = 8", dia (outer) = 1", dia (inner) = 3/8"; welded at each end. No machining has been done on the slugs. Approximately 25 are "stuck" in aluminum tubes 1 1/8" dia - the remaining are stacked in A1 tubes, 1 1/8" dia.

(2) Approximately 1957. It has been used only for studies & instructional purposes in our subcritical assembly, a steel cylinder ~ 6' dia inches and 6" deep filled w/de-ionized water. It has been irradiated w/neutrons (thermal).

(3) At 1 ft ~ 3mrem/hr when stored out of water. Surface contamination not detectable, ($<0.005 \mu\text{Ci/sqcm}$). I do not have sufficient data with me to estimate either the fission product curie content, etc. However, over the years since 1957, the duty factor has been so low, that all fission products are extremely small if it was pure NU when we received it.

(4) It has been used sparingly in recent years and always since 1957 only for instruction. It is stored since 1957 only for instruction. It is stored in the aforementioned A1 tubes in a secure nuclear physics laboratory. No NRC, EPA . . . compliances issued - all inspections have been without violation.

(5) This matter is not entirely clear. I am not in a position to alter the continuation of our present and past activity or expectations. This matter will be received again by our faculty as it pertains to our instructional programs and if our plans change, we will notify you.

University of Michigan

RIS CODE	YFH
NO. SLUGS	1,432
WT. SLUGS kg	2,498.64

Alan Jackson
Occupational Safety, Environment & Health
University of Michigan
1061 N. University Ave.
Ann Arbor MI 48109
(313) 764 - 1587
Fax (313) 763 - 1185

(1) We presently have 1431 slugs. 1 slug was disposed of since it had a small bubble which indicated a potential flaw of the uranium containment. This slug was not actually leaking.

(2) This material has been at U-M since February 24, 1958.

(3)

0.6 mrem/h at 1 ft. from assembly container (0.5 to 0.7 mrem/h)

2.2 mrem/h at 1 ft. from slugs (inside assembly container) (2.0 to 2.3 mrem/h)

Contamination level is less than 5 nCi/100 sqcm (less than MDA)

Fission products inventory is estimated at far less than 1 mCi. (gross calculation probably less)

(4) The material is not presently being used. It is stored dry within the subcritical unit assembly container. In addition to licensing and inspection issues, no radioactive material users in Michigan may dispose of low level waste due to the low level waste policy act.

(5) We wish to explore the option for disposal. We do not have a proposed schedule but would be interested in any developments that DOE makes toward facilitating disposal.

Mississippi State University

RIS CODE	ZNF
NO. SLUGS	1,384
WT. SLUGS kg	2,493.5

Dr. Charles Sparrow
Head, Department of Nuclear Engineering
Mississippi State University
PO. Drawer NE
Mississippi State MS 39762
(601) - 325 - 7323
Fax (601) - 325 - 8573

- (1) MK VIIa Reject slugs. See next page for description.
- (2) About October, 1961. Used in subcritical assembly. Has not been altered.
- (3) Very low radiation levels.
- (4) Currently used in a subcritical assembly. No unusual compliance issues.
- (5) Will probably return material in 1995.

	MAX	MIN
A	1.21"	1.19"
B	0.51"	0.49"
C	8.50"	7.90"
Wt. U.	4.1 lb.	3.7 lb.

SEPTEMBER 25, 1988

CROSS - SECTION
HOLLOW SLUG
(Not to Scale)

Rensselaer Polytechnic Institute

RIS CODE	ZSX
NO. SLUGS	1,299
WT. SLUGS kg	2498.88

Dr. Robert C Block
Head of the Department of Nuclear Engineering and Engineering Physics
Rensselaer Polytechnic Institute
110 8th Street.
Troy NY 12181
(518) 276 - 6110
Fax (518) 276 - 4832

(1)

A. Our records indicate Rensselaer received 1292 Uranium Slugs on 9/3/57. These slugs weighed 2498.75 kgs. There was no indication of model designation.

