X-822

OAK RIDGE NATIONAL LABORATORY
Operated by
UNION CARBIDE NUCLEAR COMPANY
Division of Union Carbide Corporation
Post Office Box X
Oak Ridge, Tennessee

Second Issue
COPY NO. /

DATE: June 23, 1959

SUBJECT: Trip Report: Eurochemic Company Assistance - Hanford Atomic Products Operation Spent Fuel Processing Technology

TO: F. L. Culler

FROM: E. M. Shank

Abstract

Information obtained from HAPO during visit by M. K. Twichell, UCNC, and E. M. Shank, ORNL, is given. Included are the tentative procedures for obtaining and transmitting information to the Eurochemic company. Discussions are given on Pulsed Columns, Corrosion, Pulse Generators, Centrifuges, Valves, In-line Instrumentation, Evaporators, Resin Column Design, Off-gas Processing, Solvent Recovery, Liquid-Waste handling, Process Control, Equipment Decontamination, Criticality, Radiation Protection, Diluent and Solvent Stability, Backmixing in a Pulsed Column, and Use of 40% TBP in the Purex flowsheet.

DISCLAIMER

To: F. L. Culler

From: E. M. Shank

Subject: Trip Report: Eurochemic Company Assistance --- Hanford Atomic Products Operation Spent Fuel Processing Technology*

1.0 INTRODUCTION

M. K. Twichell, UCNC
E. M. Shank, ORNL

Messrs. Twichell and Shank visited the Hanford Atomic Products Operation on September 29 and 30 and October 1 to discuss spent fuel processing technology. The information and data obtained are to be used to supplement, expand, or substantiate similar data from other U. S. AEC contractors and will be made available as part of the Eurochemic Co. and Pennsylvania Advanced Reactor chemical processing plant assistance programs. The following discussion is outlined according to subject matter. Reference documents and drawings are given in Appendix I. The people contacted are listed in Appendix II.

The Eurochemic Co. and the position of ORNL in the Eurochemic and PAR assistance programs were explained to the people contacted.

2.0 PROCEDURE FOR INFORMATION TRANSFER

J. T. Christy, AEC, HOO
L. P. Bupp, HAPO

Considerable concern was shown for the proper procedure in obtaining and transmitting information to ORNL and to E. L. Nicholson. This concern was highly justified in view of the almost complete lack of information on philosophy and/or policy from Washington AEC. Owing to this concern, it was tentatively agreed with J. T. Christy, HOO, that the information obtained orally

*This report has been referred to HAPO in the rough draft form. This final form includes suggested modifications by HAPO personnel.

would be recorded in a trip report and would be reviewed by HAPO personnel, and the information desired would be officially requested from the AEC in writing. The review of the rough draft of the trip report is desirable owing to the possibility of misunderstanding or misinterpretation by the writer. The request for and receipt of information by writing through official AEC channels could involve delay in obtaining information and reduce the effectiveness of an AEC contractor representative acting as a central collection source. In order to proceed, the procedure will be modified to: (1) providing the rough draft of this trip report to HAPO for review; (2) directing the request for information to HAPO rather than HOO (see Sec. 6.0); and (3) suggesting that only those areas incompletely covered be supplied by HAPO in writing. L. P. Bupp has been designated as the HAPO contact person, and all correspondence relative to the program will be directed to him.

3.0 EQUIPMENT DESIGN AND PERFORMANCE

3.1 Pulsed Columns (O. F. Hill, R. J. Sloat, A. M. Platt, E. R. Irish, and W. H. Swift)

Inverted pulsed columns (bottom interface, organic continuous) have been in radioactive operation for about eight months with the Purex flowsheet. The use of the inverted column has proved its value beyond any question. The philosophy of using inverted columns is location of the interface, and hence the interfacial crud, at the waste end of a column. This results in all extraction and scrub columns being inverted while the partitioning and stripping columns are standard (aqueous continuous). Proper column operation requires, however, the use of special plates and/or sections within the column. HAPO has developed and is using the nozzle plate, the louver plate, the zebra cartridge, and the pulsed packed column (2A). The louver plate is designed to redistribute flows to reduce channeling; it is thought that louver plates are not required for columns with diameters less than 6 to 8 in. i.d. The nozzle plate was originally designed to give high-efficiency high-capacity operation to the strip (C) columns; its purpose is to jet the aqueous rapidly through the continuous organic phase (the nozzles are pointed downward when the organic phase is lighter than water). However, the nozzle plate has been satisfactorily used in the A column extraction section. The design and fabrication of the nozzle plate are critical, but potentially satisfactory vendors include Hendricks Manufacturing Co., Carbondale, Pa. and Johnson and Chapman Co., Chicago, Ill. The zebra cartridge, consisting of four stainless steel sieve plates alternated with two linear polyethylene sieve plates, is used in the scrub section of the extraction column and in the scrub column. The sieve plates contain 0.125-in.-diameter holes with 23% free area. The zebra cartridge produces alternate phase inversions in the scrub section, thus effectively preventing back mixing. This alternate coolescence and dispersion of the phases results in greatly improved operating stability and at least a twofold increase in operating capacity. Nozzle plates are used in the stripping column, where they provide satisfactory performance and a slight capacity advantage (under aqueous continuous conditions) over that offered by a standard cartridge. The stripping columns now are operated with top interface since the only advantage for bottom interface is a slight (20%) increase in flooding capacity. Two disadvantages exist in stripping columns with a bottom interface:

(1) a greater possibility exists for TBP to go to the product evaporators, and (2) a larger quantity of interfacial crud may go with the product. Other innovations to facilitate inverted column operation are the densimeter and the interface float control. (Drawings of these are available.)

