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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHMOND, WASHINGTON

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ENGINEERING STUDY
PUREX TWO-PHASE CONVERSION

AUTHOR

G. K. Carpenter, J. R. LaRiviere & L. R. Miche

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ENGINEERING STUDY
PUREX TWO-CYCLE CONVERSION

BY

G. K. Carpenter, J. R. LaRiviere and L. R. Michels

May 23, 1957

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 CHEMICAL PROCESSING DEPARTMENT
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ENGINEERING STUDY
PUREX TWO-CYCLE CONVERSION

INTRODUCTION

Adoption of a two-cycle solvent extraction process at Purex, in place of the present three-cycle process, offers great potentialities for reduction of manufacturing costs, improved product and by product recovery and increased capacity (Reference 1). This report deals with the engineering feasibility of converting Purex for two-cycle operation.

At a Purex 2.75 capacity factor, the overall cost incentive for conversion of Purex to two-cycle operation is a potential savings of the order of \$200,000 per month, attributed mainly to improved plutonium and uranium recovery, reduced high-level waste storage requirements and reduced consumption of essential materials. Further, eventual expansion of Purex to 4.0 capacity factor with the Reference 1 flowsheet is considered possible without the need for replacement of the relatively expensive concentrators. According to the preliminary study of Reference 2, a capital expenditure of only about \$3,000,000 would be required to achieve 4.0 capacity factor at Purex with two-cycle operation. As delineated in Reference 3, the stepwise expansion of Purex to an intermediate capacity of 3.5 C.F. with the two-cycle flowsheet would entail an expenditure of about \$2,150,000, exclusive of the cost of replacing the HA Column. Replacement of the HA Column (References 4, 5, and 6) which is required as the first step in attaining two-cycle operation, was approved separately by the Atomic Energy Commission on April 18, 1957.

- (1) HW-47889, "Purex Phase II Proposed Flowsheet", by WH Swift and ER Irish, dated February 1, 1957.
- (2) HW-48336, "Budget Study Report, FY-1959 Plant and Equipment Budget, Separations Plant Expansion, Budget Item No. 659-023", by LR Michels, dated February 6, 1957.
- (3) HW-48904, "Proposed Purex Phase II Expansion Program", by LR Michels, dated March 8, 1957.
- (4) Letter, LL Zahn to CE Kent, "Replacement HA Column For Purex", dated February 21, 1957.
- (5) Letter, LL Zahn to CE Kent, "Scope Design - Replacement HA Column - Purex", dated April 23, 1957.
- (6) HW-48780, "Project Proposal, HA Column Replacement - Purex, Project CG-742", by RC Baker, dated February 26, 1957.

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The magnitude of the incremental cost savings of \$414 per ton, which may be realized through two-cycle operation, dictates completion of the two-cycle conversion in advance of Purex capacity increase. This report provides a preliminary delineation of the modifications to Purex which are considered necessary in order to adopt the two-cycle flowsheet with minimum delay.

Supplemental studies are in progress both on the complete process design of the two-cycle conversion and on the engineering feasibility of expansion of Purex to the modified Phase II rate of 3.5 capacity factor.

PURPOSE

The purpose of this report is to establish 1) the engineering feasibility, 2) the preliminary cost basis and 3) the preliminary schedule for the Purex two-cycle conversion for Project Engineering use in initiating action towards a construction project proposal.

SUMMARY

The results of this study indicate that conversion of Purex for two-cycle operation according to the Reference 1 flowsheet is feasible from an engineering standpoint. On completion of the two-cycle conversion, the overall potential capacity of the Purex Plant would be about 2.75 capacity factor, as limited by the capacity of the present 2A Column. The exact capacity of the 2A Column cannot be fixed precisely owing to limitations in present column flooding data.

Revised process routings for two-cycle operation appear in Drawing No. SK-2-17637.

The major changes involved in the two-cycle conversion, which appear in the Appendices, consist of a new HA Column, a new HS Column to provide additional scrubbing height for the HA Column, and removal of T-J2, the present 1A Column, from the canyon, followed by installation of a standard Purex tank in the J-2 position; this tank would, in turn, be secured from the present F-4 position. The new jumpers and instrumentation shown in Appendix C, together with necessary cold side modifications, including modification of the graphic panel board, and purchase of spare equipment would complete the installation. In two-cycle operation, the present E-H4-1 vessel would be employed as a waste backcycle concentrator.

