

PNL-10616-005



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

~~SECRET~~ * EPI

729527

OCT 26 1979

Mr. A. G. Fremling, Manager
Richland Operations Office
U. S. Department of Energy
P.O. Box 550
Richland, Washington 99352

REPOSITORY PNL
COLLECTION Yellowake
BOX No. 3161
FOLDER DHSC 81-8

Dear Mr. Fremling:

FY 1980 NUCLEAR REGULATORY RESEARCH ORDER NO. 60-80-015 FOR
PACIFIC NORTHWEST LABORATORIES

Please authorize Pacific Northwest Laboratories to execute the program
described in the enclosed NRC Order.

If this meets with your approval, it is requested that acceptance be
indicated on the enclosed form and the original be returned to the
NRC Controller and a signed copy to this office.

Sincerely,

for Frank J. Arsenault
Frank J. Arsenault, Director
Division of Safeguards, Fuel Cycle
and Environmental Research *10/18*

- Enclosures:
1. NRC Order
2. Program Briefs

- cc w/enclosures:
H. B. Spitz, PNL
L. Schwendiman, PNL
L. J. Kirby, PNL
D. G. Watson, PNL
R. Bean, PNL
J. W. Currie, PNL
Y. Onishi, PNL
G. W. R. Endres, PNL
J. C. Evans, PNL
D. E. Robertson, PNL
R. W. Barber, DOE/NSC
D. D. Mayhew, DOE/ASEV:DFS

RECEIVED

NOV 05 1979

DOE - RL OFFICE
ENERGY PROGRAMS DIVISION

1261005

FY80 PROGRAM BRIEF

TITLE: TRANSLOCATION OF YELLOWCAKE FROM THE
HUMAN RESPIRATORY TRACT

FIN NO.: B2283
CONTRACTOR: PNL
SITE: RICHLAND
STATE: WASHINGTON

NRC TECHNICAL MONITOR: J. D. Foulke

PRINCIPAL INVESTIGATOR: B. Robinson, H. B. Spitz, D. R. Fisher

BUDGET ACTIVITY: 60193102

FY80 WORK PERIOD: October 1, 1979/September 30, 1980 OBLIG: \$54K

OBJECTIVES:

The objective is to determine the biological half-life of uranium in yellowcake forms in the human lung in order to classify properly the solubility of yellowcake for purposes of limiting exposure to airborne yellowcake.

SCOPE:

The research will be carried out in two phases:

Phase I

Contact will be established with management at several uranium mills chosen for their experience in having had positive exposures to airborne yellowcake. Past practices with regard to bioassay programs will be discussed and the procedures reviewed. Both sample collection and analytical chemical methods will be evaluated. A protocol of urine specimen collection and analysis will be established. Data on the chemical composition of yellowcake will also be collected.

Phase II

Following exposure to high levels of airborne yellowcake, the mill operator will begin urine collection. The exposed individual(s) will be flown to PNL for a two-week period. At PNL daily urine sampling and in vivo organ counting will be conducted. After approximately thirty days the individual will return to PNL for two or three more days of urine sampling and lung counting. It is expected that ten cases will be necessary for study.

Scope of Work for FY80

Phase I will be completed with a program of urine specimen collection and analysis involving split sampling with mill management personnel.

Continuous alpha air monitors equipped with a "respirable fraction" discriminator will be installed at eight uranium mills. These instruments will audibly alarm to signal high levels of yellowcake in the workers' breathing zone.

A new whole body counting room will be equipped at PNL. The increased sensitivity will allow measurements to be made on workers who are chronically exposed to provide baseline data.