A general discussion of column operation and performance indicated several items of interest. All Purex flowsheet columns are single diameter except for the HA and 2D extraction columns. The bottom interface control and the new column internals provide approximately the same flooding capacity throughout the extraction column; therefore design of a single-diameter extraction column is considered possible. The 2A column is a single-diameter fluorothene-Raschig-ring packed pulsed column. All columns are operated at about 50°C (60°C max.) by preheating the entering streams. (There was no strong feeling as to the relative merits of preheating entering streams vs. direct heating of the columns.) The effect of temperature on fission product decontamination was presented by V. R. Cooper at the 1958 Geneva Conference. Briefly, decontamination from ruthenium is enhanced as the temperature increases while decontamination from zirconium-niobium is enhanced as the temperature decreases. With the separate scrub column system an interesting possibility exists of operating the extraction column cold (~30°C) and the scrub column hot (~50°C). It was emphasized that reversing the above would not help, owing to the hydrolysis of zirconium-niobium at the elevated temperatures. Also, elevated temperatures increase the flooding capacity of all the columns.

The radiation stability of linear polyethylene has been evaluated. Some linear polyethylene plate failures have occurred (apparently) during eight months of radioactive operation. This failure is thought to be the result of improper installation rather than of radiation damage. A new spacer for the [illegible] polyethylene plate has been designed and eliminates direct bearing of the upper plates on the polyethylene (Dwg. H-2-56766). At total irradiation levels up to 10^7 r, radiation damage appears negligible. At 10^8 r, the linear polyethylene passes through a brittle phase (anticipated flexure life reduced by a factor of approximately 10). With continued irradiation (up to a limit of 2×10^9 r) this brittleness disappears. Beyond 2×10^9 r, the material suffers severe damage. A report on this subject (HW-51346, The Effects of Radiation on Flexure Life of Ziegler Polyethylene) has been submitted to TIS for release to the Civilian Application Program.

The Purex process may be shut down while at equilibrium and restarted without significant deleterious effects. Column operation has been discontinued at equilibrium condition for as long as one week; this flexibility was not observed at ORNL while processing thorium. Degradation products formed by static conditions and by the elevated temperatures are satisfactorily removed by the solvent recovery system.

The main reasons for discontinuing the co-decontamination flowsheet are: (1) the improved decontamination factor obtained from inverting the extraction column and the improved solvent recovery procedure reduced the need from three cycles to two cycles of decontamination (it is estimated that the decontamination factor across the first cycle was increased by a factor of 5 to 10 and that across the second cycle by a factor of 10 to 20), and (2) the two cycles

provided increased product recovery, capacity, flexibility, and economy.

The difficulty in optimizing a cycle for both high decontamination factors and low losses was pointed out. HAPO has therefore optimized the first cycle for losses and the second cycle for decontamination factors. While high second cycle losses do occur deliberately, recycling these to the first cycle essentially eliminates losses.

3.2 Corrosion (O. F. Hill, R. J. Sloat, E. R. Irish)

Corrosion has not been a serious problem except in the stainless steel heat exchangers on the evaporators and on stainless steel heat-transfer surfaces of oxidizers. In the latter, solutions with high nitrate but low acid concentrations are oxidized with dichromate. Dichromate in nitric acid solutions gives severe corrosion. The use of type 304L has proved reasonably satisfactory for all other process equipment except the plutonium nitrate concentrators. Heat exchangers for the plutonium concentrators have been fabricated from titanium and tantalum. Titanium is preferred owing to its greater ease in fabrication. The steam side of the heat exchanger is fabricated from stainless steel type 430 and the process side is fabricated from titanium (see Appendix I for titanium fabrication references). Some difficulty encountered in the plutonium evaporator (stainless steel portion) was attributed to the existence of a concentration cell as a result of the design; this was eliminated by modifying the design (Fig. 1) A special technique has been developed (Appendix I) for titanium fabrication.