B. In 1964 one slug was lost and again in 1986 the inventory again showed one slug missing. Total remaining 1290.

(2) The Uranium slugs are plated with a protective coating of aluminum. Each slug is 21.3 cm long and 2.5 cm dia. and weighs 2.018 kgs. The slugs are being used as received and have neither been altered or machined.

Six slugs are placed in steel tubes and an array is configured to provide a subcritical assembly with normal water moderator and a pulsed neutron source.

(3) Radiological Data:

10 cm from slug we measure about 135 μ R/hr.

At the surface (TLD's) we measure 20 mRad/hr on contact.

(4) The material has been used in the Nuclear Engineering and Engineering Physics curriculum since 1957 for both student laboratory experiments and thesis topics.

There have not been any compliance issues involved. The material is carried on the New York State Health Department License #1035.

(5) Rensselaer does wish to retain the Uranium slugs and continue to use it in our subcritical facility course:

338461 Nuclear Engineering and Engineering Physics Laboratory. A laboratory course covering various topics instrumentation, neutron physics, applied physics, and multiphase science. Detectors and data acquisition systems. Decay of isotopes, diffusion of neutrons, and pulsed neutron experiments. Radiation effects on semiconductors. Optics, lasers, and imaging techniques. Boiling and condensation heat transfer.

Fall term annually

3 credit hours

Per a 8-14-92 phone conversation with Dr. Block: Due to financial problems from upkeep of the "old" facility housing the assembly, Rensselaer is now seriously considering dismantling their assembly and returning their slugs to the DOE.

Youngstown State University

RIS CODE	ZZR
NO. SLUGS	1373
WT. SLUGS kg	2493.61

Leonard A. Perry
Radiation Safety Officer
Youngstown State University
Dept. of Biological Science, 410 Wick Ave.
Youngstown OH 44555
(216) - 742 - 3361
Fax (216) - 742 - 3798

(1) Youngstown State University has in its possession 1,373 NU slugs weighing 2,493.61 kg. This information is based on a physical inventory that was taken during a period of time that the reactor was disassembled due to the renovation of Ward Beecher Science Hall in the fall of 1987.

(2) After looking back through the files and examining old records it seems that the material in question was received sometime in 1958 or 1959. It was acquired to be used as a fuel in a subcritical light water reactor assembly purchased for educational purposes. According to available information it has not been altered in any way.

(3) On 1-28-92 a reading of .10mR was recorded at a distance of three feet from the reactor. The reading was taken while there was water in the reactor.
On 6-16-92 the measured Gamma rate was measured at 10,000 cpm with water in the reactor and 18,000 cpm after water was drained.

(4) The NU slugs are being used in a subcritical lightwater reactor assembly that is used solely as a teaching tool in Nuclear Engineering classes.

(5) The University is in the process of deciding whether or not the usage of the reactor is sufficient to justify keeping it in operation. A study is being done and a decision will be made within the next three months.

APPENDIX

A.4

Pacific Union College

RIS CODE	ZRP
NO. SLUGS	1,384
WT. SLUGS kg	2,493.5

Dr. K. A. Thomson
Radiation Safety Officer
Pacific Union College
Department of Physics and Computer Science
Angwin CA 94508 - 9797
(707) - 965 - 7260
Fax (707) 965 - 6390