1261006

60-80-015

STANDARD ORDER FOR DOE WORK

DATE

October 26, 1979

ISSUED TO: (DOE Office)

Richland Operations Office

ISSUED BY: (NRC Office)

Division of Safeguards, Fuel
Cycle & Environmental Research

ACCOUNTING CITATION

APPROPRIATION SYMBOL
31X0200.600

D&R NUMBER

See Attached

PERFORMING ORGANIZATION AND LOCATION

Pacific Northwest Laboratories

FIN NUMBER

See Attached

FIN TITLE

See Attached

WORK PERIOD - THIS ORDER

FIXED

ESTIMATED

FROM:

TO:

10/1/79

0/30/80

OBLIGATION AVAILABILITY PROVIDED BY:

A. THIS ORDER

\$ 1,824,000

B. TOTAL OF ORDERS PLACED PRIOR TO THIS DATE WITH THE PERFORMING ORGANIZATION UNDER THE SAME "APPROPRIATION SYMBOL" AND THE FIRST FOUR DIGITS OF THE "E&R NUMBER" CITED ABOVE

\$ -0-

C. TOTAL ORDERS TO DATE

(TOTAL A & B)

\$ 1,824,000

D. AMOUNT INCLUDED IN "C" APPLICABLE TO THE "FIN NUMBER" CITED IN THIS ORDER.

\$ See Attached

FINANCIAL FLEXIBILITY:

- FUNDS WILL NOT BE REPROGRAMMED BETWEEN FINs. LINE D CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.
- FUNDS MAY BE REPROGRAMMED NOT TO EXCEED ± 10% OF FIN LEVEL UP TO \$50K. LINE C CONSTITUTES A LIMITATION ON OBLIGATIONS AUTHORIZED.

STANDARD TERMS AND CONDITIONS PROVIDED DOE ARE CONSIDERED PART OF THIS ORDER UNLESS OTHERWISE NOTED.

ATTACHMENTS:

THE FOLLOWING ATTACHMENTS ARE HEREBY MADE A PART OF THIS ORDER:

- STATEMENT OF WORK
- ADDITIONAL TERMS AND CONDITIONS
- OTHER

SECURITY:

- WORK ON THIS ORDER IS NOT CLASSIFIED.
- WORK ON THIS ORDER INVOLVES CLASSIFIED INFORMATION. NRC FORM 187 IS ATTACHED.

REMARKS:

Final work packages (189a's) reflecting approved FY 1980 resources and scope should be furnished within sixty days. Five copies should be sent to the Office of Nuclear Regulatory Research and one copy to the NRC Controller.

ISSUING AUTHORITY

SIGNATURE

Frank J. Arsenault
Frank J. Arsenault, Director IC/IS

ACCEPTING ORGANIZATION

SIGNATURE

Maryann H. LaRocca

TITLE

Division of Safeguards, Fuel Cycle
& Environmental Research

TITLE

Operations Administrator

DATE

11/16/79

FY 1980
PACIFIC NORTHWEST LABORATORY
(\$ in thousands)

B&R NO.	FIN NO.	TITLE	FY 1980 OBLIGATION
60193102	B2283-0	1070 Translocation of Yellowcake from the Human Respiratory Tract	\$ 54 ✓
60193201	B2095-0	382 Characterization, Resuspension and Transport of Radioactive Particles from Uranium Milling Tailings Piles	50 ✓
60193201	B2269-0	997 Attenuation of Radon Emission from Uranium Tailings Piles	50 ✓
60193201	B2270-0	995 Characterization and Environmental Significance of Gases and ²²² Rn Particles in Underground Uranium Mine Exhaust Ventilation Air	100 ✓
60193201	B2279-0	1045 Radon and Aerosol Release from Open Pit Uranium Mining	100 ✓
60193201	B2291-0	1194 Chemical Species of Migrating Radionuclides at Maxey Flats and Other Shallow Land Burial Sites	245 ✓
60193201	B2292-0	1149 Assessment of Leachate Movement From Poned Uranium Mill Tailings	150 ✓
60193202	B2072-0	782 Quantitative Assessment of Aquatic Impacts of Power Plants	60 ✓
60193202	B2098-0	894 The Synthesis, Pathways, Effects and Fate of Chlorination By-Products in Freshwater, Estuarine and Marine Environments	180 ✓
60193202	B2266-0	974 Study of the Visual Change Within a Region Due to Alternating Closed Cycle Cooling Systems and Associated Socioeconomic Impacts	15 ✓
60193202	B2271-0	1000 Mathematical Simulation of Sediment and Containment Transport in Surface Waters	115 ✓
60193202	B2275-0	1021 Sediment and Radionuclide Transport in Rivers - Field Sampling Program, Cattaraugus and Buttermilk Creeks, New York	160 ✓
60193202	B2282-0	1063 Neutron Dosimetry at Commercial Nuclear Sites	56 ✓
60193202	B2294-0	1094 Sediment and Radionuclide Transport in Rivers (Transport Modeling)	89 ✓
60193202	B2296-0	1134 Long-Lived Activation Products in Reactor Materials	150 ✓
60193202	B2299-0	1194 Characterization of Radionuclide Contamination Throughout Light Water Reactor Power Stations	250 ✓