The total project cost required for the two-cycle changeover, as supplied by Project Engineering and consistent with the conversion items in the cost estimate of Appendix D, is about \$540,000, including a design cost of \$82,000 and 25 percent contingency. Work could be performed either by Plant Forces or Construction.

The major vessels required, T-H3 O.S. (the HS Column) and TK-F4 (the new tank TK-J2) are available on-site. About 8 stainless steel control valves, 1 rotameter, and 125 connectors of various sizes and types would be required, procurement of which would govern the beneficial use date. The magnitude of the potential incremental operating cost savings of \$200,000 per month would dictate expedited procurement of the above connectors and instruments. The beneficial use date for the two-cycle conversion established tentatively as April 1, 1958, was based on the premise that the critical connectors and instruments would either be available from spare parts or could be procured on an expedited basis. On a normal procurement basis, the beneficial use date would be deferred until July 1, 1958. A major Purex shutdown of about 30 days would be required to replace columns

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and to make the cold-side tie-ins for the two-cycle conversion.

A preliminary tabulation of the necessary connectors, rotameters, control valves, jets and pumps has been made for Project Engineering use in the expedited procurement of these critical delivery items. This tabulation appears in Appendix C.

The two-cycle flowsheet calls for the routine treatment of the 2BP plutonium stream by continuous ion exchange and concentration equipment (References 7 and 8). The operational feasibility of the prototype ion exchange unit proposed for this service has not as yet been proven. Startup tests on the prototype anion exchange unit in the Regulated Shop are scheduled for September 1, 1957. Allowing three to four months for shakedown operations, the adaptability of the prototype for two-cycle operation will have been demonstrated by about January 1, 1958. Should unanticipated operational difficulties be encountered with the prototype beyond January 1, 1958 a review of the scope and schedule of project activities might be required, prior to completion of the two-cycle modifications as delineated herein.

The Reference 8 letter mentions that intermittent treatment of uranium product by silica gel might be required for startup batches. Should the amount of uranium requiring treatment exceed the capacity of our present installation, the silica gel (drum) facility might be expanded at a later date by other means.

RECOMMENDATIONS

The following modifications to Purex are considered necessary to incorporate the two-cycle flowsheet of Reference 1 at a 2.75 capacity factor:

1. Major Column Changes

- a. Convert the spare T-H3-O.S. Column into a new HS Column, T-H3 by 1) addition of a new cartridge, 2) addition of a nozzle for bottom interface control and 3) relocation of nozzle K at the top of the column. The new HS Column is to be capable of operation at a capacity factor of 4.0.
- b. Provide a spare T-H3 (HS) Column.
- c. Provide a spare for the new HA Column, T-H2, in accordance with the Reference 5 design.
- d. Remove the HC Column from the canyon following adequate flushing and decontamination to permit storage. Provide a temporary storage box and store the HC Column for spare future 1C or 2E column service.
- e. Install the new HS Column in the spot vacated by the removal of the present HC Column.

(7) Letter, LL Zahn to ER Irish, "Purex Phase II Engineering Study", dated April 9, 1957.

(8) Letter, ER Irish to LL Zahn, "Purex Phase II Flowsheet", dated April 12, 1957.

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- f. Remove the 1A Column (T-J2) and its pulse generator from the canyon following flushing and decontamination. Provide storage boxes and store the column and pulse generator on railroad cars.

2. 1BSU Tank Installation

- a. Remove tank TK-F4 from F-cell following flushing and decontamination and install TK-F4 along with its agitator in the J-2 position vacated by the 1A Column. The tank would be recoded TK-J2.
- b. Provide new dunnage for the tank TK-J2 as shown in SK-2-2783.
- c. Provide a standard Purex Group 1 Pump for TK-J2 capable of operation at a capacity factor of 4.0.

3. Jumpers

Provide new jumpers and spares as indicated in SK-2-17637, SK-2-2783 and in Table III of Appendix C. These new jumpers are required by virtue of the two-cycle conversion and changes in stream flow with present routings as a result of adoption of the Reference 1 flowsheet at 2.75 capacity factor. The instruments for the required new jumpers have been sized for 4.0 capacity factor, where old instruments were inadequate at 2.75 capacity factor.

4. Cold Side Piping and Instrumentation

Cold side modifications are required, as delineated in SK-2-17637, SK-2-2783 and Table IV of Appendix C.

5. Modifications to the Graphic Panel Board

Modification of the Graphic Panel Board in the Central Control Room will be required to permit operation of tank TK-J2 in the J-2 panel board position, in place of the present 1A Column, T-J2.