- (1) Our loan consists of 1384 slugs of NU, 2500 kg. The attached drawing shows the dimensions and type.
- (2) Pacific Union College (PUC) received this material in July, 1961. For about eight years, the NU was used in a sub-critical water-moderated reactor for experimental physics. A neutron source (PuBe) was introduced into the tank, and flux measurements, etc., were made. The material is unaltered from the original receipt.
- (3) External radiation levels at 1 ft. average 3 mrem/hr (range 2-4.5 mrem/hr). The slugs are boxed in wooden crates, and so no data on surface contamination are available. Prior to being boxed, wipe tests (last one in 1991) showed less than 5 pCi per 100 sqcm surface contamination on these slugs.
- (4) The NU slugs are currently in seven boxes on pallets. An angle-iron fabricated frame supports the slugs in racks in each box. This material is listed on our California Department of Health license. I understand that NRC permission is required to transfer it from PUC.
- (5) We have donated the sub-critical reactor assembly to UC Berkeley, and they have received it. We want to transfer the NU to them as well, and have requested DOE for permission to do this. However, I have not received a reply to our request. We would like to remove it from PUC as soon as possible!

NU slugs at Pacific Union College, ANGEWIN CA

CROSS - SECTION
HOLLOW SLUG
 (Not to Scale)

University of Virginia

RIS CODE	ZXC
NO. SLUGS	1372
WT. SLUGS kg	2491.79

J. P. Farrar
Reactor Administrator
University of Virginia
Thorton Hall
Charlottesville VA 22903
(804) - 982 - 5440
Fax (804) 982 - 5473

(1)

1372 slugs, 8.375 inch long, 1.2 inch diameter
0.5 inch hole through middle, encased in Al
4.5 lbs. each
7 digit number on each slug

(2) Received June, 1962. Used for sub-critical multiplication measurements in student labs
Slightly irradiated

(3) Dose rate: 2.5 mr/hr @ surface, 0.3 mr/hr @ 1 foot, no surface contamination

(4) Currently inactive - stored in aluminum tank, 4.5 ft. diameter, 4.25 ft. deep, slugs are stored in aluminum tubes, inserted in grid structure. Held under NRC License SUB-657, Docket No. 40-5738

(5) The University of North Texas has expressed interest in obtaining the material and have been in contact with NRC and DOE.

Their address:	Dr. Tom Harrison	Phone: (817) 565-3250
	University of North Texas	
	Department of Physics	FAX: (817) 565-2227
	Denton, Texas 76201	

APPENDIX

B

University Contacts

RIS CODE	ZAG	Responded
NO. SLUGS	1,382	Return ASAP
WT. SLUGS kg	2,494.91	
<p>Dr. William W. Walker Radiation Safety Officer University of Alabama Box 870330 Tuscaloosa AL 35487 - 0330 (205) - 348 - 3489 Fax (205) 348 - 5051</p>		

RIS CODE	ZQW	Responded
NO. SLUGS	1,289	Return ASAP
WT. SLUGS kg	2,498.72	
<p>Bruce Steel Environmental, Safety and Health Officer Occidental College 1600 Campus Rd. Los Angeles CA 90041 (213) - 259 - 2933 / 2800 Fax (213) 341 - 4978</p>		

RIS CODE	ZWH	Responded
NO. SLUGS	2,440	Return ASAP
WT. SLUGS kg	4,212.2	
<p>Dr. Phil Loretan Radiation Safety Officer Tuskegee University Carver Research Foundation Tuskegee AL 36088 (205) 727 - 8458 Fax (205) 727 - 7626</p>		

RIS CODE	YJC	Responded
NO. SLUGS	1,108	Retain Slugs
WT. SLUGS kg	1,986.0	
<p>Dr. Greg W. Dixon Chairman, Department of Mechanical Engineering California State Univ., Northridge 18111 Nordhoff Street Northridge CA 91330 (818) 885 - 2187 Fax (818) 885 - 2140</p>		

RIS CODE	ZAU	
NO. SLUGS	1,378	
WT. SLUGS kg	2,493.94	
<p>Dr. Leon West Professor, Mechanical Engineering Department University of Arkansas Mechanical Engineering Bldg., Rm. 204 Fayetteville AR 72701 (501) 575 - 3449 Fax (501) 575 - 6982</p>		

