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Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

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42 Pages,

HANFORD CATEGORY C-65 and C-57

RICHLAND

02 R&D PROGRAM

SEMIANNUAL REPORT

SUMMARY

December 31, 1969

RICHLAND OPERATIONS OFFICE

ATLANTIC RICHFIELD HANFORD COMPANY

DOUGLAS UNITED NUCLEAR, INC.

PREPARED BY RICHLAND STAFF

coordinated by

CHEMICAL PROCESSING DIVISION

and

PRODUCTION REACTOR DIVISION

Classification Cancelled and Changed To

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By Authority of RM - lten

CG NMP-1, 8-9-94

By J E Sovely 10-5-94

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RICHLAND FIVE-YEAR 02 R&D PROGRAM

SEMIANNUAL REPORT

SUMMARY

INTRODUCTION

The complete semiannual R&D report consists of this summary and two companion reports, one from DUN which covers reactors and another from ARHCO which covers separations. These companion reports are listed in the set of references in the back of this summary.

This semiannual report covers progress in R&D during the first half of FY 1970 and is based on plans outlined in the June 30, 1969 annual report. The financial status is shown in the tables following this introduction. Overall expenditures for the first half of FY 1970 are seen to be 45 percent of the \$3.5 million R&D budget for the year, which is satisfactory. Expenditures under major program headings were in the same order as the original budget figures, that is, in the order of descending magnitude as follows:

Waste Management

Environmental and Regulatory Technology

Basic Production

Product Flexibility

Within major program headings, there were some adjustments in the distribution of funds. For example, reactors reduced emphasis on Pu-238 and Columbia River Studies, and increased it on Other Isotopes (U-233) and Nuclear Safety.

Development work on the Basic Production and Product Flexibility Programs has been consistent with funding levels. Increased emphasis has been placed on N Reactor operational problems as well as on assessing the K reactor inlet cooling piping integrity and zirconium hydriding problems. Work has been in progress to improve the Purex plant extraction performance by in-plant testing of the "Zirflex Tonic" effect.

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On the Product Flexibility Program, developmental work was under way to establish either enriched uranium or nondefense plutonium (or both) as a reactor fuel and to provide further technology for the production of high-purity plutonium-238.

Activities on the Environmental and Regulatory Technology Program are engaged in developing technology to assure safe operation of the Hanford project facilities. Major emphasis was placed on the study of metal-water (irradiated N fuels) reactions to simulate loss of coolant conditions, and with attention to the related safety assurance features. Work is underway to develop accurate predictive capabilities for determining the consequences of accidental release of radioactive materials.

Increased emphasis has been placed on the Waste Management Program with intent to develop technology for a substantial reduction in releases of low- and intermediate-level radioactive waste to the environment. The salt waste processing and the waste solidification in-tank subprograms have both been reduced in level of R&D effort for the reason that B Plant and the in-tank solidification units are now operating successfully and do not need further R&D support. Emphasis has been maintained on the development program for purifying and encapsulating fission-product strontium and cesium. Efforts to reduce the salt content of Purex wastes have been increased because of the projected waste management cost savings and concomitant improved strontium recovery.

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02 R&D PROGRAM COST
(Dollars in Thousands)

<u>Program</u>	<u>FY 1970 Budget</u>	<u>Expenditures Estimated to 12-31-69 % of Budget</u>	
Basic Production	735	337	46
Product Flexibility	300	110	37
Transplutonium	-	-	-
Plutonium-238	195	63	32
Other Isotopes	5	16	320
Enriched Fuel	100	30	30
Environmental & Regulatory Technology	1040	549	53
Nuclear Safety	740	435	72 59
Radionuclides in Soils	250	108	43
Columbia River	50	6	12
Waste Management	<u>1425</u>	<u>579</u>	<u>41</u>
Total	3500	1575	45

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02 R&D PROGRAM COST
(Dollars in Thousands)

REACTORS ONLY

<u>Program</u>	<u>FY 1970 Budget</u>	<u>Expenditures Estimated to 12-31-69 % of Budget</u>	
Basic Production	480	190	40
N Reactor Operability	154	70	45
K Reactor Risers	-	-	-
K React. Zirc. Hydride	28	8	29
Fuel Performance			
Characterization	95	29	31
Reactor Plant Life	-	-	-
Plant Cost Reduction	163	73	45
Decontamination Studies	-	-	-
Oper. Support Services	40	10	25
Product Flexibility	200	74	37
Enriched Fuel	102	30	29
Plutonium-238	65	30	46
Other Isotopes	33	14	42
Environmental & Regulatory Technology	720	397	55
Nuclear Safety			
Regulatory Tech.	460	329	71
Nucl. Safety Assur.	234	62	26
Columbia River	26	6	23
Waste Management	<u>125</u>	<u>23</u>	<u>18</u>
Total	1525	684	45

Note: Overhead costs are included in this tabulation.

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02 R&D PROGRAM COST
(Dollars in Thousands)

SEPARATIONS ONLY

<u>Program</u>	<u>FY 1970 Budget</u>	<u>Expenditures Estimated to 12-31-69 % of Budget</u>	
Basic Production	255	147	58
Proc. Devlp. Extrac.		60	
Process Devlp. Pu		34	
Matl. Equip. & Inst.		40	
Nondefense Pu		13	
Product Flexibility	100	36	36
Transplutonium		1	
Plutonium-238	95	33	
Other Isotopes	5	2	
Enriched Fuel			
Environmental & Regulatory Technology	320	152	47
Nuclear Safety			
Atm. Dispersion		20	
Seismic Invest.		24	
Radionuclides in Soils			
Radio. Trans. Model		43	
Soil Waste Reactions		22	
Field Meas. Methods		43	
Waste Management	1300	556	43
Low & Inter. Level			
Waste		74	
Salt Waste Processing		168	
Waste Solidif. in Tanks		15	
Waste Packaging		187	
Salt Waste Vol. Reduc.		56	
Alter. Solidif. Methods		56	
Total	1975	891	45

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BASIC PRODUCTION PROGRAM

This program covers that research and development work which is conducted in support of plutonium production. For the K reactors, this pertains primarily to the production of weapons-grade plutonium; while for N Reactor, it pertains primarily to the production of plutonium of 12 percent Pu-240 content. For the chemical facilities, the work provides for the isolation and purification of the reactor-produced plutonium. The work involves activity in a wide variety of fields such as physics, thermal hydraulics, materials technology, fuels technology, and separations chemistry. The program spans the range from basic research to in-plant development and new process demonstration.

Objectives and Incentives

Advancements in basic production technology provide the following benefits:

1. Improved product quality.
2. Reduced costs.
3. Increased plant utilization.
4. Extended plant life.
5. Improved plant performance.
6. Reduced product losses.

