Quarterly Progress Report LWR Fuel Recycle Program

January - March 1976

April 1976

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Battelle

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QUARTERLY PROGRESS REPORT
LWR FUEL RECYCLE PROGRAM

JANUARY - MARCH 1976

Compiled by E. R. Irish

April 1976

BATTELLE
Pacific Northwest Laboratories
Richland, Washington 99352

FORWARD

This is the first quarterly progress report on research and development studies in support of the LWR Fuel Recycle Program being performed by Battelle-Northwest at the ERDA's Pacific Northwest Laboratory. The overall program, managed by SRO/SRL*, is divided into eleven categories.

CATEGORY

1. Liaison and Program Coordination
2. Economic and Environmental Documentation
3. Spent Fuel Receipt and Storage
4. Head-End Processes
5. Off-Gas Treatment
6. Purex Process (Solvent Extraction)
7. Finishing Processes
8. Waste Management
9. Environmental Effects
10. Safeguards
11. General Support

Studies reported herein were initiated following visits of the following SRL personnel to Battelle-Northwest in February 1976 during which scopes of the studies were defined:

J. M. Boswell	J. R. Hilley
J. L. Crandall	R. T. Huntton
T. V. Crawford	A. S. Jennings
H. J. Groh	G. F. Merz
W. H. Hale	P. L. Roggenkemp

Because these studies have just been initiated during March, the reports primarily define the tasks being undertaken.

* Sponsor: ERDA Division of Nuclear Fuel Cycle and Production.
SRO/SRL are Savannah River Operations and Laboratory.

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CATEGORY 2 -ECONOMIC AND ENVIRONMENTAL DOCUMENTATION

F-RL-14-007

PROJECT TITLE: Economic and Environmental Studies in
Support of LWR Fuel Recycle

PROJECT MANAGER: R. C. Liikala, Engineering Systems Analysis
Nuclear Technology Department

OBJECTIVE:

To conduct economic and environmental analyses of specific components of the LWR fuel cycle as required to support SRL LWR Fuel Recycle Program.

EXECUTIVE SUMMARY:

This task was set up during the quarter. No technical activity during the quarter.

TRIPS AND VISITORS:

R. C. Liikala - Washington, D. C., March 17, meeting with personnel from NFC&P SRL, ORNL, ORO, OMB and NFS.

TECHNICAL PROGRESS:

None

TASKS IN PROGRESS AND PLANS:

The plans for the next quarter are to develop information to analyze past performance of the uranium market and provide bases for projecting future uranium prices as functions of demand. Subsequently, the NUCOST computer program, used for GESMO cost/benefit analyses, will be documented; this may be deferred to the following quarter because of priority requirements for preparation of the Generic Environmental Impact Statement for Commercial Waste Management.

CATEGORY 4 - HEAD-END PROCESSES

F-RL-14-002

PROJECT TITLE: Alternatives to Voloxidation

PROJECT MANAGER: H. H. Van Tuyl, Applied Chemistry,
Chemical Technology Department

PRINCIPAL INVESTIGATOR: L. L. Burger, Applied Chemistry,
Chemical Technology Department

OBJECTIVE:

To review and evaluate alternate approaches to voloxidation for the removal of tritium and other volatile fission products from irradiated fuel prior to aqueous feed preparation.

EXECUTIVE SUMMARY:

Work on the program started in March, and plans are being made for carrying out the review and evaluation.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

Preliminary tabulations have been made of various treatment concepts, both U. S. and foreign. The list is being expanded, and available information on each is being organized for study.

TASKS IN PROGRESS AND PLANS:

A task breakdown has not been made, but effort will be directed towards both a review of head-end treatment methods (prior to feed preparation) and utilization of water recycle in the extraction and purification portions of the reprocessing plant. The goals will include the establishment of criteria for viable processes, and the identification of problems that need to be solved to develop a process and adapt it to a reprocessing plant.