RIS CODE	ZTP	
NO. SLUGS	1,681	
WT. SLUGS kg	3,034.35	
<p>Eric Lindstrom Radiation Safety Officer San Diego State University 5300 Campanile Drive San Diego CA 92182 - 0746 (619) - 594 - 6098 Fax (619) 594 - 2854</p>		

RIS CODE	ZAS	Responded
NO. SLUGS	1,382	May return slugs
WT. SLUGS kg	2,494.91	
<p>Keith Holbert Assistant Professor, Department of Electrical Engineering Arizona State University College of Engineering & Applied Sciences Tempe AZ 85287 - 5706 (602) 965 - 8594 Fax (602) 965 - 1719</p>		

RIS CODE	ZLB	Responded
NO. SLUGS	1,373	Return ASAP
WT. SLUGS kg	2,493.61	
<p>Dr. Ivan Rouse Chairman, Physics Department La Sierra University 4700 Pierce Riverside CA 92515 (714) 785 - 2137 Fax (714) 785 - 2901</p>		

RIS CODE	ZAQ	Responded
NO. SLUGS	1,396	Retain Slugs
WT. SLUGS kg	2,493.59	
<p>Karl Gross Assistant Reactor Supervisor University of Arizona Room 200, Engineering Building Tucson AZ 85724 (602) 621 - 2551 Fax (602) 621 - 8096</p>		

RIS CODE	YMW	Responded
NO. SLUGS	1,380	Retain Slugs
WT. SLUGS kg	2,491.31	
<p>Jim Casto Radiation Safety Officer University of California, Santa Barbara Environmental Health & Safety Santa Barbara CA 93106 (805) 961-3588 Fax (805) 893 - 8659</p>		

University Contacts

RIS CODE	ZCS	Responded
NO. SLUGS	1,384	Return ASAP
WT. SLUGS kg	2,493.5	

David O. Ragsdale, R.E.H.S.
Environmental Specialist
California Polytechnical State Univ.
Environmental Health & Occupational Safety Section
San Luis Obispo CA 94307
(805) 756 - 6662
Fax (805) 756 - 1602

RIS CODE	ZRP	Responded
NO. SLUGS	1,384	Transfer Slugs
WT. SLUGS kg	2,493.5	

Dr. K. A. Thomson
Radiation Safety Officer
Pacific Union College
Department of Physics and Computer Science
Angwin CA 94508 - 9797
(707) - 965 - 7260
Fax (707) 965 - 6390

RIS CODE	ZCT	Responded
NO. SLUGS	2,603	Retain & return some slugs
WT. SLUGS kg	5,944.43	

Jack Harrell
Department of Nuclear Engineering
University of California, Berkeley
College of Engineering
Berkeley CA 94720
(510) 643 - 1021
Fax (510) 643 - 9685

RIS CODE	ZFB	Not contacted
NO. SLUGS		
WT. SLUGS kg	2	

Phillip A. Russell (NRC)
University of Denver, Research Center
2115 University Blvd. S
Denver CO 80210
303 - 753-2141 / 3661
Fax

RIS CODE	ZJG	Responded
NO. SLUGS	1,381	Return ASAP
WT. SLUGS kg	2,493.1	

Dr. Emanuel Glakpe
Professor of Mechanical Engineering
Howard University
L. K. Downing Hall, School of Eng., 2300 6th St NW
Washington DC 20059
(202) - 806 - 6600
Fax (202) 462 - 1080

RIS CODE	ZGF	Responded
NO. SLUGS	1,522	Retain & return some slugs
WT. SLUGS kg	3,984.56	

Donald L. Munroe
Radiation Safety Officer
University of Florida
202 Nuclear Science Building
Gainesville FL 32611
(904) 392- 1581
Fax (904) 391 - 3380

RIS CODE	ZGY	Responded
NO. SLUGS	1,301	Retain Slugs
WT. SLUGS kg	2,500.93	

Jerry Taylor
Assistant Radiation Safety Officer
Georgia Institute of Technology
900 Atlantic Drive
Atlanta GA 30332
(404) 894-3605
Fax (404) 853 -9325

