PNL40616-009

PROGRAM AND BUDGET PROPOSAL

NUCLEAR REGULATORY RESEARCH PROGRAM

FIN/183a NO.:

DATE: March 1978

729531

1. BUDGET ACTIVITY NO.:	2. OFFICE:	3. PROJECT TITLE:
		Translocation of Yellowcake from the Human Respiratory Tract

4. METHOD OF REPORTING:

- ☐ 1. MONTHLY LTR.
- ☒ 2. QUARTERLY
- ☐ 3. SEMIANNUAL
- ☒ 4. ANNUAL
- ☐ 5. OTHER

5. PERSON IN CHARGE: K. R. Heid

PRINCIPAL INVESTIGATOR(S): B. Robinson/ R. L. Roswell

REPOSITORY PNL

COLLECTION Yellowcake

BOX No. 3161

FOLDER DHSC 81-8

6. CONTRACTOR:

Battelle Memorial Institute
Pacific Northwest Laboratory

7. WORKING LOCATION - CITY: Richland

8. STATE: Washington

9. TYPE:

- ☐ 1. INDUSTRIAL
- ☒ 2. DOE LAB.
- ☐ 3. EDUCATIONAL
- ☐ 4. GOVERNMENT
- ☐ 5. OTHER NONPROFIT

10. CONTRACT NO.: EY-76-C-06-1830

11. TASK NO.:

12. CONTRACT TERM - BEGIN: From Mo. 05 Day 15 Yr. 78

13. CONTRACT TERM - END: To Mo. 09 Day 30 Yr. 78

14. TERMINATION DATE OF FUNDING: Mo. Day Yr. Continuing

15. MANYEARS	FY 1978	FY 1979	FY 1980
Direct			
Scientific	0.2	0.5	0.2
Other Direct			
TOTAL	---	1	---
16.a PROGRAM SUPPORT OBLIGATIONS			
a. Direct Salaries	7	16	6
b. Materials & Services	36	44	7
c. Subcontracts			
d. Other Direct			
TOTAL DIRECT COSTS	43	60	13
e. Indirect Costs	4	10	4
f. Fee	3	5	1
Total (In Thousands)	50	75	18
16b. EQUIPMENT			
Equipment Obligations (In Thousands)			
Equipment Costs (In Thousands)			

A-1004-101.1 (1-78)

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17. (a) COST:

	Prior Years	FY 1978	FY 1979	FY 1980
Obligation Schedule*	0	$50	$75	$18
TOTAL OPERATIONS				
Fiscal Year	0	$50	$75	$18
Cumulative	0	$50	$125	$143

* Dollars in thousands

(b) DEVELOPMENT SCHEDULE:

This program is designed with two subtasks (phases). The first phase will establish the protocol for bioassay procedures, in-vivo examination procedures and establish the contacts and obtain the cooperation of at least four mill operators. The second phase will obtain bioassay samples, in-vivo examinations, and their evaluations, from which generic biological elimination rates in human organs will be developed.

18. PUBLICATIONS:

None; new project.

19. SCOPE:

The primary purpose of this study is to determine the solubility of yellowcake inhaled by mill workers. This will require collecting data on the rate of urinary elimination of uranium and/or organ (lung and kidney) burdens by bioassay or in-vivo examinations from occupationally exposed persons. Sufficient data will be obtained to permit an estimation of the biological half-life of uranium, in yellowcake forms, in the lung. This information is needed for proper assessment of the hazard from exposure to airborne yellowcake and for verification or refutation of the NRC staff's current position that, for purposes of compliance with Section 20.103 of 10 CFR 20, yellowcake is a soluble compound.

20. RELATIONSHIP TO OTHER PROJECTS:

This program is related to many new and long-standing NRC and DOE programs at PNL specifically aimed at assessment of the hazards from exposure to uranium mill tailings and mill aerosols both from a modeling viewpoint, specifically using the ICRP Task Group Lung Model, and by animal research

21. TECHNICAL ACCOMPLISHMENTS IN FY 1977:

Not applicable; new program.