CATEGORY 5 - OFF-GAS TREATMENT
F-RL-14-003

PROJECT TITLE: Investigation of Air Cleaning Process for Removing Tributyl Phosphate from Off-Gas Streams

PROJECT MANAGER: Lysle C. Schwendiman, Particulate and Gaseous Waste Research, Atmospheric Sciences Department

OBJECTIVE:

To provide a suitable air cleaning process for removing low concentrations of tributyl phosphate vapors from nuclear fuel reprocessing off-gas streams.

EXECUTIVE SUMMARY:

Methods of quantitatively analyzing low concentrations of TBP vapors in an airstream are being explored and initial development work is being done on the most promising methods. Inorganic solid sorber materials, identified through literature, which hold promise as sorbents for TBP, are being obtained. These materials will be screened in the laboratory and the most promising ones will be used in parametric studies. Other air cleaning methods are also being explored.

TRIPS AND VISITS:

None

TECHNICAL PROGRESS:

Laboratory work has been initiated in the development of a sensitive method to quantitatively analyze low concentrations of TBP vapor by capturing TBP on charcoal filters and analyzing for phosphorus using x-ray fluorescence. Charcoal filters were placed in series in an air stream which is bubbled through liquid TBP. From vapor pressure data and regulated air flow and temperature, the concentration of TBP is calculated. The filters are being analyzed for phosphorus to determine the trapping efficiency. Methods to assure x-ray analysis measures all the phosphorus present on the filter (from TBP) are also being developed.

A literature survey of possible candidate sorbent materials and other air cleaning methods for TBP removal has been conducted. Promising sorbent materials have been identified and manufacturers of these materials have been contacted for additional information.

Category 5 - Off-Gas Treatment (continued)

TASKS IN PROGRESS AND PLANS:

Laboratory samples of identified sorbent materials are being obtained from manufacturers for laboratory screening tests. A parametric study on the most promising material will follow the initial screening studies. Development of a sensitive method of quantitative analysis for TBP will be completed before laboratory testing is initiated.

CATEGORY 6 - PUREX PROCESS (SOLVENT EXTRACTION) Part 1
F-RL-14-004

PROJECT TITLE: Study of Iodine Chemistry in Process Solutions

PROJECT MANAGER: J. H. Jarrett, Chemical Development Section
Chemical Technology Department

PRINCIPAL INVESTIGATOR: J. L. Swanson, Chemical Development Section
Chemical Technology Department

OBJECTIVE:

To study the chemical species and behavior of the iodine which is not volatilized from the dissolver solution and to develop means of managing iodine in the various plant streams in order to minimize its release to the environment.

EXECUTIVE SUMMARY:

Following initiation of this task in mid-March, the bulk of the effort was devoted to preparation of proposals and work plans. Some needed materials have been ordered.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

None

TASKS IN PROGRESS AND PLANS:

The initial studies will emphasize the removal of iodine from aqueous streams (simulating concentrator overheads condensate) by sorption by commercially available polymeric sorbents and ion exchange resins.

CATEGORY 6 - PUREX PROCESS (SOLVENT EXTRACTION) Part 2
F-RL-14-004

PROJECT TITLE: Evaluation of Solvent Extraction Equipment

PROJECT MANAGER: J. H. Jarrett, Chemical Development Section
Chemical Technology Department

PRINCIPAL INVESTIGATOR: D. H. Lester, Chemical Development Section
Chemical Technology Department

OBJECTIVE:

To provide an integrated study of solvent extraction equipment types. Such information will provide information needed in optimizing reprocessing plant design. Where voids in existing understanding are identified, additional R&D will be proposed.

EXECUTIVE SUMMARY:

The task was initiated in late March. A work plan is in progress and individual assignments for task participants are being determined.

The initial effort will be a literature search including information now available from declassified sources (e.g., the declassified Purex Plant Manual at Hanford). Most of the effort in FY-76 will be information gathering with preliminary interpretation. A report draft is planned for the end of the year.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

Work plans are being prepared. Current plans are to investigate four types of equipment: Packed Columns, Pulsed Columns, Mixer Settlers, and Centrifugal Contactors. The emphasis will be on the latter three since it is generally understood that height of a transfer unit in packed columns is large for typical Purex applications. While much information is in the literature, there now exists a large body of recent declassified material on the Hanford Purex Plant which will be used in the analysis of the pulsed column.