In this way, the Richland complex can continue to perform consistently with both the near-term and the long-term requirements.

Progress During Report Period - Reactors

N Reactor Operability

The object of this activity is to reduce unscheduled shutdowns and extended outages so that a high level of operational reliability will be achieved.

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V-11 Valve Development and Evaluation

Alternate seal designs were conceived, fabricated and tested for V-11 valve development and evaluation. An engineering study and analysis was completed for the specification of primary loop components. Engineering and economic analyses were completed for evaluation of the various design approaches. Design and fabrication of the "sleeve inside the nozzle" concept was completed, and off-reactor testing was started. An engineering study and evaluation of sleeve installation equipment was started. The Mark I prototype cap remover was designed, fabricated, and successfully tested on-reactor.

V-12 Valve Development and Evaluation

An engineering study and analysis has been made to define the leakage problem of the V-12 valves and to develop corrective concepts. Redesign of the present actuator has been completed, and the components which were fabricated from corrosion resistant material are being tested. A unique concept of a multi-ply metallic bellows seal to eliminate the valve stem packing leakage was designed, fabricated, and successfully tested off-reactor in a life cycle test equivalent to 20 years of operation at loop temperature and pressure.

System Isolation Techniques

Work continued on development of the "balloon" concept of system isolation whereby a boss would be added to the object pipe through which a flexible, high strength balloon or bladder would be inserted and inflated to seal off coolant flow. This would supplement the freeze technique where coolant flow through the lines is too great to permit freezing.

Exposure Reduction

An engineering study for exposure reduction and evaluation was continued to achieve a better definition of radiation sources and exposure levels. Special columnated detectors were designed, fabricated, and used in both the front and rear pipe spaces. Location and intensity of radiation levels have been established, and several concepts for custom shielding have been designed.

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Zone I Stainless Steel Lines - Development and Evaluation

A nuclear safety study was conducted to determine whether or not there were any problems attendant to deterioration of the Zone I stainless steel sensing lines. It was concluded that in all cases, except in flow monitoring, sensing line failure would be fail-safe. For individual tube flow monitoring, close surveillance and correction of leaking sensing lines should prevent a safety problem from developing.

Circulating Raw Water Filtering

Evaluation of the present primary raw water screening system effectiveness was completed and recommendations are being reviewed. Raw water quality criteria are nearly complete. A document outlining system modification schedule guidelines on a priority basis was completed to provide the basis for decisions relative to which systems should be considered when planning backup screening. Improved freeze protection has been implemented in the primary screening facility.

Flux Monitor Systems

All nuclear flux monitor instrument systems were modified to assure operational reliability. Prototype chambers with new seal and cable configurations were received, and operational tests were started. Design of revisions to the readout instrumentation was completed, and a laboratory prototype was fabricated. A specification for intermediate range readout instrumentation was prepared, and a market survey was conducted. Testing of a vendor supplied intermediate range instrument was completed. A new sub-critical chamber drive system was designed, and fabrication is 90 percent complete.

Reliability Appraisal Efforts

Reliability appraisal efforts were started on the confinement, the AC electrical power, the primary coolant, and the emergency raw water systems. Individual system models are being developed for fault-free and critical failure modes, mechanisms, and effects analyses. Appraisal of the fog spray subsystem has been completed. The reliability analysis in support of high pressure injection and seal water subsystem control was also completed.

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Ball Safety System

Work accomplished included addition of the dryer to the trip mechanism air purge system, accumulation of reliability data, conversion of the cocking and locking devices to manual operation, continued development of alternate trip mechanisms, and completion of an engineering evaluation of the ball recovery system.

A and B Bus Independence

Operational and shutdown testing of the circulating raw water system was completed to determine safe operating conditions for N Reactor while the A-B Bus intertie study is progressing. Tests were performed which provide the necessary data to develop a set of operating requirements which meet the independent electrical system criteria under certain conditions of river temperature and elevation. A preliminary engineering study on a feasible method of assuring A-B Bus independence during operation and shutdown was completed.

Horizontal Control Rod System

Performance of the left-side half of the control rod system has been monitored following conversion, at the mid-year, of the hydraulic fluid to a water-in-oil emulsion. Several slow rods were noted, analyses were performed, and corrective action was taken. Buildup in the bacteria content of the emulsion was detected, and a study is underway to provide an effective bactericide.

K Reactor Risers

The object of this activity is to assess the integrity of the K reactor inlet coolant supply piping, define reactor operating modes consistent with piping system limitations, identify and carry out improvements required to enhance the integrity of the K reactor piping, and return the reactor to a normal operating mode consistent with restraints which are found to be required.

Accomplishments

Planning was completed for replacement of the eight 24-inch by 36-inch wye joints in the inlet piping systems. Programs related to seismic analysis of piping, residual crack detection, and proof

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test planning either continued or were started. The final evaluation of fracture mechanics was essentially completed and the transient pressure analysis is being prepared. Basic methods for development of technical bases for tube power limits for K reactors to prevent fuel clad melting in the event of coolant loss due to inlet riser failure were developed and applied.

K Reactor Zircaloy Hydride

The object of this activity is to determine the causes and mechanisms contributing to the hydriding of K reactor Zircaloy process tubes, promote measures to minimize additional hydriding, and develop methods and techniques for hydride case layer removal for restoration of the base metal.

Mechanisms

Further insight into the mechanics of the hydriding phenomenon was gained from the current Zircaloy coupon studies. Preliminary data indicate the following trends:

1. Bare aluminum dummy elements in Zircaloy tubes have the greatest hydriding potential. Anodized aluminum dummies will cause some hydriding if good electrical contact is maintained. Regular fuel supports do not give a good contact. Although stainless steel itself will not cause hydriding, it will not prevent further hydriding when a case layer is already present.
2. A case layer of hydride platelets on the inner tube surface causes the continued buildup of hydrogen in the base metal.
3. Removal of all traces of a case layer from previously hydrided surfaces restores them to a condition where anodized aluminum spacers will prevent further hydriding.

Case Layer Removal

Development of an electrolytic method of case layer removal to supplant the grit blasting process was continued. It was demonstrated that the case layer can be removed at a rate of 0.1 mil per minute using a current density of 0.1 ampere per square centimeter.

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However, the process leaves an objectionable trace of hydride needles covered by an anodic oxide film. Work is under way on a secondary electrochemical etch to remove the trace.

Tube Examination

The downstream 66-inch lengths of 25 Zircaloy tubes were removed from C reactor for use in an electrochemical cleaning development. Samples from the tubes revealed very erratic hydriding, more so than at the K reactors.