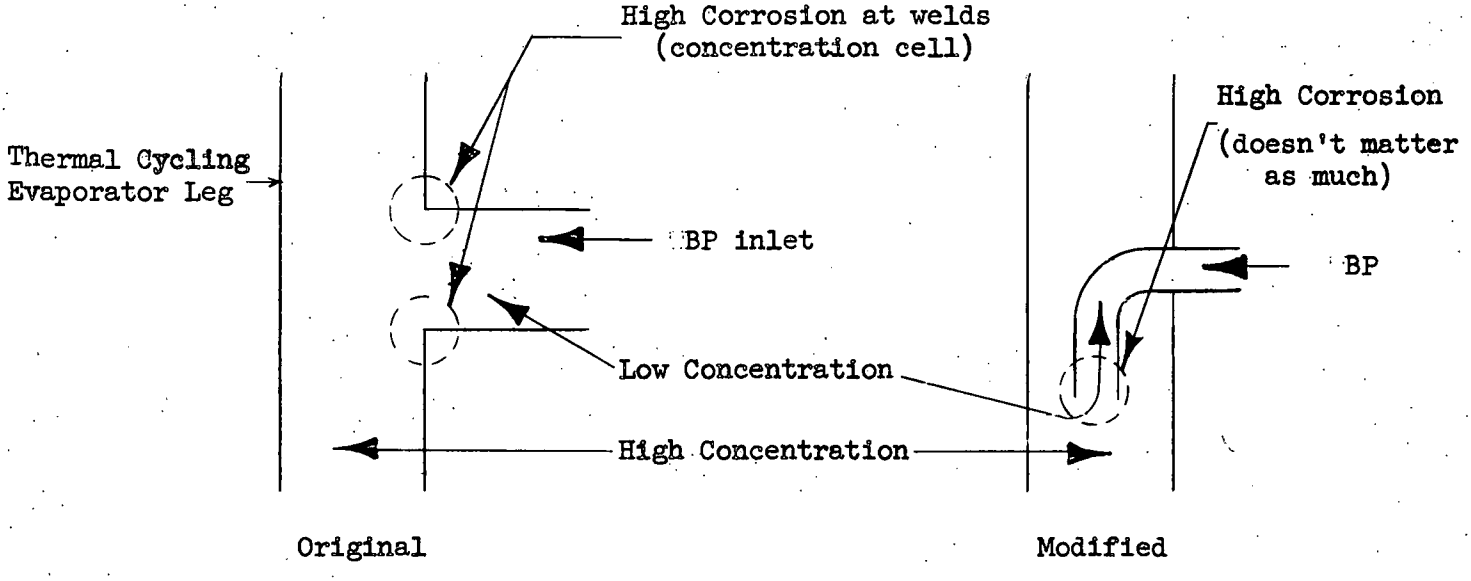

Fig. 1. Plutonium Evaporator.

While the initial fabrication was done at HAPO, C. H. Brahn, San Francisco, California, has fabricated the plutonium evaporator replacement. Since titanium is an oxygen getter, it is necessary to assure a complete blanket of inert gas.

The high-activity-level wastes are neutralized to a pH of 9 prior to storage in mild steel tanks. Waste storage corrosion is no problem.

3.3 Pulse Generators (R. J. Sloat)

HAPO uses electrically driven cam-operated plug-piston pulse generators. Pulsing equipment containing teflon bellows has also been used in several Hanford installations. Although such bellows have given satisfactory service in non- or slightly radioactive service, they have proved unsatisfactory for high-level radioactive service because of the radioactive damage susceptibility of teflon. Although it has not been tested in radioactive service, a plug-piston pulser (HW-51884) has been developed and is considered reliable. With an air purge to the shaft seal packing during operation and to the process side of the piston during shutdown there is essentially no leakage. The positive displacement action of this pulser is a considerable advantage (writer's opinion substantiated by HAPO) over the unknown displacement afforded by the Lapp pulser. The design also appears applicable to small directly maintained facilities.

3.4 Centrifuges (O. F. Hill, A. M. Platt)

HAPO does not like centrifuges but prefers them to filters. However, properly designed and maintained centrifuges have lasted several years with only routine-remote lubrication. (Writer's opinion: the development work at ORNL on the sand filter looks very promising for use in small directly maintained radiochemical processing plants. If the remote removal of the sand can be depended on, and it appears that it can, the sand filter should require much less maintenance than the centrifuge.)

3.5 Valves (R. J. Sloat)

Remotely operated valves are extensively used at HAPO. Specifications for these valves will be available. The Hammel-Dahl valve is used extensively. This valve is bellows-sealed and the valve body is fabricated from bar stock. Initially, the valves were fabricated from type 347 stainless steel, but replacement or new valves are fabricated from type 304L stainless steel. All valves used are metal-to-metal seat and plug. Two considerations were indicated: (1) Valves should not be used if other possibilities exist, and (2) for good operation, the solutions must be clean. Properly designed valves have given excellent service.

3.6 In-line Instrumentation (O. F. Hill, G. J. Alkire)

In-line instrumentation was not discussed at length since the HAPO program and status have been reported in HW-57232 by G. J. Alkire and in the June 1958 issue of the ISA Journal by C. L. Pleasance. Since HW-57232 was indicated as programmatic, no discussion will be given here. Rather, the program and status summary, along with report references, which may be transmitted to E. L. Nicholson

will be requested. Also, information from the ORNL In-line Instrumentation program will be available to supplement the HAPO summary. However, it should be stated here that no in-line instrument is available or being considered for monitoring uranium and plutonium losses from scrubbers and jacket removal solutions; this is because such streams are not monitored routinely for uranium and plutonium losses.