Category 6 - Purex Process (Solvent Extraction) (continued) Part 2

TASKS IN PROGRESS AND PLANS:

The work will be subdivided into tasks. Currently envisioned is the following task breakdown.

Task 1 - Pulsed Column Data Gathering and Evaluation

Task 2 - Mixer Settler Data Gathering and Evaluation

Task 3 - Centrifugal Contactor Data Gathering and Evaluation

Task 4 - Data Gathering and Evaluation of All Other Methods

Task 5 - Applications and Comparisons

CATEGORY 7 - FINISHING PROCESSES
F-RL-14-005

PROJECT TITLE: Mixed Oxide Studies

PROJECT MANAGER:

Tasks 1, 2, and 4 - S. Goldsmith, Manager of Fuels Design and
Development Section, Materials Department

Task 3 - W. S. Kelly, Manager of Equipment Development Section,
Engineering Technology Department

OBJECTIVE:

The objectives of the four tasks are to: (1) establish the data base required to formulate product specifications for mixed oxide fuels, (2) formulate reference quality assurance/quality control (QA/QC) requirements for mixed oxide fuel fabrication, (3) evaluate mixed oxide fuel fabrication plant equipment and materials handling, and (4) investigate the effect of microstructural parameters on fuel performance limits.

EXECUTIVE SUMMARY:

Work on the project started in March, and the collecting of applicable literature needed for planned evaluations was initiated for Tasks 1-3.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

Task 1 - Establish Data Base Required to Formulate Product
Specifications for Mixed Oxide Fuels (W. J. Bailey)

A search was initiated to collect applicable literature needed for this study.

A task description was prepared and it indicates that available data on material properties irradiation effects and service demands will be compiled, evaluated, and collated in such a way as to provide the information needed to formulate product specifications for mixed oxide fuels. With such data available, individual product designs can be evaluated according to the service demands to be applied to the fuel.

Category 7 - Finishing Processes (continued)

Task 2 - Formulation of Reference QA/QC Requirements for
Mixed Oxide Fuel Fabrication (D. W. Brite, W. J. Bailey)

Collecting of appropriate literature needed for this task was initiated.

A task description was completed and it states that a reference set of quality assurance-quality control requirements for manufacturing LWR mixed oxide fuel will be developed. With such data available, evaluation of procedural alternatives as to their effect on fuel integrity and to the potential for reducing QA/QC personnel exposure would be facilitated.

Task 3 - Mixed Oxide Fuel Fabrication Plant Equipment and
Materials Handling Evaluation (D. E. Blahnik)

Work was initiated on gathering applicable literature that will be required for this study.

A task description was prepared and it indicates that existing process and material handling equipment will be evaluated for functional performance, safety, maintenance, modification, and replacement. Assistance will be provided on the conceptual design, development, demonstration and operational acceptance of equipment components that are found lacking during the initial evaluation.

Task 4 - Investigation of Effect of Microstructural Parameters
on Fuel Performance Limits (M. D. Freshley, D. W. Brite)

Work on this task is to be initiated in FY-1977.

A task description was written and it states that studies are to be made of fabrication processes suitable for producing mixed-oxide fuels which have specific microstructural characteristics to improve performance and irradiation tests are to be conducted to define performance limits as they relate to mixed-oxide fuel pellet specifications. Processing parameters to be investigated include powder treatment, blending and prepressing conditions, granulation methods, and sintering conditions. The effects of PuO_2 particle size, PuO_2 particle distribution, and impurity and actinide content on irradiation behavior which includes fuel densification, swelling, fission gas release, in-reactor PuO_2 particle diffusion or homogenization, and restructuring characteristics will be investigated. These experiments will provide input data needed for evaluating the predicting mixed-oxide fuel behavior using existing fuel performance codes.