22. EXPECTED RESULTS IN FY 1978:

Concern over the potential hazard to mill workers from exposure to yellowcake has recently been voiced by NRC, precipitating action to investigate the solubility properties of yellowcake in the lung. Heretofore, it has been assumed that for all Class Y uranium compounds, including yellowcake, the lung is the principal organ of concern. There is now speculation that at least specific types of yellowcake have a greater solubility in the lung, shifting attention from the radiation dose to the lung to the chemical toxicity in the kidney as the organ of concern. Recent evidence from bioassay data indicate 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 state, thereby bringing uranium more quickly into contact with kidney tissues. However, these data are questionable from the standpoint that specimens were possibly contaminated. Until the retention of various forms of yellowcake in the human lung is known to a greater degree of accuracy it has become prudent to treat such aerosols as soluble, rather than insoluble, in which case the overexposure reporting requirements need to be changed commensurate with the shift in critical organ from lung to kidney. The proposed research will help clarify some of these issues ultimately by properly classifying the solubility of yellowcake for proper assessment of the hazard, and investigating the bioassay programs at the mill sites from collection through analysis to evaluate the probability of contamination of specimens and insure quality of procedures. The question of solubility as a function of calcining temperature, processing methods and chemical composition will also be investigated. The thorough investigation of the solubility properties may ultimately involve a redirection of this program.

Phase I: This portion of the program attempts to establish validity of past practices and assess existing bioassay data. Contact will be established with management of at least 4 mills or mill sites chosen on the basis of past experience to have "high" rates of positive exposures. Arrangements will be made at these sites to establish a protocol of urine specimen collection and analysis to insure proper handling and evaluation of future incidents. Arrangements will also be made for transporting employees involved in future incidents to Richland, Washington, for whole-body counting and additional analysis. This will involve removal of such employees from the mill atmosphere for approximately 30 days and will require concurrence of the mill operator. During these contacts and visits the individual licensees' bioassay programs will be obtained including procedures and arrangements made

to collect existing data. Hopefully, that data will include both background measurements, i.e., current body burdens, and measurements from previous instances of high exposure. This data will be statistically analyzed and evaluated to insure proper collection and radiometric analysis procedures for quality assurance purposes. To assure quality of analysis, backup samples will be analyzed by PNL or a suitably chosen alternate for comparison with analysis by the mill operator or his vendor. Data on chemical composition of yellowcake will be collected, if available, at each mill site. This phase of the program is estimated to cost $31,000 and can be started immediately.

Phase II: This portion of the program involves the careful and controlled collection of all new data surrounding future incidents of high exposure. Based upon the protocol previously established in Phase I, the mill operator will commence, immediately upon determination of a high exposure incident to collect urine which will be analyzed by both the mill operator and PNL or our chosen alternates. The person or persons exposed will, after proper cleanup, be flown to Richland, Washington, for further analysis over about a two-week period. This will involve daily urine sampling, portions of which will be saved for future analysis by the worker's employer, and in-vivo organ counting to more accurately assess elimination rates from the lung than what can be inferred indirectly via urine analysis. 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. Therefore, only exposures which exceed this level can be measured in-vivo. The reasons for having the worker in our laboratory is to insure a contamination-free environment and accessibility to whole-body or organ counters. After about 15 days the worker will be allowed to return home but not back to work for another approximately two-week period to avoid possible sample contamination or additional exposure. During this time he will continue to collect daily urine samples that will be split between PNL and his employer for future measurement. Just prior to his return to work, after approximately 30 days, the worker will be flown back to PNL for 2 or 3 more days of urine sampling and lung and kidney counting. It is expected that this later data will establish the background for the worker from which proper assessment of the early data can be made for biological half-time in the lung. This sharing of all urine samples and the counting of organ burdens will be duplicated for at least 10 cases to adequately develop a generic biological elimination rate in man.