Fuel Performance Characterization

The object is to conduct a fuel development program aimed at fuel monitoring and utilization, fuel cladding performance improvement, elimination of fretting failures, supporting transition to full-scale Mark IV usage, verifying technical feasibility of long hot-die-size fuel, supporting transition to full-scale hot-die-size usage and reducing N fuel cost.

Fuel Monitoring and Utilization

Routine fuel monitoring was continued. In the light of lower exposure operation and improved measurement capabilities, a review of current monitoring requirements has been started. The charging of four types of Class II category fuel (minor defects) in the fringe and upstream central tube positions of N Reactor was authorized. The preparation of a document was initiated which will describe the objectives, bases, and administration of the HDS Class II fuels program for the K reactors. The premise is that both cost savings and problem-free experience can be achieved by use of hot-die-sized fuel in the Class II category.

Fuel Cladding Performance Improvement

A modified fuel support design has been selected to alter coolant flow characteristics in the vicinity of supports on AlSi elements in an attempt to minimize fuel failures resulting from erosion-corrosion adjacent to the supports. Procurement has been started so that fuel equipped with the improved support may be in-reactor by the summer of 1970. A program was developed for establishing the proper cladding alloy condition prior to fuel fabrication by the hot-die-size process.

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Elimination of Fretting Failures

Significant and detailed study of factors and mechanisms contributing to N fuel fretting failures was accomplished, and an interim report is being issued. Apparently work hardened Zircaloy buildup on the support shoes was providing a cutting tool that made the fretting debris. A set of criteria for simulation of support environment and its function was derived and used to design a support wear test machine which is being constructed.

Transition to Mark IV

Conversion of the central zone of N Reactor to Mark IV fuel is approximately 70 percent complete. The swelling characteristics of the Mark IV fuels discharged to date have been analyzed, and the results show that alloy-503 cores swell less than do the design cores which were made of British alloy-601. Both of these alloy fuels swell with increasing enrichment and also with increasing clad thickness. An evaluation is in progress to assess, reactivity-wise, the relative merits of the Mark IA and the proposed Mark IVAA designs. A test is being prepared to irradiate 25 Mark IV fuel columns in the central zone with exposures ranging from 3000 to 7000 MWD/T to determine the inherent design strengths and weaknesses of this fuel model.

Technical Feasibility of Long Hot-Die-Size Fuel

An initial 42 columns of 11.23-inch, 94 metal, hot-die-size fuel was charged into a K reactor to establish the technical feasibility of longer fuel which would have significant economic advantages. Two different sizes of aluminum dummies, one simulating the 8-inch model and the other simulating the proposed 11-inch model, were charged separately into the same process tubes for a comparison test. This test showed no significant difference between the two insofar as moderator distortion with resulting tube distortion is concerned.

Transition to Hot-Die-Size Usage

Tentative schedules have been made up for the transition from AlSi canning to hot-die-size usage and are based on the anticipated adequacy and acceptability of long fuel performance.

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N Fuel Cost Reduction

Fabrication development and ex-reactor testing of prototypic unbonded end closure designs were accomplished in an effort to reduce N fuel cost. End support development was concentrated on fabrication and ex-reactor flow loop testing of an inner support system which would replace only the conventional inner support hardware. Irradiation testing and fabrication processing of alternate billet fabrication techniques continued at a relatively low level of effort.

Reactor Plant Life

The object of this activity is to assure that the ability of the Hanford reactors to produce irradiation products economically does not become constrained by irreplaceable facilities. Irreplaceable facilities are defined as those which cannot be replaced without essentially rebuilding the entire complex (the graphite stack or reactor shield for example), or those which are so expensive to replace that economic considerations suggest reactor decommissioning as the more acceptable alternative (external piping complex or water treatment system for example).

Water Chemistry and Corrosion - K Reactors

The half-plant test of 1.0 versus 0.5 ppm dichromate addition to the process water in the K reactors was completed. The 36 evaluation fuel columns are being examined. As a result, the reactors are being operated on interim specifications permitting 0.5 ppm dichromate and 6.7 pH at below 90°C coolant outlet, and 1 ppm and 6.6 pH above 90°C. Laboratory tests to evaluate the effects of coolant chemistry variables on the erosion-corrosion characteristics of aluminum fuel cladding alloys were terminated for budget reasons. During the tests, a laboratory technique was developed for use in screening alloys and/or process water compositions with respect to corrosion tendencies. Laboratory studies to compare alternate methods of preventing pitting and tuberculation in low velocity carbon steel piping were continued.

Water Chemistry and Corrosion - N Reactor

An Inconel-600 tube was removed from steam generator 6A of N Reactor after 40 months' residence and 24 months' operation in

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the continuing program of steam generator tube corrosion surveillance. The tube is being compared to others previously removed.

Seal section tubes from N Reactor control rods 46 and 34 were removed for destructive examination. Two problems, loss of cooling flow and progressive pitting, with respect to the control rod cooling system were defined.

A test program at N Reactor to measure the in-reactor corrosion of acid stained Zircaloy-2 was started. Plastic replicas of the steel nozzle Zircaloy process tube junction taken before and after the 1969 through-reactor decontamination have confirmed the bore-scope observation that scattered localized corrosion occurred on the carbon steel adjacent to the tube.

Graphite - K Reactors

Samples of graphite from KW reactor continued to be irradiated in the Engineering Test Reactor.

An in-reactor program of tube diameter measurements and probing with fuel size probes has confirmed that process tubes are being flattened at some trunion block locations by trunion block shrinkage onto the tube. Oxidation monitoring of the graphite stack continued.

Graphite - N Reactor

Dimensional measurements of irradiated full-size graphite bars and laboratory-size samples in N Reactor showed that dimensional changes in the full-size bars were substantially greater than those occurring in the laboratory samples. Four ball channels were inspected in addition to routine measurement of stack movement. Two were found to be in good condition, one had a 1-inch misalignment, and the fourth had an apparent bowing. Oxidation monitoring of the graphite stack was continued.

N Reactor Process Tube Surveillance

Nine N Reactor tubes were borescoped. No detrimental effects due to in-reactor service were noted.

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K Reactor Aluminum Tubes

Examination of leaking aluminum tubes removed from the KE reactor revealed those tubes with characteristically thin walls and low ribs which have reached the end of their normal corrosion life.

N Reactor Primary Pipe Surveillance

High stress areas were ultrasonically examined to determine whether or not there were weld flaws in the N Reactor primary piping, and if so whether or not the flaws were growing. No flaws have been detected.

Plant Cost Reduction

The object of this activity is to adapt existing technology or develop new technology which, when implemented, will result in a direct reduction in plant operating cost or avoidance of costs which can be projected on the basis of current experience and conditions.