TOTAL OPERATING \$1,824

U.S. NUCLEAR REGULATORY COMMISSION

B 2293

PROGRAM AND BUDGET PROPOSAL

DATE: April 18, 1979

1. BUDGET ACTIVITY NO.: 60193002	2. OFFICE: HFCR	3. PROJECT TITLE: Translocation of Yellowcake from the Human Respiratory Tract
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4. METHOD OF REPORTING: <input type="checkbox"/> 1. MONTHLY LTR. <input type="checkbox"/> 4. ANNUAL <input checked="" type="checkbox"/> 2. QUARTERLY <input type="checkbox"/> 5. OTHER <input type="checkbox"/> 3. SEMIANNUAL	5. PERSON IN CHARGE: (Include FTS No.) K. R. Heid	PRINCIPAL INVESTIGATOR(S): (Include FTS No.) B. Robinson/H. B. Spitz/D. R. Fisher
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6. CONTRACTOR: Battelle Memorial Institute Pacific Northwest Laboratory	7. WORKING LOCATION - CITY: Richland	HUMAN SUBJ. MAY 3 1979 COMMITTEE	8. STATE: Washington
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9. TYPE: <input type="checkbox"/> 1. INDUSTRIAL <input type="checkbox"/> 4. GOVERNMENT <input checked="" type="checkbox"/> 2. DOE LAB. <input type="checkbox"/> 5. OTHER NONPROFIT <input type="checkbox"/> 3. EDUCATIONAL	10. CONTRACT NO.: EY-76-C-06-1839	11. TASK NO.: (PNL Proposal No.) 30CA01198, Am. TD 1070
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12. CONTRACT TERM - BEGIN: From Mo. Day Yr. 10 01 78	13. CONTRACT TERM - END: To Mo. Day Yr. 09 30 79	14. TERMINATION DATE OF FUNDING: Mo. Day Yr. 09 30 79
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15. MANYEARS	FY79	FY 80	FY 81
Direct			
Scientific	0.5	0.5	0.1
Other Direct			
TOTAL	0.5	0.5	0.1

16.a PROGRAM SUPPORT OBLIGATIONS	FY79	FY 80	FY 81
a. Direct Salaries	17.1	17.8	2.7
b. Materials & Services	5.6	48.0	1.7
c. Subcontracts			
d. Travel - Domestic	8.0	2.6	.5
e. Travel - Foreign			
f. Other Direct Costs	1.0	1.0	.2
g. Indirect Costs	4.1	4.5	.7
h. General and Administrative	10.5	11.6	1.9
i. Indirect Services	1.7	3.5	.3
Total (In Thousands)	48.0	89.0	8.0

16b. EQUIPMENT	FY79	FY 80	FY 81
Estimated Capital Equipment	20.0	-	-
Total Estimated Program Costs	68.0	89.0	8.0

17. (a) COST:

(\$ in Thousands)	<u>Prior Years</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>FY 1981</u>
Obligation Schedule	10	68	89	8
TOTAL OPERATIONS				
Fiscal Year	10	68	89	8
Cumulative	10	78	167	175

(b) DEVELOPMENT SCHEDULE:

This program is designed with two subtasks (phases). The first phase will establish protocols for bioassay procedures, in-vivo examination procedures and establish the contacts to obtain co-operation of at least four mill operators. The second phase includes collection of samples and in-vivo examinations. Evaluation of the data will attempt to characterize generic biological elimination rates for human organs.

18. PUBLICATIONS:

None; new project.