RIS CODE	ZKB	Responded
NO. SLUGS	2,162	Retain & return some slugs
WT. SLUGS kg	4,176.3	

Dr. R. Danofski
Mechanical Engineering Department
Iowa State University
107 Nuclear Engineering Laboratory
Ames IA 50011
(515) 294 - 5840
Fax (515) 294 - 3261

RIS CODE	ZJZ	Not contacted
NO. SLUGS	2	Per SRFO, return ASAP
WT. SLUGS kg	3.86	

Twaler, W. E. (NRC)
University of Iowa
311 Grand Ave.
Iowa City IA 52242
(319) 353-3458
Fax

RIS CODE	ZJL	Responded
NO. SLUGS	1,384	May return slugs
WT. SLUGS kg	2,489.73	

Vicky Schur
Laboratory Safety Technician
University of Idaho
College of Engineering
Moscow ID 83843
(208) 885 - 6524
Fax (208) 885 - 5969

University Contacts

RIS CODE ZJR
NO. SLUGS 2,772
WT. SLUGS kg 4,991.69

Barkely Jones, Head
Nuclear Engineering Department
University of Illinois at Urbana-Champaign
103 South Goodwin
Urbana IL 61801
(217) 333 - 3535
Fax (217) 333 - 2906

RIS CODE YBF
NO. SLUGS 1,396
WT. SLUGS kg 2,493.59

Responded
Retain Slugs
Dr. Martin E. Nelson, Marine Engineering
Dept. of Naval Arch., Oceanography and Marine Eng.
United States Naval Academy
590 Holloway Road
Annapolis MD 21402 - 5042
(301) 267 - 3871
Fax (301) 267 - 2591

RIS CODE ZWZ
NO. SLUGS 1,425
WT. SLUGS kg 2,499.88

Responded
May return slugs
Dr. Donald D. Koetke, Chairman
Department of Physics and Astronomy
Valparaiso University
Neils Science Center
Valparaiso IN 46383
(219) 464 - 5377
Fax (505) 665 - 1712

RIS CODE ZMF
NO. SLUGS 1,386
WT. SLUGS kg 2,493.33

Edgar Bowden, Director
Facilities
Maine Maritime Academy
Castine ME 04420
(207) 326 - 4311
Fax (207) 326 - 9703

RIS CODE ZQH
NO. SLUGS 1,054
WT. SLUGS kg 1,899.91

Responded
Return ASAP
Andy G. Welding
Health Physicist
University of Notre Dame
119 Student Health Center
Notre Dame IN 46556
(219) 239 - 5037
Fax (219) 239 - 8794

RIS CODE YFH
NO. SLUGS 1,432
WT. SLUGS kg 2,498.64

Responded
May return slugs
Alan Jackson
Occupational Safety, Environment & Health
University of Michigan
1061 N. University Ave.
Ann Arbor MI 48109
(313) 764 - 1587
Fax (313) 763 - 1185

RIS CODE ZKP
NO. SLUGS 1,415
WT. SLUGS kg 2,494.15

Prof. O. J. Hahn, Professor
Mechanical Engineering Department
University of Kentucky
800 Rose Street
Lexington KY 40506
(606) 257 - 5862
Fax (606) 257 - 3342

RIS CODE ZYA
NO. SLUGS 1,045
WT. SLUGS kg 1,819.97

Phone Response
Return ASAP
James Barrows
Health Physicist
Wayne State University
645 Mullet St.
Detroit MI 48226
(313) 577 - 1253
Fax (313) 577 - 5579

RIS CODE ZLS
NO. SLUGS 1,419
WT. SLUGS kg 2,496.84

Responded
Retain Slugs
Dr. L. Max Scott, Radiation Safety Officer
Center for Energy Studies
Louisiana State University
East Fraternity Circle
Baton Rouge LA 70803
(504) 388 - 4400
Fax (504) 388 - 4541