Accomplishments

The reactor systems study was completed. In selecting systems or components for application of automatic surveillance, the principal emphasis was placed on Process Standards, systems critical to nuclear safety, identified problem areas within the process audit check list, and consolidation of control in the 105-N Control Room. Software programs have been identified and program requirements specified. Hardware requirements have been established based upon performance and reliability requirements. Due to budgetary elimination of the control computer, this work is being discontinued.

Decontamination Studies

The object of this activity is to evaluate effectiveness, corrosivity, and cost of available decontaminating reagents; to develop practical, safe and economic procedures for their use; and to develop and evaluate possible new approaches to the attaining of reduced radiation levels and attendant personnel exposure.

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K Reactors

A program was started to determine the practicality of adapting through-reactor decontamination to the K reactors. Material compatibility tests were performed to assure acceptable corrosion rates for all reactor materials in contact with the decontamination solutions. Tests were made to evaluate decontamination effectiveness as a function of solution temperatures, reagents, solution concentrations and application times, as well as valving and control procedures and the use of externally heated solutions. The best results were obtained with Turco 4528 solution externally heated to 85°-90°C.

N Reactor

The third successful through-reactor decontamination of N Reactor was carried out. Steam generators in cell No. 1 were decontaminated as was the No. 4 graphite coolant system heat exchanger. Screening tests of commercially available decontaminating reagents were continued.

Operational Support Services

The object of this activity is to maintain continuity of reactor plant production and to provide the technical support required to maintain the plant in a high state of efficiency. This is to be accomplished primarily through the maintenance and improvement of physics computer codes and through development work associated with product assaying problems.

Physics Code Development

The input section for using the WIGL2 two-group kinetics physics code on the UNIVAC 1108 computer has been largely completed, and subroutines have been tested by using sample cases. An input manual for the FLARE flux distribution and control computer code is being prepared. An analysis of performance of the HAMMER lattice computer code was completed, and minor problems with two subroutines were found.

Product Assaying

Arrangements have been made for individual batch dissolution and sampling of PT-NR-95 material for product assay which contained higher than normal initial uranium-236.

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Progress During Report Period - Chemical Separations

Process Development - Extraction

Laboratory Studies demonstrated that fluoride, when added to the feed just prior to extraction or when the feed is digested in the presence of fluoride, is effective in improving the decontamination factor (DF) for zirconium by the "Zirflex tonic" effect. The major improvement in the zirconium DF occurs in the first cycle codedecontamination column (HA).

The processing of long-cooled (2-year) Fast Flux Test Facility fuels in the Purex Plant was studied. This processing appears to be feasible. It is estimated that a capital investment of about \$1.6 million would be required to modify a dissolver cell for the task. However, the fuel could be received after 60 days' cooling (with a lead heat-transfer media) and stored for processing after 180 days' aging for an additional \$200,000. A transfer cask was estimated to cost \$150,000.

Neptunium Chemistry

Rate accelerating material (RAM) for neptunium(V) oxidation has been prepared in engineering-scale prototype equipment. It was possible to achieve a product with a yield amounting to 85 percent of that achieved on a laboratory scale. Further work on RAM has been deferred pending evaluation of recent new possible improvements in neptunium recovery.

Equipment, Instrumentation and Materials

Analytical methods studies indicate that x-ray fluorescence has a high potential for successful application in monitoring neptunium and plutonium in the Purex extraction column waste. This method generates the fewest installation problems, is highly selective, and may require the least amount of separations. The method and instrumentation is approaching the stage of final evaluation testing by the use of Purex waste samples.

A specific gravity and conductivity analysis can be used as a method to accurately determine the concentration of nitric acid in the reclamation facility slag and crucible dissolver. Development of instrumentation for the measurement of these parameters under process conditions is nearing completion.

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Barium-133 shows advantage over cesium-137 and has been adopted as the isotopic source to measure self-absorption in bulk plutonium package samples being analyzed by gamma spectroscopy. The optimum lithium-drifted germanium detector system for nondestructive plutonium assay can measure as little as 1 gram of plutonium in an 18" x 18" x 24" waste carton with a precision of ± 5 percent.

Evaluation of Effort

Expenditures under the Basic Production Program for the fiscal year to date are 46 percent of the FY 1970 budget for this program.

Progress has been in general conformance with original planning and allocated funding.

Definite progress has been made in defining N Reactor deterioration problems and in providing solutions. Licensability is still required. Assessment of K reactor inlet cooling piping integrity and the zirconium hydriding problems have been defined and solved, and corrective measures remain to be put into effect. Conversion to Mark IV N Reactor fuel is well developed and proved for 94-metal elements, but evaluation of the spike element is still in progress. Long (11.23-inch) hot-die-size fuel has been successfully developed, but testing remains to be completed. This work appears to be on schedule for the changeover from AlSi to hot-die-size fuel. Evaluation of routine plant corrosion and graphite problems have continued. A new problem involving K reactor graphite trunnion block shrinkage is being studied to determine a solution. Studies have shown that decontamination development provides a sound basis for reducing personnel exposure.

Laboratory studies have confirmed that zirconium decontamination can be increased by adding fluoride to the Purex coextraction column feed and also this may enhance neptunium recovery. Development work on the rate accelerating material for neptunium(V) oxidation has been deferred, pending evaluation of improvements in neptunium recovery.

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PRODUCT FLEXIBILITY PROGRAM

The purpose of this program is to develop production capabilities other than that of weapons-grade plutonium.

Objectives and Incentives

The initial objective was to develop the full production potential of the Richland site. The individual R&D items included were tritium, transplutonium, plutonium-238, other isotopes, and enriched fuel. Efforts within the reporting period have been directed toward the development of highly-enriched (oralloy) fuels to be used as the sole fuel or in conjunction with slightly enriched uranium fuel elements (spike concept) to produce a desired product mix in the reactors. Development of the technology for the production of medical-grade plutonium-238 includes the advantage of the reactors favorable thermal neutron spectrum. The incentives are, for example, improved production capability, reduction of product unit costs, and beneficial safety analyses. Since this program is composite, each sub-item has a unique objective.

Progress During Report Period - Reactors

Enriched Fuel

The purpose of this activity is to develop and demonstrate technology for the use of enriched uranium or nondefense plutonium as reactor fuel and to perform the nuclear safety evaluations required for the use of enriched fuels.

Oralloy

Planning for the oralloy test load, which involves charging 20-30 columns of fuel in the upper enriched ring of a K reactor, was completed. The required oralloy has been obtained and development work on fuel element fabrication has been started. Tube power limits have been determined and loading patterns established. Planning for loading of the test is under way.

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Plutonium

A preliminary evaluation has been made on the use of nonweapon plutonium fuel as spike enrichment. Preliminary planning identifying methods of allowing a nominal annual throughput of 200 kg without introducing nuclear safety problems has been done. Detailed studies are being started.