19. SCOPE:

The primary purpose of this study is to determine whether yellowcake exhibits any significant degree of solubility in the lung as indicated by the presence of uranium in the urine of occupationally exposed mill workers. Since the current NRC staff position indicates that, generically, yellowcake is a soluble compound, the question regarding the degree of solubility in the human lung must be verified through actual exposure incidents. Analysis of uranium in sequentially collected excreta samples from occupationally exposed uranium mill yellowcake workers will characterize and quantitate uranium removal rates. In vivo measurements of uranium deposited in the lung will also be performed as an adjunct to the assay of uranium in excreta.

20. RELATIONSHIP TO OTHER PROJECTS:

This project is related to many new and long-standing NRC and DOE studies at PNL, specifically directed towards assessment of human exposure to radioactive aerosols from uranium mills and mill tailings.

21. TECHNICAL ACCOMPLISHMENTS IN FY 1979:

Accomplishments thus far during FY 1979 include completion of the literature search, completion of the study description sent out to mills, and coordination of the study with other NRC projects at both Pacific Northwest Laboratory and other sites.

The literature search was completed, including a computer search of the EDS, NTIS, NSA, and chemical abstract files. This work showed that although overexposures have occurred in the past, the uranium companies do not typically report these incidents with sufficient of the nature required for the present study. One exception, brought to our attention by Dr. Ted Wolf's group with the State of New Mexico, was an overexposure to yellowcake dust during the decommissioning of a mill in New Mexico about 1974, in which a series of bioassay and chest counting data were obtained.

Contacts were established with investigators (both here at Pacific Northwest Laboratory and other sites) of proposed and funded NRC projects related to the yellowcake study. Meetings were held to coordinate this study in such a way as to maximize the information which can be obtained. For example, it is possible that some of the urine sample collection can be coordinated with other studies so that additional background information on internal deposition for other radionuclides may be obtained on uranium mill yellowcake workers.

A descriptive letter of the yellowcake solubility study was sent to all uranium mills in the U.S.A. Followup visits to several mills were made for the purpose of providing details of the study to management and safety directors, and to arrange for company cooperation.

Several logistical complications were dealt with during FY 1979. A major complicating factor is the difficulty involved in identification of the overexposure incident. To obtain meaningful clearance data on the short-term retention component, the occurrence must be firmly established and the occupationally-exposed worker must be immediately removed from the working environment and transported to our laboratories. For the more soluble forms of yellowcake, delays in this action become increasingly important.

Defining the overexposure conditions suitable to initiate a comprehensive individual examination requires a complex series of criteria. One way to achieve immediate notification of an occurrence could be the utilization of a continuous alpha air monitor with alarm capabilities. We anticipate that about eight instruments may be required. These could be used in conjunction with a "respirable fraction" flow-through apparatus. The additional exposure involved in acquiring this equipment was not included in the cost estimated for the original research proposal.

The NRC-sponsored study, "In Vitro Dissolution of Uranium Product Samples From Four Uranium Mills," by A. F. Edison and J. A. Mewhinney (NUREG/CR-0414) is especially pertinent to the present project. This report indicates a dissolution rate for yellowcake in simulated lung fluid, such that an actual initial deposition of 15 mg highly soluble yellowcake would not be detectable in the lungs after 48 hours. However, for the other three forms of yellowcake studied, an equivalent deposition would be sufficiently above detection limits to permit in vivo chest counting. Thus, it was decided that this procedure must begin within 24 hours of the overexposure.

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22. EXPECTED RESULTS IN FY 1980:

Recent evidence indicates that a significant fraction of inhaled yellowcake may have a short biological residence in the lung (probably because a significant fraction of uranium is in the more soluble hexavalent). Since up to now, yellowcake has been considered a class Y compound, the lung has been the principle organ of concern whereas the chemical toxicity to the kidney has not been considered. There is now speculation that some forms of yellowcake may have a greater degree of solubility in the lung than previously considered which would shift attention from the radiation dose to the lung to the chemical toxicity in the kidney. The proposed research will attempt to classify yellowcake solubility in the human lung from actual occupational exposure incidents involving uranium mill yellowcake workers.

An evaluation of the bioassay programs at those mills which provide on-site analysis and/or collections will be made to identify any potential sources or means for external contamination during sample collection procedures. The question of solubility as a function of calcining temperatures, processing methods and chemical composition will also be investigated.