Category 7 - Finishing Processes (continued)

TASKS IN PROGRESS AND PLANS:

Task 1

Compilation and evaluation of available data on mixed-oxide fuel for the data base report will be initiated in FY-1976.

Task 2

Work will be initiated in FY-1976 on formulating a reference set of quality assurance-quality control requirements for mixed-oxide fuel manufacture.

Task 3

Effort will be initiated in FY-1976 on the evaluation of existing and planned plant equipment for functional performance, safety, maintenance, modification and replacement.

Task 4

No work in progress. (This task commences in FY-1977.)

CATEGORY 9 - ENVIRONMENTAL EFFECTS

F-RL-14-008

PROJECT TITLE: Removal and Reentrainment of Plutonium and
Other Radionuclides

PROJECT MANAGER: C. L. Simpson, Atmospheric Sciences Department

PRINCIPAL INVESTIGATOR: W. G. N. Slinn, Atmospheric Sciences
Department

OBJECTIVE:

To develop realistic parameterizations for wet and dry
removal from the atmosphere and for reentrainment into the
atmosphere of plutonium and other radionuclides which are
potential hazards from the nuclear fuel cycle.

EXECUTIVE SUMMARY:

Project will be initiated in the Fourth Quarter, FY-1976.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

None

TASKS IN PROGRESS AND PLANS:

This project will be initiated during the fourth quarter,
FY-1976, starting with a visit of the principal investigator
to SRL to discuss experimental design and to identify the
highest priority in the parameterization development.

CATEGORY 11 GENERAL SUPPORT
F-RL-14-006

PROJECT TITLE: Criticality Safety and Shielding

PROJECT MANAGER: C. L. Brown, Criticality Safety and Shielding
Analysis, Nuclear Technology Department

OBJECTIVE:

To provide up-to-date criticality safety and shielding analysis support during ERDA-SRL engineering and modular design activities to "close" the back end of the nuclear fuel cycle. Design studies will cover fuel reprocessing, Pu conversion, UF₆ preparation, and Pu fuel fabrication. Program consists of two major tasks:

Task 1 - Criticality Safety Analysis to Support Design Studies

Task 2 - Shielding Analysis to Support Design Studies

EXECUTIVE SUMMARY:

Work on the project started in March, and the planning of subtasks was initiated.

TRIPS AND VISITORS:

None

TECHNICAL PROGRESS:

Since approval to proceed with this program was received near the end of March, progress was limited to planning for the next quarter.

TASKS IN PROGRESS AND PLANS:

Four tasks will be initiated during the next quarter:

Task 1A - PREPARATION OF ERDA SOURCE BOOK ON CRITICALITY
SAFETY APPLICABLE TO FUEL FACILITY DESIGN

The preparation of a source book entitled ERDA SOURCE BOOK - CRITICALITY SAFETY IN LWR PU RECYCLE FACILITIES will be initiated. This source book will bring together current facility design experience and criticality safety technology for each phase of the back end of the nuclear fuel cycle. The book is intended to become a basic reference for future facility designers.

Category 11 - General Support (continued)

Task 1B - APPLICATION OF FAULT TREE METHODOLOGY TO
CRITICALITY SAFETY

Fault tree methodology has been successfully applied to many areas of safety. The objective of the method is to identify weak areas of safety and to compare risks. This task will determine if this methodology can be successfully applied to criticality safety analysis.

Task 2A - NORMALIZE BNW SHIELDING CODE SYSTEM WITH SYSTEM
AT SRL

The objective of this task is to implement the BNW plutonium shielding calculational system at SRL. Once this advanced calculational system is in place at both sites, a common basis will be provided for assigning primary and verification shielding work.

Task 2B - PREPARE A TABULATION OF RECYCLE PLUTONIUM SOURCE
TERMS FOR USE IN SHIELDING ASSESSMENT STUDIES

This tabulation is needed as a standard reference for design shielding calculations involving facilities for processing high burnup plutonium.

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