Plutonium-238

The purpose of this activity is to demonstrate continued capability to produce medical-grade Pu-238, to develop improved technology for medical-grade Pu-238 production, and to evaluate alternative methods for producing this isotope.

Accomplishment

The 1200-gram neptunium irradiation test consisting of five columns was completed. One column of aluminum-clad neptunium-graphite matrix target elements experienced failures in all six elements; one central zone and one fringe column of zirconium-clad neptunium-graphite matrix elements were discharged even though no failures had been experienced. The two centrally charged aluminum matrix columns were irradiated to essentially goal and discharged. The graphite matrix elements have been analyzed, but the aluminum matrix elements have not. The cause of the failure of the graphite matrix elements was axial growth of the wafer, for some undetermined reason. The irradiation of the 150 grams of americium oxide, charged in KE reactor in May 1969, is continuing.

Other Isotopes

The object of this activity is to enhance capability of the Hanford reactors to produce various isotopes and to determine the cost and capability of production for those isotopes not included in other activities.

Cobalt-60

Calorimetric measurements were completed on all C reactor overbore cobalt targets. The cobalt base alloy tube (Haynes Alloy-25, nominally 51 percent cobalt) which was installed in KW reactor has now operated over six months and has been recharged twice. There

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have been no significant problems. Battelle-Northwest cobalt strips irradiated in N Reactor were discharged.

Lithium-Bearing Spline Development

Spline samples containing lithium in three different chemical forms were received and are now being irradiated. The forms include lithium-manganese alloy particles dispersed in a powder metallurgy matrix, lithium-carbonate crystals dispersed in a powder metallurgy aluminum matrix, and lithium-fluoride crystals dispersed in a powder metallurgy aluminum matrix. All samples are clad with 3-6 mils of aluminum.

Plutonium Burning

The 13-column slab of plutonium-aluminum alloy fuel elements in KE reactor continued to operate without incident. The reactivity of the block has decreased steadily allowing replacement of essentially all of the ^{94}Pu metal and thoria with natural uranium.

Progress During Report Period - Chemical Separations

Plutonium-238

One kilogram of neptunium was converted from nitrate to oxide for use in further target fabrication and irradiation studies. The neptunium was denitrated continuously by calcination in a heated tube provided with a conveying scraper blade agitator. Although product quality was adequate and operability was considerably improved over that of the vibrating tube calciner, the performance required of a production unit was not achieved.

Due to scheduling of the integrated program, no plutonium-238 was processed during the report period.

Chemical flowsheets for either coextraction or consecutive extraction of neptunium and plutonium-238 from nitric acid solutions of irradiated aluminum-neptunium oxide targets have been devised and demonstrated. Unexpected difficulties were encountered in partitioning neptunium from plutonium-238, and work is in progress to improve this process. The second and third plutonium cycles operated most efficiently with dilute plutonium-238 feed.

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Separation requirements to provide capability for toll irradiation were reviewed. Capital costs estimated were \$950,000 for Purex and \$2,100,000 for the 234-5 building. A campaign size of at least 100 kilograms of neptunium is required for processing in the Purex Plant. When production rates are less than 100 kilograms per year, capability can be provided in Pacific Northwest Laboratory facilities for an estimated startup cost of about \$600,000.

Other Isotopes

A minor amount of work was performed to scope the recovery of precious metals from Hanford wastes. It was found that activated carbon selectively sorbed palladium from alkaline waste. Initial palladium breakthrough on activated carbon occurred at 72-bed volumes (BV), 50 percent breakthrough occurred at 94 BV, and 100 percent breakthrough occurred at 110 BV. Rhodium was not removed from the feed by the carbon. Technetium was held by the carbon for 10 BV with 100 percent breakthrough at 40 BV. The rhodium and technetium in the palladium-free effluent were recovered on IRA-401 (trade name--Rohm & Haas Company) anion exchange resin. Palladium was removed from the carbon column by treatment with hot water and dilute ammonium hydroxide.

Attempts to recover rhodium from Hanford alkaline wastes using mossy zinc or mossy tin were unsuccessful. No rhodium was reduced when alkaline wastes were contacted with zinc metal powder on a batch basis for 24 hours.

Evaluation of Effort

Process Development expenditures for the fiscal year to date are 37 percent of the FY 1970 budget for Product Flexibility. The minimal effort on this program was consistent with the level of funds allocated.

The oralloy program is proceeding as planned. However, the program is being redirected to include use of plutonium as a fuel as well as oralloy.

The Pu-238 program has been delayed by the unexpected rupture of the neptunium oxide-graphite matrix elements. Original analysis of the partially irradiated elements indicates higher than expected (0.28 ppm) of plutonium-236, but new analyses are being made with more precise instruments. Work has just started on elements using a thin annulus of target material.

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To date no problems have arisen from irradiation of a Haynes Alloy-25 (51 percent cobalt) tube in a tube channel.

Irradiation of 13 columns of plutonium-aluminum alloy is proceeding according to plan with first discharge planned for the fourth quarter FY 1970.

One kilogram of neptunium was converted to the oxide in a partially successful continuous calciner test unit. No irradiated neptunium was scheduled for separation during the report period.

Difficulties in the partition of plutonium-238 from neptunium will require further flowsheet development.

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ENVIRONMENTAL AND REGULATORY TECHNOLOGY PROGRAM

The Environmental and Regulatory Technology Program contains the following research and development items: Nuclear Safety, Columbia River Studies, and Radionuclides in Soils. The activities under these items are conducted to assure that the Hanford production reactors and separation plants are maintained and operated safely, to minimize the heat and isotope loading of the Columbia River, and to determine those parameters by means of which the consequences of accidental releases (including those caused by earthquakes) of radioactive and chemically toxic materials to the atmosphere or groundwater can be predicted.

Objectives and Incentives

Effort is under way to model the consequences of reactor loss of cooling accidents including temperature transients, reactions in the overheated core, and fission-product release from overheated fuel. Development of this technology will permit a quantitative assessment of the basic risk of facility operation. Methods for controlling the fission gas released following reactor accidents are being developed. This will reduce the most acute consequences of reactor accidents. The characteristics of aerosol formation from nuclear materials are being determined in support of shipping hazards analyses. A transport model is being developed to predict the rate and direction of travel of fission-product materials from accidental release to the soil.

Progress During Report Period - Reactors

Regulatory Technology

General

In-place iodine removal tests of charcoal filters at the K and N reactors have been completed. New Process Standards requiring semiannual charcoal sample tests from each reactor cell and annual in-place tests of all reactor cells have been approved. The laboratory facility for testing charcoal samples has been reassembled in the 190-H building water laboratory and used extensively.