6. Burial of Jumpers

Jumpers not required for two-cycle operation should be disposed of in special burial boxes.

ACKNOWLEDGEMENT

The contributions of many individuals in Purex Operation, Purex Technology and Project Engineering are acknowledged. Project Engineering furnished cost estimates and project schedule information. Purex Operation and Purex Technology provided suggestions on routings and transfer of function of major vessels to permit the two-cycle conversion with a minimum of new major equipment.

REFERENCES

1. HW-47889, "Purex Phase II Proposed Flowsheet", by WH Swift and ER Irish, dated February 1, 1957.
2. HW-48336, "Budget Study Report, FY-1959 Plant and Equipment Budget, Separations Plant Expansion, Budget Item No. 659-023", by LR Michels, dated February 6, 1957.

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3. HW-48904, "Proposed Purex Phase II Expansion Program", by LR Michels, dated March 8, 1957.
4. Letter, LL Zahn to CE Kent, "Replacement HA Column For Purex", dated February 21, 1957.
5. Letter, LL Zahn to CE Kent, "Scope Design - Replacement HA Column, Purex", dated April 23, 1957.
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HMDX ADDITION FROM PUREX
 RECOVERED ACID HDA = 7.50

- NOT SHOWN:

- LEGEND

- NEW (FOR 2-CYCLE 2.75 C.F.)
— NEW (FOR 3.5 CF)
--- EXISTING

DATE	DATE
1964	1964

NONE

CLASSIFIED BY 1711 JPM DATE 1/14/81

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TK-J2 CELL ARRANGEMENT

SCALE - 1" = 1'-0"

LEGEND:
 NEW JUMPS ———
 EXISTING JUMPS - - -

Flow Stream / Equipment	Elevation (ft)	Flow Rate (gpm)
EL 200'0" - 1071.2' W. COIL OUTLET-TK-J2	200'	T-11
EL 687'4" - 1039'2" P	687'4"	T-12
EL 687'4" - 1070'2" P	687'4"	T-13
EL 200'0" - 1045'2" P	200'	T-14
EL 623'3" - 1045'3" P	623'3"	T-15
EL 711'0" - 1239'2" P	711'0"	T-16
EL 631'3" - 1041'3" P	631'3"	T-17
EL 700'0" - 1043'2" P	700'	T-18
EL 623'3" - 1042'3" TO TK-F10	623'3"	T-19
EL 633'5" - 1044'3" P	633'5"	T-20
EL 712'0" - 1047'3" P	712'	T-21
EL 702'0" - 1050'2" P	702'	T-22
EL 700'0" - 1046'2" P	700'	T-23
EL 200'0" - 1046'2" FROM 1046'1046' T-22	200'	T-24
EL 623'3" - 1049'2" P	623'3"	T-25
EL 700'0" - 1044'2" H3SL VENT - T-26	700'	T-26
EL 200'0" - 1032'2" P	200'	T-27
EL 711'0" - 1034'3" P	711'0"	T-28
EL 711'0" - 1140'3" P	711'0"	T-29
EL 681'6" - 1043'2" P	681'6"	T-30
EL 681'6" - 1041'4" P	681'6"	T-31
EL 200'0" - 1132'2" P	200'	T-32
EL 200'0" - 1126'2" P	200'	T-33
EL 200'0" - 1023'5" TO F14C	200'	T-34

Notes:
 G-130-131/12-5 - NET SYSTEM EL 220'0"
 G-131-132/12-5 - NET SYSTEM EL 220'0"
 G-140-141/12-5 - NET SYSTEM EL 220'0"
 G-141-142/12-5 - NET SYSTEM EL 220'0"
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 G-225-226/12-5 - NET SYSTEM EL 220'0"
 G-226-227/12-5 - NET SYSTEM EL 220'0"
 G-227-228/12-

SCALE - 1" = 1'-0"

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PLAN & ELEVATION
TK-J2 SUPPORT

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REF. NO.	REFERENCE DRAWINGS
NEXT USED ON	42-23522
CLASSIFICATION	NONE

DESCRIPTION		REV. NO.	DATE	BY	FOR	DATE
REVISIONS						
DWG. NO.	SK-2-2783					
SCALE	1" = 10'	APPROVALS				
DRAWN BY	DATE	DATE				
CHECKED BY	DATE	DATE				
DES. ENG.	DATE	DATE				
UNIT NO.	65-0322	DATE				
PROJECT NO.		DATE				
U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION 2500 GENERAL ELECTRIC						
CELL APPROPRIATE STUDY FOR TK-J2						
BUILD. NO.	202A	DWG. NO.	SK-2-2783	DATE		