RIS CODE ZNK
NO. SLUGS 1,289
WT. SLUGS kg 2,499.5

Responded
Retain Slugs
Professor William H. Miller
Nuclear Engineering
University of Missouri
333 Engineering Building West
Columbia MO 65211
(314) - 882 - 4211
Fax (314) 882 - 6360

University Contacts

RIS CODE	ZNL	Responded
NO. SLUGS	1,412	Retain Slugs
WT. SLUGS kg	2,540.1	
Albert E Bolon Chairman, Nuclear Engineering Department University of Missouri, Rolla Building C Rolla MO 65401 (314) 341 - 4236 Fax (314) 341 - 4192		

RIS CODE	ZTX	Responded
NO. SLUGS	1,381	Return ASAP
WT. SLUGS kg	2,493.1	
Dr. George Martin, Academic Vice President Academic Vice President Saint Peters College 2641 Kennedy Boulevard Jersey City NJ 07306 (201) - 915 - 9406 Fax (201) 451 - 0036		

RIS CODE	ZNF	Responded
NO. SLUGS	1,384	May return slugs
WT. SLUGS kg	2,493.5	
Dr. Charles Sparrow Head, Department of Nuclear Engineering Mississippi State University PO. Drawer NE Mississippi State MS 39762 (601) - 325 - 7323 Fax (601) - 325 - 8573		

RIS CODE	ZPL	Responded
NO. SLUGS	1,382	Retain Slugs
WT. SLUGS kg	2,494.91	
Ken Carpenter, Nuclear Eng. Laboratory Supervisor Department of Chemical and Nuclear Engineering University of New Mexico Dept. of Nuclear Engineering Albuquerque NM 87131 (505) 277 - 5431 Fax (505) 277 - 0813		

RIS CODE	ZPA	
NO. SLUGS	1,384	
WT. SLUGS kg	2,493.5	
Steven Crandell Assistant Radiation Safety Officer University of Nebraska 501 N. Tenth St. Lincoln NB 68588 - 0208 (402) 472 - 2155 Fax (402) 472 - 6803		

RIS CODE	ZEB	Per SRFO, return ASAP
NO. SLUGS	2,762	
WT. SLUGS kg	4,767.48	
Neil Wotherspoon Radiation Safety Officer Columbia University 500 West 120th Street New York NY 10027 (212) 854 - 4442 or 6532 Fax (212) 316 - 4937		

RIS CODE	ZQA	
NO. SLUGS	1,401	
WT. SLUGS kg	2,493.47	
Dale Patrick Assistant Radiation Safety Officer University of North Dakota P. O. Box 8275 - University Station Grand Forks ND 58202 (701) 777 - 3341 Fax (701) 777 - 3342		

RIS CODE	ZPT	
NO. SLUGS	1,410	
WT. SLUGS kg	2494.46	
Prof. Ken Stanton Science Department State University of New York at Maritime Fort Schuyler Bronx NY 10465 (212) 409 - 7388 Fax (212) 409 - 7392		

RIS CODE	ZPU	
NO. SLUGS	1,380	
WT. SLUGS kg	2,490.67	
Dr. Benjamin Stevenson Department of Physics New Jersey Institute of Technology 161 Warren St. Newark NJ 07102 (201) 596 - 3562 Fax (201) 596 - 5794		

RIS CODE	ZMH	
NO. SLUGS	2,799	
WT. SLUGS kg	4,988.38	
Dr. Joseph Augustus Department of Mechanical Engineering Manhattan College, School of Engineering 3825 Corlear Ave. Bronx NY 10471 (212) 920 - 0144 Fax (212) 796 - 9812		