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N Reactor

Experimental apparatus to simulate loss-of-coolant incidents has been constructed by the thermal hydraulics laboratories of Battelle-Northwest, and tests are in progress. Additional work was carried out to develop analytical tools for coordinated calculations of primary loop blowdown transients, confiner transients, and fission product transport. Building 324-D and 292-T facilities have been used for metal-water reaction tests of irradiated N Reactor fuel pieces. A major effort was made to verify the travel time of radioiodine from the 1301-N crib to the river-bank springs. A minimum time of five days seems most likely. A qualitative study was performed to correlate N Reactor fuel element failures with increased iodine-131 activity in spring water. Meteorological data acquisition has been continued using the automated N Met System, and software for handling data from the system is about 90 percent completed. Estimates have been obtained of the maximum rainout of noble gases by fog sprays in the confinement zones, and of the amount of fission gases to be expected in a loss-of-coolant accident.

K Reactors

Evaluation of the seismic adequacy of critical K reactor safety systems was started by John Blume and Associates.

The heats of reaction for the various uranium-aluminum compounds in the standard state were obtained.

Nuclear Safety Assurance

An in-depth analysis of the Operating Safety Limits for both the K reactors and N Reactor was initiated. A program was started to provide an overall review, correlation and updating of the Safety Analysis Reports for the K and N reactors. Progress was made in several areas toward upgrading the technical bases for both the Safety Analysis Reports and the Process Standards. Analytical programs were carried out to enable development of technical bases for process limits for production loading of Mark IV fuel. Parametric relationships affecting trade-offs in K reactor utilization of the high speed scanner for nuclear safety protection were developed and published. Initial technical bases for K reactor tube power limits for a natural uranium load were developed.

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Columbia River

Routine monitoring of the river continued, as did river model studies at Washington State University where the primary emphasis was placed on correlating river model results with infrared imaging data. Laboratory studies of effluent flocculation indicated that this is a potential method of cleaning up radioactivity. Planning for pilot plant tests is under way, and development of a preliminary concept of a full plant operation has been started.

Progress During Report Period - Chemical Separations

Nuclear Safety

Atmospheric Dispersion of Radioactive Particles

Laboratory studies, to characterize plutonium aerosols produced during combustion, were scaled up to investigate release of aerosols from large-scale burning incidents was completed, and renovation and modification of an unused building (242-B) suitable for housing this facility was started. To reduce the hazard of alpha contamination from these large-scale tests, uranium was selected as a suitable stand-in for plutonium compounds.

Seismic Investigations

The frequency, intensity, and spatial distribution of microearthquakes occurring in the region about Hanford are being determined by the U. S. Geological Survey National Earthquake Research Center with an array of highly sensitive geophones. This work by the U. S. Geological Survey, together with a detailed field study of possible young faulting in the region, is being sponsored jointly by the Division of Reactor Development and Technology and the Division of Production. Forty of the 107 microearthquakes, detected during a six-month period, were situated near the center of the Pasco Basin where the geologic structure of the bedrock is concealed by more than 1100 feet of sedimentary rock. There were no microearthquakes detected along the anticlinal ridges on the Hanford Reservation where faults have been inferred. In support of the U. S. Geological Survey investigation of young faulting on Gable Mountain and Gable Butte, approximately 2000 feet of trenching was excavated. As many as four different hypotheses were advanced to explain the geological structures exposed in the trenches.

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Radionuclides in Soils

Movement of Groundwater

A general solution method was developed for predicting the rate and direction of water flow through porous media. Using this solution method, a number of computer routines have been written to solve groundwater flow problems. The computer routine, developed for solving flow problems in the vadose zone beneath waste disposal sites, was extended during this report period to the entire saturated zone of the groundwater flow system beneath the Hanford Reservation. Error and sensitivity analyses are being made on a sorption model which relates the relative rate of movement of contaminants to that of groundwater. A transport model was developed, based on this sorption model, which provides a limited capability for predicting the rate and direction of strontium-90 and cesium-137 through the vadose zone underlying a waste disposal site and in the saturated portion of the groundwater flow system.

Long-Term Storage of Nuclear Waste

Rock and water samples of the geological formations underlying the Hanford Reservation have been collected to a depth of 5661 feet. Data obtained from these samples and from hydrological tests and geophysical logs made in the borehole indicate that the basalt flows are effective barriers to vertical groundwater movement; in some zones the permeability of the basalts was so low that measurements could not be made by standard hydrological testing techniques.

Soil moisture potentials of 20 to 100 negative atmospheres have been observed in the vadose zone of the sand-silt region south of the 200-East area. These desiccated zones range from 20 to 30 feet in thickness and occur 15 feet to 45 feet below grade. On the bases of these data, it has been determined that incident precipitation in this region cannot percolate to the underlying water table.

Evaluation of Effort

Process Development expenditures for the fiscal year to date are 53 percent of the FY 1970 budget for Environmental and Regulatory Technology.

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Evaluation testing of the reactor confinement system charcoal filter for removal of iodine from exhaust air was completed. The filter performed very satisfactorily throughout the testing.

Work under the N fuel heatup transient experimental program is progressing on schedule.

Resolution of the groundwater travel time between the 100-N crib and the river has removed a major barrier to the completion of studies of consequences of accidents involving fission-product transport by water leaving the reactor and reactor building.

Experimental measurement of metal-water (irradiated N fuels) reactions have progressed very satisfactorily within the past six months. Measured hydrogen releases are in close agreement with analytical models. Tests are continuing at temperatures 50° to 100°C below the uranium melting temperature.

Work under the meteorological studies program is progressing satisfactorily, except that diffusion test planning is undergoing review because of the high costs.

Rapid progress in the K reactor seismic evaluations will provide timely input to the upgrading of safety studies.

An in-depth review of the technical bases for nuclear safety criteria and of the administrative system to assure the continued safe operation of the reactors have been prompted by curtailment of the technical support effort at a time of evolving nuclear safety philosophy and corresponding advances in technology. An aggressive program is being continued to assure safety of the reactors.

Emphasis has been placed on investigation of flocculation of K reactor effluent water as a method for removal of radioactivity. A one-tube flocculation test is being prepared. Manpower and funds are limiting.

Extensive measurements were made of the geological, hydrological, geochemical, and seismic parameters which influence the rate and direction of radioactive materials displacement in the environment. The knowledge gained has led to the development of predictive capabilities for determining the consequences of accidental release of radioactive materials.

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Data obtained from samples, hydrological tests and geophysical logs made in the deep borehole at Hanford, ARH-DC-1, indicate that the basalt flows are effective barriers to vertical groundwater movement. Certain of the basalt flows have natural radioactivity levels that appear to be characteristic and which may prove useful in identifying and correlating stratigraphy through the use of natural gamma logs.