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APPENDIX A

Description and Discussion of the Proposed Two-Cycle Conversion

The salient physical aspects of the two-cycle conversion are presented in SK-2-17637 (Purex Flow Sketch) and SK-2-2783 (Cell Arrangement Study For TK-J2). The principle features of the conversion are:

1. A change in function for the T-H3 C-Column from its present service to an auxiliary series scrub service for the T-H2 A-Column. The organic overflow from T-H3, containing partially decontaminated uranium and plutonium would be routed to the 1B and 1C columns via the 1BXF Tank, TK-J3, for stripping of plutonium and uranium, respectively, into the aqueous phase, as in present three-cycle operation. The present HC Column is unsuitable for HS service by virtue of modified cartridge-function and unavailability of nozzles to permit bottom-interface control.
2. Installation of a tank in the J-2 position, now occupied by the 1A Column, to permit recycle of organic to the 1A Column from the 1BS Column, along with recycle organic in the HAO stream from the #1 solvent treatment system. The new TK-J2 would serve to 1) blend both organic streams for process uniformity and 2) permit pumping to overcome hydraulic limitations of present columns. The present 1A Column is not required for two-cycle operation.
3. Use of E-H4 as a waste backcycle concentrator. At present, F-H4 is used as an intercycle concentrator between the HC and 1A Columns for three-cycle operation.

For proposed two-cycle operation, concentrated waste from E-H4 is to be routed back to the HA Column via the present tank, TK-J1. For two-cycle operation, feed to E-H4 (chiefly second-cycle wastes) will be supplied from the present pump-decanter tank, TK-F10. The proposed waste recycle method has as its objective the recovery of uranium and plutonium in the HA Column from second cycle wastes and the overall volume reduction of wastes requiring underground storage.

4. Overflow from the waste concentrator condenser E-F11-2 to the Acid Concentrator, E-F6. Under present three-cycle operation, tank TK-F10 is used to route condensate from E-F11-2, along with the above-mentioned second cycle wastes, to E-F6. The proposed use of TK-F10 for waste backcycle under two-cycle operation precludes its normal use as a condensate receiver and feed tank for E-F6. The proposed two-cycle routing of condensate from E-F11-2 directly to E-F6 involves the use of Line #7707, the Spare #1 Acid Waste Header. Several alternate routings were examined and rejected owing to unfavorable hydraulics. Jetting of condensate from E-F11-2 to E-F6 through the spare pattern in the Hot Pipe Trench was also considered but not regarded favorably owing to possible difficulties in condenser vent vacuum control. In the preferred routing involving gravity flow through the Spare #1 Acid Waste Header, the header should have almost unlimited service life from the standpoint of corrosion. According to the Reference 1 flowsheet, condenser effluent should contain less than 1 molar nitric acid and should be relatively cold thermally.

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5. Removal of the present acid receiver tank, TK-F4 from the F-4 canyon position and relocation of the tank, along with its agitator, in the J-2 position. The required changes are delineated in SK-2-2783.

Special dunnage would be required to support the F-4 tank in the new position because 1) the J-2 spot is a normal column location, and 2) a 5' deep pit was provided in the cell floor. The new dunnage required would extend into the pit and furnish a level surface for the J-2 tank, slightly above normal dunnage level. The trunnion guides for the present 1A Column would be used to guide the new dunnage into position. The tank in turn would be guided into place by new trunnion guides mounted on the new dunnage.

A new pump P-J2 would be required for the J-2 tank to transfer the LBSU & HAO stream to T-H2.

Included in the list of new jumpers required for the J-2 tank are those which furnish the normal services for a standard 5,000 gallon canyon tank. Jet transfer would be provided in both directions between TK-J-2 and TK-J-3. The existing cell Fireye would be relocated on the jumper providing power to the agitator. Provision would be made for jetting out the 5' deep pit onto the cell floor so that the contents could flow into the normal floor sump (Sump S-J) for removal. This jet-out jumper would be supported off a nozzle on the top of the TK-J-2 and contain both the steam jet and weight factor piping for the pit sump. A mike would be provided for A-J2 and P-J2 which would be mounted on the P-J2 power jumper. A jumper would be provided for chemical addition. Necessary cold-side chemical addition piping would be provided at a later date.

The HAO stream, from #1 Organic Header, would be routed via Line No. J-046 in the Hot Pipe Trench to TK-J2 through a new jumper, containing a rotameter and control valve.