It is estimated that urinanalysis, organ burden determinations, travel and living expenses and payment of salary will cost about $7,000 per exposed mill worker and will be somewhat an adjustable expense dependent upon incidence rate and experience. The accretion of this data, therefore, will also be dependent upon incidence rate. The analysis and interpretation of the incidence data, PNL travel, salary, reporting and QA expenses are estimated to cost about $42,000. This latter cost is not expected to vary. The total cost of this phase, therefore, is expected to be about $112,000.

23. EXPECTED RESULTS IN FY 1979:

Continuation or completion of Phase II will be the major activity this fiscal year. If the sponsor is interested in obtaining the adjunctive data this could be performed coincident to the obtaining of the human data.

24. EXPECTED RESULTS BEYOND BUDGET YEAR:

Continuation of Phase II through 10 cases.

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

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

27. UTILIZATION OF FACILITIES AND TASK INSTALLATION: NA

28. COMMENTS:

Overview of Program:

The degree of exposure of uranium mill workers to aerosols from yellowcake and from the ore dust itself has been estimated from bioassay measurements. The reliability of some of these measurements is in serious question because of several factors. These include possible contamination during sample collection and the possibility of errors in the analytical measurements.

The contamination during bioassay sample collection is certainly a serious problem. Mill workers are exposed to dust and their clothing, hair and other parts of their bodies, specifically their hands, may become contaminated. In addition, these materials may be carried to their homes and serve as a continual source of contamination. Thus, bioassay samples collected either at the mill or at home may always be contaminated, and their analysis may therefore reflect contamination rather than actual absorption of uranium into the blood stream through the pulmonary system of the digestive tract.

Because of these problems and uncertainties as to the actual protocol which was followed in the collection of bioassay samples, we feel that the first step in determining the reliability of bioassay results must include the following:

(1) A review of the bioassay sample collection protocol. This review should provide an indication of the probability of contamination of bioassay samples during collection.

(2) A review of the analytical chemical methods used for the analysis of uranium. The appropriateness of the analytical method for an extension which would permit the analysis of uranium daughters should also be determined.

(3) Review a sufficient amount of the bioassay data which have been collected thus far to determine:

(a) The reliability based on information as to the methods of sample collection and the analytical method used for analysis; and

(b) Its significance in terms of exposure of the individual to uranium-containing aerosols and possible associated health consequences.

The above reivew should provide a basis for determining the appropriateness of conducting further bioassay sampling and, if this is appropriate (which it seems that it may be) to develop a sound program that can insure the reliability of both sample collection and analysis of these samples. While the exact course of any new research must necessarily await the results of the above review process, we anticipate that it may include the following steps:

(1) Outlining a bioassay protocol which would insure the reliability of the samples which were collected. It is assumed that bioassay samples will be restricted to urine samples but may also include other materials. Because of the extreme difficulty of obtaining samples without contamination, and only a few particles of aerosols may be sufficient to seriously bias the results, it may be necessary to actually place a person in the mill who would be assigned sequentially to the various tasks that would result in exposure and analyze bioassay samples from this individual to determine what exposure could be anticipated from conducting the various tasks necessary in mill operations.

(2) Recommend an analytical program with built-in QA to insure reliability of measurements at the levels of interest. The analytical program must insure that not only the samples which are deemed positive are above a certain blank level, but the sensitivity and precision of the method is sufficient to make meaningful measurements at the required concentration which would be of concern from an exposure standpoint.

(3) Oversee a bioassay program which would provide defensible data for assessing the deposition of yellowcake in mill workers.

After we have established protocol for both sampling and analysis of bioassay samples, it would be essential to insure that a bioassay program was conducted in the prescribed manner so that data would be meaningful.

Carrying out the first phase of this program, which would include the collection of a significant amount of data from the mill areas of interest, must be overseen by a person(s) who understands all of the potential problems and possible errors associated with the entire program.

Beyond this, the program activity would include attention to defining the aerosols the millers are exposed to, especially during incidents, as well as independent analysis of their contamination by in-vivo counting and bioassay.