3.7 Evaporators (E. R. Irish)

Evaporators are used for waste, uranium product, and plutonium product concentration (the plutonium concentrator is not used routinely). All evaporators are thermal syphon evaporators with vapor towers. The acid recovery (waste) and uranium evaporators are identical in design but are operated differently, the former with feed to the pot and the latter with feed to the stripping tower. The plutonium evaporators are geometrically safe. The vapor towers contain either 8 ft. of Raschig ring packing (plutonium concentrator) or six bubble cap trays with 1 ft. of rings above the trays. The different tower packing is dictated by the size; rings are used in towers up to 24 in. dia. TBP is steam stripped from the aqueous in the uranium concentrators; the CU is admitted at the top bubble cap tray and the tower is operated wet. Steam stripping is used in the plutonium concentrator when operated. The phosphate concentration in the uranium concentrate is 5 to 10 ppm. The nitric acid concentrators do not steam strip TBP (stream enters pot and tower operates dry). Deposits of an iron-DBP complex accumulate, which is removed every few months with a 5% caustic flush at room temperature. No difficulty is observed from ruthenium volatilization; this is probably due to the presence of organic which forms nitrite to suppress ruthenium. The nitric acid recovery system uses double distillation, which effects about a 10^5 decontamination factor; the predominant fission products in the overhead are zirconium-niobium.

3.8 Resin Column Design (G. C. Oberg)

A plutonium recovery system (Dwg. H-2-56944) using resin columns is being installed on the HAW concentrated stream (no plant operating experience). The system will use downflow sorption and elution. The resin will be remotely replaced by fluidizing and backflushing with water. Permutit SK anion resin will be used; it has been shown to be radiation stable to 3×10^8 r.

4.0 CHEMICAL PROCESSING

4.1 Off-gas Processing (V. R. Cooper, O. F. Hill, A. M. Platt, R. G. Geier, E. R. Irish)

The details of off-gas handling equipment cannot be made available. However, the technology and general procedure for handling dissolver off-gases were discussed. Tube cooling, with finned tubes, is used for the downdraft condensers. The nitric acid utilization for uranium dissolution is affected by the nitric acid addition procedure, the cooling water temperature, and the type of condensers:

Acid Addition Procedure	Type of Condenser
All at once	Updraft
Continuous	Updraft
Continuous	Downdraft

The general dissolver off-gas handling flowsheet is shown in Fig. 2. The numbered comments below refer to the figure (see Appendix II for reference reports and drawings).

(1) A water scrubber, which may be made nonoperative by disconnecting the water supply, is being designed; this scrubber will be used only for ammonia removal.

(2) The silver reactor tower is for iodine removal. The maximum removal efficiency is 99.5%, and the tower is regenerated when the efficiency drops to about 93%. The dual-pass tower is essentially two towers in series and was found to be more efficient (>99.9%) than the single tower. The tower is packed with ceramic Berl saddles coated with silver nitrate. Sorption and tower regeneration are downflow for most Purex plant reactors. It is not apparent that the direction of flow is important. The tower is sized for a superficial gas flow rate of 1 ft/sec; the maximum recommended gas flow rate is 8 ft/sec.

(3) The filter is glass fiber designed to handle a gas flow rate of 20 ft/min.

(4) The water absorber tower is primarily for nitric acid recovery. It is also effective for removing about 90% of the residual iodine. The present acid recovery could be improved by providing lower temperature cooling water and by reducing the temperature of the gas feed; this tower operates at too high a temperature for maximum NO to NO_2 conversion. The acid concentration is about 15% and an acid fractionator is used subsequently. It was suggested that an acid absorber might be desirable upstream to the silver reactor tower.

(5) This scrubber was initially a caustic scrubber for iodine removal. Owing to the observed high efficiency of the acid absorber for iodine removal, this scrubber has been replaced by a second acid absorber.

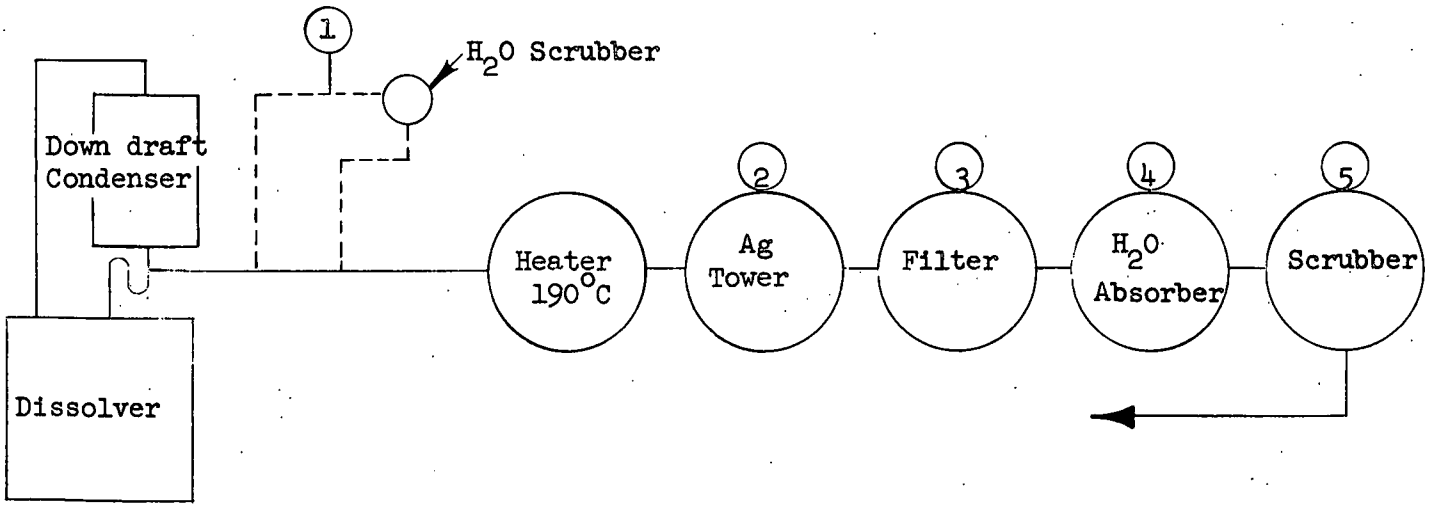

Fig. 2. Purex Dissolver Off-gas System.