The LBSU stream from T-J4 would be routed to TK-J2 via an in-canyon jumper across the top of TK-J-3.

The LBSU & HAO stream would be pumped by P-J2 to T-U2, via lines H-160 and H-070, through a new jumper containing a rotameter and valve.

In its present three-cycle service, Tank TK-F4 functions as a receiver for T-F5 absorber acid; acid batches are jetted into tank TK-F3 for sampling, following which the sampled acid is pumped to Tank TK-U5, the feed tank for the Vacuum Acid Fractionator. Following startup of the 293-A Facility, thirty percent nitric acid solution recovered from dissolver off-gas would be pumped batchwise into Tank TK-F3, to be blended with 20 percent acid which drains into the tank continuously from T-F5. Under two-cycle operation, an increment of acid from the 293-A Facility could be added to each TK-F3 batch at the start of the filling cycle, to assure uniformity in the strength of acid pumped batchwise to the Vacuum Fractionator and to permit adequate sampling of 293-A acid for radioactivity through the use of the present TK-F3 gamma monitor. The incentive for replacement of TK-F4 and its agitator in the J-2 position is a savings of about \$30,000 required otherwise for new equipment.

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Two other alternates to the tank TK-F4 shift which were considered were 1) the use of a contaminated tank, TK-J5, in the J-2 position and 2) the use of a spare 1,800 gallon E-1 tank. The former J-5 tank would have insufficient surge volume both for normal operating control and for backflow from the HA Column in the event of pump failure. The spare E-1 tank could not be employed owing to space limitations on the top of the tank to permit installation of both a pump and an agitator.

The two new jumpers between T-F5 and TK-F3 shown in SK-2-17637 for overflow and jet-out of T-F5 should be routed, if possible, close to the canyon wall to allow future use of the F-4 position for storage of contaminated equipment.

6. Final processing of the 2BP stream. Details on the Prototype Continuous Anion Exchange Unit (Columns XA and XC and XAF Feed Tank) and on the Prototype XCP Concentrator, which are required in accordance with the Reference 1 flowsheet for decontamination and concentration of the 2BP stream, do not appear in SK-2-17637. The above items, including process tie-ins to solvent extraction, are entirely within the realm of the prototype development study and are not considered as a part of a new project for the two-cycle conversion.
7. Use of other major Purex equipment. The function of the remaining Purex equipment not delineated above, including head-end equipment, extraction columns, concentrators, run-down tanks, etc. would be the same under two-cycle operation as at present under three-cycle operation.

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APPENDIX B
Limitations of Present Purex Equipment In Two-Cycle Operation

Limitations of present Purex equipment and services in two-cycle operation, in accordance with the Reference 1 flowsheet, are presented in Table I.

With the exception of the present HA Column, which is to be replaced under Project CG-742, and the present T-H3 Column which is unsuited for HS Column service, the remainder of the major Purex equipment is considered adequate for a 2.75 capacity factor, the primary capacity objective of the two-cycle conversion. All concentrators are considered adequate for 4.0 capacity factor operation. Plant tests would be required to define absolute peak concentrator capacities.

Flooding data used to establish peak solvent extraction column capacities are not exact. The range of capacity limitations of the columns which appear in Table I are based on extrapolations of pilot plant flooding data; confirmatory capacity tests are required on present columns. Minor changes in flowsheet, in column L/V ratio, and in pulse frequency may permit increased extraction column capacity.

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Item No.	Item	Equipment No.	Capacity
1.	2A Column	T-L1	
2.	1C Column	T-J7	
3.	1BX Column	T-J6	
4.	1BS Column	T-J4	
5.	Raw Water Supply		
6.	Centrifuge Catch Tank	TK-E5	
7.	2E Column	T-K3	
8.	Dissolvers, A-B-C	Tks. A-3, B-3, C-3	
9.	1CU Concentrator	E-J8-1	
10.	Waste Concentrator Condenser	E-F11-2	
11.	In Canyon Dissolver Off-Gas System	A-B-C	
12.	Acid & Iodine Recovery Facility	293-A	
13.	2D Column	T-K2	=
14.	HA Column	T-H2	=
15.	HS Column	T-H3	
16.	Plant Air		Ade
17.	UNH Lag Storage		Ade
18.	10 Column	T-G2	
19.	20 Column	T-R2	
20.	Demineralized Water		
21.	Waste Tank Farm		Ade
22.	Cribs		Ade
23.	Other Major Utilities		Ade
24.	Waste Concentrator	E-F11-1	
25.	Acid Concentrator	E-F6	
26.	1CU Concentrator Condenser	E-J8-2	
27.	2EU Concentrator	E-K4-1	
28.	HNO ₃ Absorber Condenser	E-F5	
29.	HNO ₃ Absorber	T-F5	
30.	2EU Concentrator Condenser	E-K4-2	
31.	Centrifuges, A-B	GE-2-4	
32.	2B Column	T-L2	
33.	Vacuum Fractionator	T-U6	
34.	10 Centrifuges, A-B	G-G3-4	