Samples collected from the Rocky Flats fire are being studied to characterize the particle-size distribution and nature of plutonium aerosols to aid in evaluating the consequences of accidents.

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WASTE MANAGEMENT PROGRAM

The research and development work under this program will provide technology whereby the wastes (gaseous, liquid, solid) generated in the chemical processing of irradiated fuels and targets may, at low cost, be solidified and confined for long-term surveillance and control, or safely dispersed in the environment.

Objectives and Incentives

The purpose of this activity is to provide long-term high-integrity confinement and control of hazardous nuclear waste and to reduce the amount of radioactivity released to the environment to the lowest practical value.

The incentives for solidifying the bulk salt waste as opposed to continued in-tank storage are both safety (immobilization of fission products) and economics (estimated savings have a present worth of \$60 million as compared with continued storage in tanks having a 20-year life).

The incentive for improved treatment of low-level wastes is safety in keeping with the AEC anti-pollution campaign aimed at reducing significantly the amounts of radioactivity released to the environment.

The incentive for removing the long-lived heat emitters for separate high-integrity storage is near-term safety. The long-lived heat emitting isotopes, strontium-90 and cesium-137, are to be removed by solvent extraction and ion exchange, respectively, and packaged in high-integrity containers. The residual bulk wastes will be solidified in underground storage tanks in a few years instead of in several decades.

Progress During Report Period - Reactors

Reactor Waste Management

A plan has been developed to establish requirements and methods for ultimate return of the reactor operating areas to the original state and to define safeguard requirements consistent with these methods. Also involved are the definitions of special facilities and systems, removal techniques, disposal sites and transportation methods,

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development of costs and schedules and radiological mapping. Preliminary concepts for disposing of N Reactor waste products have been sufficiently completed to submit a budget data sheet outlining requirements for the necessary facility.

Progress During Report Period - Chemical Separations

Low- and Intermediate-Level Waste

Evaluation of a prototype monitoring system on the Purex Plant cooling water line continued. The monitoring system has been operating satisfactorily. In laboratory tests, a plastic scintillator was 2 to 5 times more sensitive to beta radiation than present detectors.

Methods for fabricating sample cells of Kynar (trade name--Penn Walt Corporation) with cast-in-place plumbing adapters are being developed. In early models, the Kynar slabs were not adequately fused, and the cell split in half when the adapters were machined out of the cell.

A reverse osmosis test unit successfully removed salts and radioactive materials, but not tributylphosphate, from Purex process condensates.

Tributylphosphate and normal paraffin hydrocarbon were found in a Purex process condensate stream (1UD) at concentrations of 1.15 and 1.97 g/gal, respectively. Other unidentified acidic material is also present. Plant tests indicate that at these concentrations 1UD can be used as process water in the uranium extraction column without affecting plant performance.

A column of AW-500 zeolite (trade name--Union Carbide Corporation) was successfully used in the laboratory to remove cesium-137 from 241-A and AX tank farm condensates. Decontamination factors exceeded 100; cesium-137 concentrations in the effluent were less than 0.1 of the maximum permissible concentration for water (MPC_w).

Preliminary tests by Idaho Nuclear Corporation personnel indicate that a fluidized bed unit can be used to immobilize Z Plant waste organics while calcining Z Plant high salt aqueous waste. Purex and B Plant solvents may also be suitable for burning in a fluidized bed unit.

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Organic materials present in Z Plant high salt waste can be effectively removed by sorption on activated carbon, silica gel and alumina-type calcine. Regeneration of the carbon bed using acetone or low temperature steam was only partially successful.

Salt Waste Processing

Molecular weights of di-(2-ethylhexyl) phosphoric acid (HDEHP) were determined as a function of irradiation conditions. Some polymerization of HDEHP occurred under all conditions tested. The polymerization was highest for HDEHP irradiated while in intimate contact with 1 M nitric acid. Initial scouting tests were successful in removing HDEHP from irradiated B Plant solvent by using a weak base macroreticular ion exchange resin (Amberlyst, trade name--Rohm & Haas Company). The recovered HDEHP, when mixed with fresh tributylphosphate and normal paraffin hydrocarbon to prepare B Plant solvent, demonstrated strontium extraction capability comparable to unirradiated solvent.

Testing of various flocculating agents to increase the settling rate of water-leached sludges continued. Only Purifloc A-21 (trade name--Dow Chemical Company) was successful in increasing settling rates of water-leached sludges in tanks 104-A and 106-A.

The Hanford sluicer has been used to successfully remove sludges from underground storage tanks 101-A and 104-A. Sulfuric acid containing a corrosion inhibitor (Rhodine A) was effective in softening and/or dissolving a hard sludge layer encountered during removal of sludge from tank 105-A. After spraying about 750 gallons of 1 M sulfuric acid in the center of the tank, the sludge in the test area was removed successfully by sluicing.

Modifications of the B Plant pH measurement systems have permitted considerable improvement in pH measurement accuracy and reliability.

An electronic unit capable of measuring nitric acid concentration in the Purex Plant extraction column waste stream (HAW) was developed and is ready for plant testing.

Use of cathodic protection to reduce corrosion of waste tanks has shown encouraging results. A laboratory-scale tank protected at 10 milliamperes per square foot has not failed after 49 weeks' contact with simulated boiling Purex alkaline waste. An unprotected tank and a protected tank (1 milliamperes/square foot) failed after 5 and 8 weeks of exposure, respectively.

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Recovery of strontium from current acid waste (CAW) solids was attempted in the laboratory by contacting adjusted CAW, which contained the usual chemicals added in preparing B Plant solvent extraction feed, with B Plant solvent. Only 24 percent of the strontium was removed from the solids. Plant tests have shown that the caustic-carbonate metathesis process for removing strontium from CAW solids is preferred to the N-hydroxyethylethylenediaminetriacetic acid leach process.

Laboratory results indicated that rare earths (RE) may be substituted for lead as a strontium carrier in the sulfate precipitation flow-sheet. About 95 percent of the strontium in Purex acidified sludge was precipitated at a pH of 0.5 to 1.0 by using 1 M sulfate and 0.01 M RE.

Early laboratory data show that strontium can be purified using a zeolite 13X (trade name--Union Carbide Corporation) ion exchanger when metal ions in the feed are complexed with sodium nitrilotriacetate. The process appears to be attractive as an alternative to purification of B Plant strontium product by second solvent extraction cycle and magnesium hydroxide precipitation steps.

Waste Solidification in Tanks

Thermal conductivity of Redox sludge from tank 108-SX was measured. The value obtained [0.110 Btu/hr ft² (°F/ft)] agreed reasonably well with synthetic Redox sludge [0.121 Btu/hr ft² (°F/ft)].