4.2 Solvent Recovery (E. R. Irish, W. H. Swift, G. L. Richardson)

In the HAPO first cycle solvent recovery system there are three washes: a carbonate-permanganate, an acid, and a carbonate. In the second cycle is a carbonate wash followed by centrifugation. Details of the equipment were not obtained since similar equipment is being used or designed in the ORNL Power Reactor Fuel Reprocessing program. Since the chemistry of the system is different from that at ORNL, the flowsheet is discussed here. It should be pointed out that the HAPO solvent recovery flowsheet as used is considered quite satisfactory since it apparently removes the TBP and diluent degradation products sufficiently. The two separate systems (first and second cycles) now in use may be combined into one system by collecting all used solvent in one vessel and redistributing the recovered solvent to each cycle.

The used solvent is contacted with recirculating 5% sodium carbonate to which a 1% potassium permanganate is continuously added to maintain 0.05 M permanganate (potassium permanganate is rapidly reduced to manganese dioxide by the solvent). The carbonate-washed solvent is then contacted in a pulsed column with a 5% nitric acid solution. The acid wash removes the bulk of manganese dioxide and eliminates the need for a centrifuge. The acid-washed solvent is polished by contact with 5% sodium carbonate in a Turbo-Mixer unit. The final carbonate wash is designed to remove the final traces of manganese dioxide.

It is the writer's opinion that the method of solvent recovery is still somewhat a matter of individual preference. In view of the items below, it would be difficult to say just what system is required or preferred.

(1) Hanford Atomic Products Operation's success in using Na_2CO_3 and $KMnO_4$--HNO_3--Na_2CO_3. (Production experience is generally most valuable.)

(2) ORNL laboratory scale data and Feed Materials Processing Center reported pilot plant data on the benefits of $Ca(OH)_2$.

(3) Oak Ridge National Laboratory Power Reactor Fuel Reprocessing scheduled Na_2CO_3--KOH system.

4.3 Liquid-Waste handling (V. R. Cooper, R. E. Tomlinson)

Liquid wastes are divided into two principal categories: high-activity-level wastes which are semipermanently stored in underground tanks, and low-activity-level wastes which are disposed of to the ground via cribbing. Only the high-activity-level waste storage was discussed since ground disposal by the Eurochemic Company does not appear feasible. Two factors are important in considering liquid waste handling at HAPO: existing storage space greatly exceeds the demand, and any new facility will probably include interim tank storage for fission product decay followed by reduction of the waste to solid. The existing Purex underground storage facility contains 1,000,000-gal mild steel tanks, six tanks collectively provided with a cyclone de-entrainer and condenser. The cyclone underflow returns to the waste tank, and the overhead is condensed and returned to the process as reflux water.

Purex and Redox waste storage were compared. Purex jacket-removal solutions are stored in old existing tanks at a cost of about ¢0.25 per gallon. Purex extraction waste (HAW) is neutralized and stored along with solvent recovery sodium carbonate wastes. With the new two-cycle flowsheet Purex waste storage (after self-concentration) costs about ¢0.60 per gallon. Future tankage costs will probably go to about 1.00 per gallon. Redox high-level waste storage approximates a cost of ¢0.35 to ¢0.40 per gallon. Replacement cost here would probably go to ¢0.50 per gallon. Based on an interim storage condition, Redox high-level waste storage costs are about five times those of the Purex high-level wastes; storage costs of low-level wastes from the two programs are approximately equal.

4.4 Process Control (V. R. Cooper, O. F. Hill, W. H. Swift)

Several generalized items associated with process control were discussed. Chapters in the Purex manual dealing with chemistry of Purex process solutions have been reviewed for declassification.

Losses observed in the jacket-removal step have followed ORNL's experience. The only loss occurs from inadequate dissolver rinse prior to dejacketing. Aluminum removal may occasionally be incomplete as aluminum has been detected in the HAW (high-level waste). The quantity of aluminum adds insignificantly to the waste volume. This aluminum concentration, however, may be a very significant factor in potential fission product recovery or alternative waste disposal processes.

The effects of flow rate and flow ratio variation were discussed briefly. The most significant control requirement is the U/TBP ratio in the HA column. Wide variations in feed concentration can be tolerated by adjusting the feed and extraction flows to maintain the proper U/TBP ratio. Information on the exact effects of variations in flow rates, flow ratios, concentrations, etc. will be requested.

4.5 Equipment Decontamination (E. R. Irish)

Very little time was spent discussing decontamination since the development of procedures is of less concern to a remote-replacement facility than with a directly maintained plant. The new equipment decontamination facility is performing satisfactorily. Detergents such as ORNL uses for degreasing and for decontaminating the solvent recovery system are not used owing to the waste disposal problems.