APPENDIX B - TABLE I
LIMITATIONS OF PRESENT PUREX EQUIPMENT, SERVICES AND OTHER
FACILITIES IN TWO-CYCLE OPERATION

<u>Limiting</u> <u>Capacity Factor</u>	<u>Limitation</u>	<u>Comments</u>
2.75-4.0	Column Flooding	Further data required to establish 2A Column capacity.
3.2	Column Flooding	
3.2 -3.9	Column Flooding	
3.5 -4.1	Column Flooding	Detailed study is necessary to determine the need for additional pumps for 4.0 C.F.
3.5	Overall	
3.5	Overall Cycle	
3.7	Column Flooding	Series Operation of TK-E5-E6. Capacity could probably be improved if contents of TK-E5 were pumped to TK-E6 prior to receipt of analysis. C.F. for parallel operation of Tks. E5 & E6 is 5.0.
3.7	Overall Cycle	
3.8	Tower Loading	
3.9	Pressure Drop - Vapor Side	Installation of slug charging chutes would permit increase to about 4.1 C.F.
~4.0	Downdraft Absorber	
4.0	Pressure Differential	
4.0	Overall	Downcomer velocity is limiting. Maximum allowable downcomer velocity may be increased by further studies.
>4.0	Column Flooding	
or >4.0	Column Flooding	
or >4.0	Column Flooding	To be placed in service shortly.
uate at 4.0		
uate at 4.0		
4.0 -5.0	Column Flooding	New column will be installed on a separate project.
4.0 -5.0	Column Flooding	
>4.0	Overall	
uate at 4.0		New cartridge required for 4.0 C.F.
uate at 4.0		
uate at 4.0		
4.2	Concentrator Heat Transfer	At 4.0 C.F. and 10.0 MW/T, minimum slug cooling time of 84 days required prior to dissolution.
4.3	Concentrator Heat Transfer	
4.3	Condenser Heat Transfer	
4.4	Tower Loading	Crib replacement is not considered from budget standpoint as a function of Purex capacity.
4.7	Condenser Heat Transfer	
4.7	Tower Flooding	
4.7	Overall	Downcomer velocity is limiting. Maximum allowable downcomer velocity may be increased by further studies.
>> 4.0		
4.0 -6.0	Column Flooding	
5.1	Reboiler Heat Transfer	Based on Lummus <u>design</u> criteria. Increased capacity can probably be obtained.
5.5	Overall	
		Based on 80% operating time for both units and one minute hold-up time.

(Cont'd Appendix B - Table I)

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<u>Item</u> <u>No.</u>	<u>Item</u>	<u>Equipment No.</u>	<u>Li</u> <u>Capac</u>
35.	Vacuum Fractionator Condenser	E-U6-1	
36.	20 Centrifuges, A-B	G-R3-4	
37.	HAF Make-Up Tank	TK-E6	
38.	3WW Concentrator Condenser	E-H4-2	
39.	3WW Concentrator	E-H4-1	

<u>Limiting ity Factor</u>	<u>Limitation</u>	<u>Comments</u>
5.8	Condenser Heat Transfer	Based on Lummus <u>design</u> criteria. Increased capacity can probably be obtained.
6.2	Overall	Based on 80% operating time for both units and one minute hold-up time.
6.3	Overall Cycle	See Item No. 6 above.
8.4	Condenser Heat Transfer	
8.7	Tower Loading	Downcomer velocity is limiting. Maximum allowable downcomer velocity may be increased as a result of further studies.

DECLASSIFIEDAPPENDIX CMinor Equipment Required For Two-Cycle Conversion

Table II presents an overall summary of the flow limitations of present Purex routings under proposed two-cycle flow. Present routings and instrumentation were examined to assure that flows at 2.75 capacity factor could be handled under two-cycle operation. Where present control instrumentation was found to be limiting below 2.75 capacity factor, it was replaced with instrumentation designed for 4.0 capacity factor. The control valves, rotameters, jets, pumps, etc. which appear in Tables II and III have therefore been specified for 4.0 capacity factor under the Reference 1 flowsheet.