University Contacts

RIS CODE	YBB	Responded
NO. SLUGS	1,396	Retain Slugs
WT. SLUGS kg	2493.59	

LTC Larry Luckett, CHP
 Department of Physics
 United States Military Academy
 Department of U.S. Army
 West Point NY 10996 - 1790
 (914) 938 - 5012
 Fax (914) 938 - 3828

RIS CODE	ZYL	
NO. SLUGS	1,381	
WT. SLUGS kg	2499.15	

Mark Pierro, Radiation Safety Officer
 Radiation Protection Services
 State University of New York at Buffalo
 14 Parker Hall, Main Street Campus
 Buffalo NY 14214
 (716) - 831 - 3281
 Fax (716) 831 - 2029

RIS CODE	YBA	Responded
NO. SLUGS	1,384	Return ASAP
WT. SLUGS kg	2493.5	

Dr. Albert Stwertka
 Head, Department of Mathematics and Science
 United States Merchant Marine Academy
 U.S. Dept. of Transportation, Maritime Administration
 Kings Point NY 11024-1699
 (516) 773 - 5531
 Fax (516) 773 - 5509

RIS CODE	ZES	Phone Response
NO. SLUGS	2,100	Return ASAP
WT. SLUGS kg	3,864.28	

Howard C. Aderhold
 Nuclear Science & Engineering
 Cornell University
 Ward Laboratory
 Ithica NY 14853
 (607) 255 3481
 Fax (607) 255 - 9417

RIS CODE	XGL	Responded
NO. SLUGS	2,570	Return ASAP
WT. SLUGS kg	4,627.0	

S. C. Meepagala
 Assistant Professor
 Polytechnic University
 333 Jay Street
 Brooklyn NY 11201
 (718) 260 - 3195, 3196, or
 Fax (718) 260 - 3136

RIS CODE	ZQY	
NO. SLUGS	2,271	
WT. SLUGS kg	3,956.93	

Joseph Allgeier, Assistant Director
 Office of Radiation Safety
 Ohio State University
 200 Meiling Hall, 370 W. Ninth Ave.
 Columbus OH 43210 - 1238
 (614) - 292 - 0122
 Fax (614) 292 - 1544

RIS CODE	YDB	
NO. SLUGS	61	
WT. SLUGS kg	205.77	

Edward J. O'Connell, Radiation Safety Officer
 Department of Environmental Health & Safety
 State University of New York at Stony Brook
 Suffolk Building, Rm-104
 Stony Brook NY 11794
 (516) 632 - 6410
 Fax (516) 632 - 6319

RIS CODE	ZZR	Responded
NO. SLUGS	1373	May return slugs
WT. SLUGS kg	2493.61	

Leonard A. Perry
 Radiation Safety Officer
 Youngstown State University
 Dept. of Biological Science, 410 Wick Ave.
 Youngstown OH 44555
 (216) - 742 - 3361
 Fax (216) - 742 - 3798

RIS CODE	ZSX	Responded
NO. SLUGS	1,299	May return slugs
WT. SLUGS kg	2498.88	

Dr. Robert C Block
 Head of the Dept. of Nuclear Eng. and Eng. Physics
 Rensselaer Polytechnic Institute
 110 8th Street.
 Troy NY 12181
 (518) 276 - 6110
 Fax (518) 276 - 4832

RIS CODE	ZDP	Responded
NO. SLUGS	1427	Retain Slugs
WT. SLUGS kg	2,493.86	

Prof. Joel Weismen
 Nuclear Engineering Laboratory, Director
 University of Cincinnati
 Dept. of Mechanical, Industrial and Nuclear Eng.
 Cincinnati OH 45221 - 0072
 (513) 556 - 2739
 Fax (513) 556 - 3390

University Contacts

RIS CODE	ZRA	Responded
NO. SLUGS	1331	Return ASAP
WT. SLUGS kg	2494.67	

Dr. P. Skierkowski
Radiation Safety Officer
University of Oklahoma
905 Asp, Room 112
Norman OK 73019
(405) 325 - 1015
Fax (405) 325 - 7909