4.6 Criticality (V. R. Cooper)

Criticality control was not discussed extensively. Critically safe operation at HAPO requires that a minimum of two unrelated incidents must occur to produce a neutron excursion. Geometry and solution concentration, but no in-line instrumentation, are depended on for control.

4.7 Radiation Protection (J. W. Healy, J. T. Christy, E. R. Irish)

The subject of radiation protection was briefly discussed from the viewpoint of the design philosophy and the health physics requirements. The advisability of providing Eurochemic a large amount of the technical assistance needed for design and operation of radiochemical processing plants without guidance on the administrative requirements was questioned. Whether or not the administrative requirements have been adequately covered in previous European conferences is not known. Several reports on design philosophy are listed in Appendix I.

The radiation protection requirements at HAPO, a remotely operated remote-replacement facility, will differ somewhat from the requirements at ORNL and probably at the Eurochemic plant. Plutonium handling, and contamination detection and control were incompletely covered. A few plutonium references are listed, however, and will be expanded. A summary paper covering HAPO's experience in handling plutonium and in controlling radiation exposure will be helpful.

5.0 CHEMICAL DEVELOPMENT

5.1 Diluent and Solvent Stability (M. T. Walling, E. E. Voiland, L. L. Burger, W. H. Swift, G. L. Richardson, R. E. Tomlinson)

The diluent currently used in the Purex process is Shell E-2342, a five-carbon cyclic hydrocarbon. This diluent is admittedly not the optimum for radiation and chemical stability and physical characteristics, but since performance of the process is satisfactory, no incentive for changing diluents exists. Amsco 125-82 is a preferred diluent (based on laboratory-scale development) except for its low flash point. n-Dodecane ($C_{12}H_{26}$) would be an ideal diluent since it is a fully saturated nonbranched compound with a minimum viscosity for a given vapor pressure; the principal drawback is its high cost. Soltrol-170, a Phillips Petroleum Co. pure paraffin hydrocarbon, appears good from laboratory tests and is not too expensive.

Solvent stability studies have not been too extensive. One reference is listed in the appendix.

5.2 Backmixing in a Pulsed Column (A. M. Platt, L. L. Burger)

The references to the theoretical effects of backmixing are listed in Appendix I. One conclusion reported is that backmixing is insensitive to pulse frequency, plate spacing, and throughput and sensitive to pulse amplitude and continuous-phase flow rate. Backmixing in the scrub section is objectionable primarily because of lower decontamination from fission products by scrubbing. As previously indicated, the zebra cartridge is considered the best anti-backmixing device developed to date.

5.3 Use of 40% TBP (O. F. Hill, A. M. Platt)

Since Eurochemic is considering the use of 40% TBP, the effects of this were discussed. The flooding rate, viscosity, and interfacial tension charac-

teristics of a TBP-kerosene solution do not change significantly above 15% TBP. A density increase and a corresponding $\Delta\rho$ decrease will result. While HAPO personnel could see no disadvantages or problems, they questioned the advantage of 40% TBP over 30% TBP.

5.4 Miscellaneous

Accurate Pu(III) distribution coefficients have not been determined. It was indicated that the distribution coefficient of Pu(III) was always 0.01 or less for all the conditions studied. Pu(III) distribution is difficult to measure owing to the small amount of Pu(IV) always present.

No information was obtained on the chemistry of a system for processing uranium-molybdenum alloy. The effects of magnesium (from dejacketing) on solvent extraction was thought to be the same as aluminum.

Based on laboratory-scale development, a square pulse or a mixer-settler pulsed column will decrease the HTU by as much as a factor of 10.

6.0 ITEMS NOT COVERED

The extent of the information given in this trip report is, in general, considered adequate for the subject discussed. Below are listed requests for information on subjects which were not covered. Information should be based on a Purex-type plant of 100 metric tons/year capacity (Eurochemic design).

1. The list of references given in Appendix I should be reviewed. The reports that may be transmitted to E. L. Nicholson without clearance or approval should be indicated. Additional references that may be transmitted now will be appreciated.

2. A list of preferred contact people for specific areas is desired.

3. Can the dual-diameter extraction columns be designed as unidiameter columns when using the nozzle plates and zebra cartridges? If so, what is the flooding capacity for the various column internals design?

4. What types of plate are used in 1BX, 1BS, 2B, 1C, and 2E columns?

5. What is the HETS relation between stainless steel plates and other types of column internals for all columns?

6. What effect does % TBP have on the contactor design?

7. Are satisfactory polyethylene-coated stainless steel plates available?

8. Can actual specifications for remotely operated valves be supplied?

9. What reports on instrumentation can be sent to E. L. Nicholson (reference Appendix I)? Are additional reports not listed available covering process control

and in-line instrumentation? Can in-line instrumentation status reports be made available to E. L. Nicholson routinely?

10. Can all the IWW plutonium recycle system design prints be made available? If so, please list prints by number only.

11. All information on off-gas handling, iodine removal technology, design criteria, etc., which can be made available should be listed (references in Appendix I on off-gas should be checked and expanded for availability).

12. What is the activity level observed in the aluminum dejacketing solutions?

13. Can a summary report covering HAPO's plutonium-handling experience be prepared? (See J. W. Healy)

14. Reports covering all phases of power reactor fuel head-end processing have been requested. Can these be listed and approval given for transmittal to E. L. Nicholson? Can future issues of these reports be made available routinely?