Table III presents a list of the new in-canyon jumpers and spares which are required for the two-cycle conversion, in accordance with SK-2-17637 and SK-2-2783. The bulk of the jumpers are required to establish new process routings. Other jumpers, containing control instrumentation, require replacement because of inadequate capacity for two-cycle flow rates.

Table IV presents a list of the new cold-side instrumentation required in connection with increased stream flows under two-cycle operation.

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APPENDIX C - TABLE II
ESTIMATED LIMITATIONS OF PUREX ROUTINGS FOR
TWO-CYCLE OPERATION

<u>Stream</u> <u>Designation</u>	<u>(1) Phase II</u> <u>Relative Flow</u>	<u>(2) HW #4</u> <u>Relative Flow</u>	<u>Ratio of</u> <u>Flow Per Unit</u> <u>of Uranium</u> <u>(1.112 (1)/(2))</u>	<u>Estimated</u> <u>Capacity Factor</u>
HAF	75	100	0.834	3.30
LBSU	32	-	-	- **
3WB	23.7	-	-	-
HAX	333	405	0.914	3.00
HAW	142	158	0.999	2.75
HAP	413	417	1.101	2.50*
HAO	33	-	-	- **
ESR	57	-	-	- *
HSS	56	-	-	-
HSP-1BXP	410	-	-	- *
LBX	25	30	0.927	2.97
LBU	407	418	1.083	2.54*
LBXP	26	31	0.933	2.95
HNO ₃ to LBXP	4.4	0	-	-
LBSF	30.4	31	1.090	2.52*
LES	31	25	1.379	1.99*
LBP	30	31.5	1.059	2.57*
NaNO ₂ to LBP	1.3	3.5	0.413	6.66
2AF	31.3	56	0.622	4.42
1CX	407	521	0.869	3.16
1CW	397	406	1.087	2.53*
1CU	418	533	0.872	3.15
1UD	320	447	0.796	3.45
1UC	88.8	86	1.148	2.40*
Fe(SA) to 1UC	0.6	0.6	1.112	2.47*
2DF	89.4	100	0.994	2.77
2DS	33	35	1.048	2.62*
2DIS	36	35	1.144	2.40*
2DX	345	370	1.037	2.65*
2DU	357	382	1.039	2.65*
2DW	150	158	1.056	2.60*
2EX	357	476	0.834	3.30
2EW	345	370	1.037	2.65*
2EU	368	488	0.839	3.28
2UD	305	410	0.827	3.33
2UC	63.8	78.1	0.908	3.03
2AS	3.75	7.2	0.579	4.75
2AX	7.5	11	0.758	3.63
2AP	7.5	11	0.758	3.63
2AW	33.8	63.2	0.595	4.62
2BX	3.0	5	0.667	4.12
2BW	7.5	11	0.758	3.63
2BP	3.0	5	0.667	4.12
XAF	3.0	-	-	-
XAS	0.31	-	-	-
XAIS	0.43	-	-	-

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Stream Designation	(1) Phase II Relative Flow	(2) HW #4 Relative Flow	Ratio of Flow Per Unit of Uranium (1.112 (1)/(2))	Estimated Capacity Factor
XAW	3.74	-	-	-
XAP	0.09	-	-	-
XCS	0.31	-	-	-
XCX	0.46	-	-	-
XSW	0.28	-	-	-
XCW-XAX	0.09	-	-	-
XCP	0.49	-	-	-
XPD	0.61	-	-	-
XPC	0.163	-	-	-
H ₂ O to HAW	230	0	-	-
1WF	374	158	2.632	1.04*
2WF	369	617	0.665	4.14
1WW	5	15	0.371	7.41
AAF	367	594	0.687	4.00
2WW	2	23.2	0.096	28.65
AAR	70	-	-	-
AAD	350	445	0.875	3.14
AAA	87.2	190	0.510	5.39
647 HNO ₃	36	-	-	-
UO ₃ HNO ₃	21	-	-	-
AFF	144	190	0.843	3.26
AFR	39.5	-	-	-
AFD	132	108	1.359	2.02*
AFA	51.7	82	0.701	3.92
3WF	188	-	-	-
3WD	166	-	-	-
10B	6.2	-	-	-
10S	0.5	40	0.014	196.43
10R	397	270	1.635	1.68*
100	369	811	0.506	5.43
20F	352	370	1.058	2.60*
20S	5.9	40	0.164	16.77
20R	352	370	1.058	2.60*
200	353	370	1.061	2.59*
10F	397	811	0.544	5.06
10W	6.7	40	0.186	14.78

*Streams having possible capacity limitations (two-cycle flowsheet at capacity factor, 2.75) were inspected for limiting instrumentation. New instrument requirements appear in Table III.