RIS CODE	ZVM	Responded
NO. SLUGS	2760	Retain Slugs
WT. SLUGS kg	4988.22	

Dr. Nicholas G. Demas, Prof.
Electrical Engineering Department
Tennessee Technical University
P. O. Box 5004
Cookeville TN 38505
(615) 372 - 3185
Fax (615) 372 - 6172

RIS CODE	ZSW	Not contacted
NO. SLUGS	1	
WT. SLUGS kg	4	

Michael A. Kay (NRC)
Radioisotope Committee, Nuclear Reactor Facility
Reed College
3203 SE. Woodstock Blvd.
Portland OR 97202
(503) - 771 - 1112, ext. 205
Fax

RIS CODE	ZVT	
NO. SLUGS	1406	
WT. SLUGS kg	2494.23	

Dr. John Posten, Professor and Head
Nuclear Engineering Department
Texas A&M University
Radiological Safety Office
College Station TX 77843 - 3133
(409) - 845 - 4161
Fax (409) - 845 - 6443

RIS CODE	ZRH	Responded
NO. SLUGS	620	Retain Slugs
WT. SLUGS kg	2,050	

Rainer Farmer
Radiation Safety Officer
Oregon State University
Radiation Center
Corvallis OR 97331
(503) - 757 - 2227
Fax (503) 737 - 0480

RIS CODE	ZXC	Responded
NO. SLUGS	1372	Transfer Slugs
WT. SLUGS kg	2491.79	

J. P. Farrar
Reactor Administrator
University of Virginia
Thorton Hall
Charlottesville VA 22903
(804) - 982 - 5440
Fax (804) 982 - 5473

RIS CODE	XOK	Responded
NO. SLUGS	1378	Retain Slugs
WT. SLUGS kg	2493.94	

Dr. Walter Hahn (NRC), Radiation Safety Officer
Department of Biological and Physical Sciences
Benedict College
Harden and Blanding Streets
Columbia SC 29204
(803) 253 - 5274
Fax (803) 253 - 5085

RIS CODE	ZXG	Responded
NO. SLUGS	1532	Retain Slugs
WT. SLUGS kg	2772.25	

Dr. Phillip B. Peters, Radiation Safety Officer
Department of Physics
Virginia Military Institute
Department of Physics
Lexington VA 24450
(703) - 464 - 7225
Fax (703) 464 - 7169

RIS CODE	ZVK	
NO. SLUGS	4709	
WT. SLUGS kg	6356.59	

Roy Osborne
Radiological Safety Office
University of Tennessee
Old Cherokee Road
Knoxville TN 37996 - 3512
(615) 974 - 7179
Fax (615) 974 - 0978

RIS CODE	ZXW	Not contacted
NO. SLUGS	77	Per SRFO, return ASAP
WT. SLUGS kg	92.	

Miller, W. P. (NRC)
University of Washington
College of Engineering, Dept. of Nuclear Eng., Mail Stop
Seattle WA 98195
(206) 543 - 4170 or 2754
Fax

University Contacts

RIS CODE	ZZA	Responded
NO. SLUGS	1289	Retain Slugs
WT. SLUGS kg	2499.5	

Richard J. Cashwell, Director Nuclear Reactor Lab.
Mechanical Engineering Department
University of Wisconsin
Nuclear Reactor Laboratory, Mechanical Eng. Bldg.
Madison WI 53706
(608) 262 - 3392
Fax (608) 262 - 6707

RIS CODE	ZYG
NO. SLUGS	751
WT. SLUGS kg	1351

Dr. Keith R. Honey, Head
Department of Physics
West Virginia Institute of Technology
Orndoff Hall
Montgomery WV 25136
(304) 442 - 3194
Fax (304) 442 - 3307

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G. W. Becker, 773-41A (5)

W. D. Clark, 703-A

N. S. Khalil, 703-A

END

**DATE
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8 / 13 / 93