15. Can approval for transmitting HW reports to E. L. Nicholson be obtained by submitting a list of these reports to HAPO? If so, to whom should the list be sent?

16. What design drawings can be made available on:

a. Column internals
b. Pulse generators
c. Solvent recovery equipment
d. Iodine removal and nitric acid recovery equipment
e. Downdraft condensers
f. De-entrainment devices
g. Building and process ventilation
h. Special instrumentation
i. Waste storage tanks

17. Can the two-cycle flowsheet containing stream compositions and flow ratios be sent to E. L. Nicholson?

18. Are concentration profile curves for H^+, U, Pu, and fission products available on the Purex process?

19. Can the Purex flowsheet be evaluated for stream composition, flow ratio, and flow rate limitations for maximum flowsheet departure and effects of flowsheet departure?

20. What are the total flow vs. HETS vs. flooding relations?

21. What are the effects of temperature on flooding, decontamination factors, and solvent degradation?

22. Can chapters 3, 4, 5, 7, 9, 10, 13, 19, 20, 21, 22, 23 of HW-31000 be declassified either with or without deletions? Can a copy of HW-31000 (rev) be sent to ORNL for declassification?

23. All the information on fumeless dissolution which can be made available is needed.

24. Are solvent recovery carbonate wastes ever recycled for U-Pu recovery? What problems might be encountered in this operation?

25. How are off-standard streams, both aqueous and organic, handled? Please outline a preferred system for handling this type of operation.

26. Information on steam-stripping of TBP from aqueous solutions (including tower design) is needed.

APPENDIX I

BIBLIOGRAPHY OF REPORTS AND DRAWINGS

Instrumentation

Reports

1. HW-29348 --- Gamma Monitoring
2. HW-33901 --- Gamma Monitoring
3. HW-33148 --- pH
4. HW-33948 --- pH
5. HW-30148 --- Polarography
6. HW-42637 --- Polarography
7. HW-30791 --- Alpha Printer
8. HW-41525 --- Alpha Printer
9. HW-39926 --- Colorimeter
10. HW-40313 --- Colorimeter
11. HW-36788 --- Gamma Absorptiometer
12. HW-39971 --- Gamma Absorptiometer
13. HW-47003 --- Contact Alpha
14. HW-57232, "Process Control Development Program," G. J. Alkire (Unclassified)
15. HW-56674, "Density Monitor for Purex HA Column," C. E. Huck (Unclassified)
16. HW-55166, "A Removable Float-Type Liquid Interface Controller," K. J. Hahn (Unclassified)
17. HW-55156, "A Removable Float-Type Liquid Interface Controller," K. J. Hahn and H. M. Jones
18. HW-50355, "Information for the Application of Dual-Filter Photometers for Continuous Analysis of Plant Streams," R. D. Dierks (Unclassifed)
19. HW-49447, "Information for the Application of a Contact Alpha Monitor," P. E. Brown (Confidential)
20. HW-46065, "Technical Information for Application of Differential Pressure Transmitters in Pulse Column Bottom Interface Control Systems," A. E. Smith (Unclassified)
21. HW-45664, "Information for Application of Gamma Absorptiometers for Chemical Processes," G. J. Alkire (Declassified)
22. HW-44919, "Technical Specifications for pH Monitors," A. E. Smith (Unclassified)
23. HW-39821, Rev. 1, "Technical Specifications for Gamma Scintillation Monitors," G. J. Alkire (Unclassified)
24. Pleasance, C. L., "Continuous Analysis in Nuclear Processing," ISA Journal, Vol. 5, June 1958
25. Hahn, K. J., and K. Koyama, "An Industrial-Type Flow Cell for Monitoring pH," Ind. and Eng. Chem., Vol. 49, November 1957

26. Alkire, G. J., K. Koyama, K. J. Hahn, and C. E. Michelson, "A Plant-Type Polarographic System for Determining Uranium in Radioactive Waste Streams," Analytical Chemistry, accepted for publication in Fall 1958

Drawings

1. H2-56729 --- Interface Float Control
2. H2-57408 --- Densimeter

Off-Gas

Reports

1. HW-52943, "Gamma Radiolysis of TBP and TBP-Diluent Systems," L. L. Burger and E. D. McClanahan, Jr.
2. HW-35579, "The Relation of Flash Point to Vapor Pressure," L. L. Burger
3. HW-40820, "The Flammability of Vapors Above Purex Systems," L. L. Burger
4. HW-46134, "Gas Production in Waste Tanks"
5. AERE-CE/R-1784 --- Effects of Radiation on TBP

Drawings

1. H2-52456 --- First Solvent Recovery Contactor
2. H2-56880 --- Turbo-Mixer

Solvent Extraction Columns

Reports

1. HW-49542 A, "Application of the Pulse Column to the Purex Process," R. G. Geier
2. Geneva Conference 1958, "Improved Pulsed Solvent Extraction Column Internals," R. G. Geier, Paper No. 515
3. HW-50145, "Organic Continuous Cartridge for the Purex HA Column," G. A. Nicholson
4. HW-40550, Vol. 1 and 2, "Purex Pulsed Column Studies with Hydrocarbon Diluent," G. A. Nicholson
5. HW-40322, "Purex Plant Small Pulse Generator Operation," P. B. McCarthy
6. HW-51884, "Plug-Piston Pulse Generator," V. P. Kelly
7. HW-26459, "Valve Actuated Pulse Column," L. H. Clark and L. L. Burger
8. HW-23141, "Valve Actuated Pulse Column," L. H. Clark and L. L. Burger