Phase I: Several uranium mills will be contacted in order to establish the validity of past bioassay analytical programs and health physics practices. Protocols will be proposed for the management of any eventual yellowcake worker exposure incidents to provide a uniform method of sample collection and processing and to immediately transport the individual to BNW (Richland) for extensive analysis. The worker(s) will initially remain at Battelle for several days, the length of which is governed by the elimination rate of uranium for a particular yellowcake material. Further urine samples will be collected and in vivo measurements performed while the workers are at Battelle. These leaves of absence will require concurrence of the mill operators.

During these contacts and visits the mill bioassay programs will be examined. Collection and analysis of background data will be accomplished at PNL and will result in an additional cost of \$12,000. This includes travel to PNL for in vivo measurements. Also, additional approval from the Battelle Human Subjects Committee may be needed. To assure quality analysis, backup samples will be analyzed by PNL or a suitable chosen alternate for comparison with analysis by the mill operator or his vendor. Data on chemical composition of yellowcake will be collected at each mill site. This phase of the program is estimated to cost \$78,000 and has begun.

Phase II: This portion of the program involves collection of new data surrounding future incidents of high exposure. Based upon the protocol established in Phase I, the mill operator will, immediately upon determination of a high exposure condition, commence collection of excreta from those workers involved in the overexposure incident. The urine samples will be analyzed by PNL and the mill operator (if so desired). The person or persons exposed will be flown to Richland, Washington immediately following exposure.

The program involves daily urine collections, portions of which will be saved for future analysis by the worker's employer. In vivo measurement to assess elimination rates from the lung are also scheduled. At the Hanford whole-body counter, the minimum detectable amount of natural uranium at the 95% confidence level is 2.4 nCi (3.6 mg) in the lung and 1.0 nCi (1.5 mg) in the kidney.

The reasons for having the worker in our laboratory is to ensure a contamination-free environment and accessibility to whole-body or organ counters. It is established that urinalysis, organ burden determinations, travel and living expenses and payment of salary will cost about \$7,000 per exposed mill worker and may be a variable accrual expense depending upon the actual incidence rate. The analysis and interpretation of the incidence data, PNL travel, salary, reporting and QA expenses are estimated to cost about \$27,000. This latter cost is not expected to vary. The total cost of this phase, therefore, is expected to be about \$97,000.

It is anticipated that during FY 1980, Phase I will be finished, plus most or all of Phase II, depending on the number of exposure cases available.

23. EXPECTED RESULTS IN FY 1981:

Continuation of Phase II through 10 cases.

24. EXPECTED RESULTS BEYOND BUDGET YEAR:

The evaluation for 10 research subjects may require continuing study.

25. DESCRIPTION AND JUSTIFICATION OF MAJOR MATERIALS, SUBCONTRACT ITEMS AND OTHER UNUSUAL SIGNIFICANT COST ITEMS:

Not applicable.

26. DESCRIPTION, JUSTIFICATION, AND SEQUENTIAL PRIORITY OF ALL EQUIPMENT ITEMS:

DESCRIPTION:

Item:	Air monitors (continuous, alpha), alarming type; equipped with "respirable fraction" discriminator.
Number Required:	8
Cost Per Unit:	\$2,500
Total Cost:	\$20,000

JUSTIFICATION:

This equipment is essential for detection and notification of "high" exposures early enough for in vivo and bioassay measurements to be taken. Without these bioassay measurements no models can be developed. Also, no other instrumentation is available to give the desired early detection and air level concentrations. See also, discussion in section 22.

27. TRAVEL:

	<u>Number Of Trips</u>	<u>Number Of Travelers</u>	<u>Days in Travel Status</u>	<u>Cost</u>
FY 1979	12	4	39	\$8,000
FY 1980	4	4	11	\$2,600
FY 1981	1	1	2	\$ 500

28. UTILIZATION OF FACILITIES AND TASK INSTALLATION:

Not applicable.

29. COMMENTS:

NOTE: Performance of this project is contingent upon the secondary review and approval of the Battelle Human Subjects Committee.