Water leaches of tank 108-SX Redox sludge removed 2.2, 2.6 and 19.2 percent, respectively, of the plutonium, strontium-90 and cesium-137 after 21 leaches in which fresh water or 0.1 M sodium nitrate solution was vigorously mixed with the sludge during each leach cycle. Leachates were passed through a soil column to demonstrate adsorption of the leached radionuclides by the soil. Similar leaching and soil column measurements were made with a salt cake sample from tank 116-TX (the in-tank solidification unit). Plutonium and cesium were more readily dissolved from this sludge sample, and loading on soil was less efficient.

The effect of soil moisture on thermal conductivity of the soil was determined in laboratory experiments. The one-dimensional computer program for calculating temperature gradients in underground waste tanks and surrounding soil was rewritten and debugged after errors were found.

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Waste Packaging

The cesium chloride and strontium fluoride flowsheets were verified in the laboratory by using both simulated and radioactive plant feeds. Test capsules of nonradioactive cesium chloride and strontium fluoride were prepared for container compatibility studies. Based upon initial compatibility results (3 months) with nonradioactive cesium chloride, Hastelloy C-276, was equal to or better than Hastelloy C. Preliminary results indicated that 316L stainless steel may be a good alternative to Hastelloy C for containing strontium fluoride.

Immersion of the capsules in boiling water was found to be effective in removing most of the radioactive contamination from the metal surfaces.

Pilot-scale equipment for conversion of nonradioactive strontium nitrate to strontium fluoride followed by filtering and sintering of the strontium fluoride was successfully used to demonstrate the various process steps. The impact consolidation prototype equipment was used to encapsulate nonradioactive strontium fluoride to about 85 percent of theoretical density. A thermosiphon evaporator and downdraft condenser were used to concentrate the nonradioactive cesium-ammonium carbonate product from the zeolite ion exchange purification process. The resulting cesium carbonate concentrate was acidified with hydrochloric acid and evaporated to dryness. The nonradioactive cesium chloride formed was then melted and transferred by vacuum into a series of stainless steel containers. Studies indicated that relatively low amounts of cesium are volatilized during the evaporation, drying and melting steps; and that conventional off-gas equipment can trap the volatilized cesium.

A computer program was written to determine steady-state temperature profiles in doubly encapsulated sources when stored either singly or in various arrays.

Six Hastelloy C capsules containing nonradioactive strontium fluoride were welded with a Gas-Tungsten-Arc welding system. No leaks were observed with helium leak tests, and the capsules are undergoing nondestructive testing. Welding tests on 316L stainless steel capsules for containment of cesium chloride are under way. The ability to measure weld penetration ultrasonically was established with developmental weld samples.

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A cell mockup of B cell was constructed as presently designed for the Strontium and Cesium Packaging Facility. Various equipment arrangements were tried to obtain assured remotability and operability of all equipment.

Salt Waste Volume Reduction

Miniature centrifugal contactors were fabricated to test the flow-sheet for reducing plutonium(IV) to plutonium(III) with hydrazine-stabilized uranium(IV) reductant. Preparations for a plant test to demonstrate the use of uranium(IV) as a replacement for the reductant ferrous sulfamate are being completed.

Further laboratory tests show that uranium(VI) and plutonium(IV) can be reduced with hydrazine catalyzed by platinum. Mixtures of simulated 2DF feed (feed to the second uranium cycle uranium-plutonium column) and hydrazine, when passed through a bed of platinum pellets, yielded uranium(IV) concentrations proportional to the hydrazine content up to about 30 percent 7 M hydrazine nitrate and 70 percent of 2 DF feed. Acid consumption was determined to be 1.5 moles per mole of uranium(IV) formed which agreed with theory. More hydrazine was consumed than theory would predict.

Use of ultraviolet light to stimulate reduction of plutonium(IV) to plutonium(III) by tributylphosphite was concluded to be unsuitable for plant operation. Organic soluble nitrite suppressors were tested; phenylhydrazine and phenylurea were most effective in destroying nitrite ion.

Macroreticular ion exchange resins were scouted for possible use in treatment of Purex solvent. A mixture of Amberlyst A-21 and Amberlyst 15 (trade name--Rohm & Haas Company) successfully removed fission products (zirconium, niobium and ruthenium) and the principal solvent radiation degradation product, dibutylphosphate (DBP) from used Purex solvent.

A modified falling-film evaporator was successfully used to concentrate Z Plant high salt aqueous wastes by factors of 1.3 to 2.4.

Plutonium can be recovered from Z Plant sump wastes by Dowex-50 resin (trade name--Dow Chemical Company) without reducing plutonium to the trivalent state. Some unidentified cation was loaded on the resin with the plutonium and restricted the resin capacity for plutonium.

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Alternative Solidification Methods

An engineering study to evaluate several alternative processes for solidifying Purex high heating and low heating wastes has been started.

Tests conducted by Idaho Nuclear Corporation personnel have shown that Z Plant high salt aqueous wastes can be calcined in an in-bed combustion, fluidized bed unit. A test run using acidified Purex coating waste was unsuccessful as the high sodium content caused particle agglomeration and lumping.

Evaluation of Effort

Process Development expenditures for the fiscal year to date are 43 percent of the FY 1970 budget for Waste Management. The minor program for reactor waste management has been limited, to date, to definition of the requirements in the reactor area.

Increased effort has been placed upon developing the technology for reducing annual quantities of radionuclides released to the environment in low- and intermediate-level liquid wastes to less than 400 beta curies and less than 10 grams of plutonium. Progress is satisfactory toward developing sensitive radiation detection instruments for use in diverting contaminated wastes to tanks for later treatment, toward finding economical methods for recycling or removing radionuclides from intermediate-level liquid wastes, and toward treatment of organic gaseous and solid wastes for removing radionuclides and noxious chemicals. The development schedule should allow facilities to be installed to attain the above release quantities by the end of FY 1975.

The salt waste processing and waste solidification in tanks sub-programs have been reduced in level of effort since B Plant and the in-tank solidification units are now operating successfully. Work has centered upon improving flowsheet and equipment operation and in developing alternative flowsheets for increasing safety and reducing costs.

A major development program for defining and demonstrating methods to encapsulate fission-product strontium and cesium has been progressing satisfactorily in support of a plant startup in FY 1974.

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Efforts to reduce the salt content of Purex wastes have increased because of the projected waste management cost savings and concomitant improved strontium recovery from current acid wastes. Laboratory development work has been completed, and uranium(IV) will be tested in the plant as a replacement for ferrous sulfamate.

Reduction of Z Plant aqueous waste to a solid calcine has been demonstrated in a fluidized bed system.

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