Drawings

1. H2-56944 --- Column Detail
2. H2-56766 --- Modified Zebra Cartridge Design

Backmixing

Reports

1. Swift, W. H., and E. R. Irish, "Interpretation of Backmixing in Terms of Plate Efficiency," September 5, 1955
2. Bobb, A. L., and R. G. Geier, "Backmixing in Pulsed Columns: Resume of Summer Program," September 15, 1955
3. HW-29010, "Backmixing in Pulsed Column II, Experimental Values and Effects of Several Variables," L. L. Burger and W. H. Swift
4. HW-28867, "Backmixing in Pulsed Columns with Particular Reference to Scale-up" L. L. Burger and W. H. Swift

Health Physics

Reports

1. Geneva Conference, 1955, "Radiation Exposure Experience in a Major Atomic Energy Facility," H. M. Parker, Paper No. 240
2. Geneva Conference, 1955, "Health Protection in Chemical Processing Plants," H. M. Parker and J. M. Smith, Paper No. 248

Miscellaneous

Reports

1. "Design Philosophy of Remote Operation," Nuclear Engineering, Part III, Vol. 50, 1954
2. HW-55680, "Aqueous Processes for Separation and Decontamination of Irradiated Fuels," V. R. Cooper and M. T. Walling (Geneva Conference, 1958, Paper No. 2409)
3. Geneva Conference, 1958, "Critically Safe Equipment for Solvent Extraction Processes," T. Calven, Paper No. 222
4. Pu^{+3} Distribution Coefficients:
   HW-31000, Figures IV-20 and IV-21
   KAPL-602
   AERE-C/R-999
5. HW-24321 --- Corrosion
6. HW-52389 --- Purex Two Cycle Flowsheet

Drawings

1. H2-52061 and H2-52064 --- Purex Building Layout
2. H2-56944 --- IWW Resin Column Design

APPENDIX II

PERSONS CONTACTED

1. Christy, J. T. (Joe), Chief, USAEC

   Separation Branch
   Process Engineering and Manufacturing Division
   Hanford Operations Office
   United States Atomic Energy Commission
   Richland, Washington

2. Cooper, V. R. (Vance), Manager, HAPO

   Research and Engineering Operation
   Chemical Processing Department
   Hanford Atomic Products Operation
   Richland, Washington

3. Bupp, L. P. (Lamar), Manager, HAPO

   Chemical Research and Development Operation
   Hanford Laboratories Operation
   Hanford Atomic Products Operation
   Richland, Washington

4. Irish, E. R. (Everett), Manager, HAPO

   Purex Technology Operation
   Research and Engineering Operation
   Chemical Processing Department

5. Tomlinson, R. E. (Tommy), Acting Manager, HAPO

   Production Operation
   Research and Engineering Operation
   Chemical Processing Department

6. Geier, R. G. (Bob), Acting Manager, HAPO

   Advance Process Development Operation
   Research and Engineering Operation
   Chemical Processing Department

7. Swift, W. H. (Ward), HAPO

   Purex Technology Operation
   Research and Engineering Operation
   Chemical Processing Department

8. Oberg, G. C. (Carroll), HAPO

Purex Technology Operation
Research and Engineering Operation
Chemical Processing Department

9. Schmidt, W. (Walt), HAPO

Purex Technology Operation
Research and Engineering Operation
Chemical Processing Department

10. Switzer, W. O. (Bill), HAPO

Technical Administration
Chemical Research and Development Operation
Hanford Laboratories Operation

11. Reas, W. H. (Bill), Manager, HAPO

Chemical Research Operation
Chemical Research and Development Operation
Hanford Laboratories Operation

12. Walling, Jr., M. T. (Mat), Supervisor, HAPO

Chemical Separations
Chemical Research Operation
Chemical Research and Development Operation
Hanford Laboratories Operation

13. Burger, L. L. (Lee), HAPO

Chemical Separations
Chemical Research Operation
Hanford Laboratories Operation

14. Richardson, G. L. (Jerry), HAPO

Chemical Separations
Chemical Research Operation
Hanford Laboratories Operation

15. Voiland, E. E. (Gene), Supervisor, HAPO

Heavy Elements Chemistry
Chemical Research Operation
Hanford Laboratories Operation

16. Hill, O. F. (Orville), Manager, HAPO

    Chemical Development Operation
    Chemical Research and Development Operation
    Hanford Laboratories Operation

17. Alkire, G. J. (George), Supervisor, HAPO

    Process Control Development
    Chemical Development Operation
    Hanford Laboratories Operation

18. Gloat, R. J. (Bob), Supervisor, HAPO

    Process Equipment Development
    Chemical Development Operation
    Hanford Laboratories Operation

19. Platt, A. M. (Al), Supervisor, HAPO

    Chemical Engineering Development
    Chemical Development Operation
    Hanford Laboratories Operation

20. Healy, J. W. (Jack), HAPO

    Consulting Radiological Scientist

Distribution
Second Issue

1-15. TISE, AEC