** Combined in TK-J2.

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REQUIRED NEW MINO

No.	Stream Designation	Type of Jumper	New Or Existing Routing	Hot Pipe Trench Line No.	Connect
1	1BSU & HAO	Proc. Inst.	New	H-160-3"P	P-J2 to J
2	" "	Air to DOV	New	-	J-G161 to
3	" "	Elec. to Rota.	New	-	J-G166 to
4	" "	Process	New	H-160-3"P	H-T4 to H
5	" "	Process	New	H-070-2"P	H-T44 to M
6	HSR	Proc. Inst.	New	H-190-3"P	H-T18 to M
7	"	Air to DOV	New	-	H-G29 to I
8	"	Stm. to Jet	New	-	H-G30 to J
9	"	Process	New	H-190-3"P	H-T30 to M
10	1BS	Proc. Inst.	Existing	J-104-2"P	J-T50 to M
11	HAO	Proc. Inst.	New	J-046-2"P	J-T82 to M
12	"	Air to DOV	New	-	J-G144 to
13	"	Elec. to Rota.	New	-	J-G156 to
14	1WF	Proc. Inst.	Existing	F-105-2"P	F-T126 to
15	2DW	Proc. Inst.	Existing	K-042-3"P	K-T48 to M
16	HS Col. Bottom Interface Control	Proc. Inst.	New	-	H-G43 to M
17	3WB	Proc. Inst.	New	H-158-3"P	P-J1 to H
18	"	Air to DOV	New	-	J-G182 to
19	"	Elec. to Rota.	New	-	J-183 to R
20	"	Process	New	H-158-3"P	H-T40 to M
21	HSP-1BXP	Process	New	H-055	H-T32 to M
22	"	Process	New	H-055	J-T68 to M
23	3WF	Process	New	G-352-3"P	H-T7 to No
24	"	Process	New	G-352-3"P	G-T15 to G
25	"	Process	New	G-349-3"P	G-T48 to G
26	1WD	Process	New	F-775-3"P	F-T88 to No
27	"	Process	New	F-687-4"P	F-T88 to No
28	TK-J1 Empty Out	Process	New	Hdr. #7707	F-T131 to
29	"	Stm. to Jet	New	F-632-4"P	Hdr. #7707
30	1BXP	Process	New	J-042-3"P	J-T77 to M
31	"	Stm. to Jet	New	-	J-G167 to
32	T-F5 Jet Out	Process	New	J-159-2"P	J-T46 to M
33	T-F5 Overflow	Process	New	-	J-G89 to J
34	Coil Inlet	Service	New	-	F-G 225 to
35	TK-J2	Service	New	-	T-F5 Nozz.
36	Sampler TK-J2	Proc. Splr.	New	-	T-F5 Nozz.
37	Agitator	Service-Elec.	New	-	J-G139 to
38	TK-J2 & Fire-eye	Service-Elec.	New	-	J-G141 to M
39	Temp. TK-J2	Service-Elec.	New	-	J-G142 to
40		Service-Elec.	New	-	J-G151 to M

APPENDIX C - TABLE III
IN-CANYON EQUIPMENT FOR TWO-CYCLE OPERATION AT 2.75 CAPACITY FACTOR

Items	Number of New Connector Heads Required								Rated C _v For New D.O.V.	New Rotameter		New Jet Spec. No.	Other
	Process (M)		Process (F)			3-1/2" P		Elec.		Range G.P.M.	ΔP Max. In. H ₂ O		
	2"	3"	2"	3"	4"	M.	F.	M.	F.				
T87			1	1		1		1		5.5	1.5 to 15	40	
DOV							2						
Rota.									2				
T5			1	1									
Nozz.(V) T-H2			2										
Nozz.(F) T-H3 1			1	1		1				10		J-H3-1	
DOV							2						
Jet			2										
Nozz.(A) T-H2			1	1									
Nozz.(G) T-J4			2			1		1		1.77	0.72-7.2	30	
Nozz.(M) TK-J2			1		1	1		1		1.63	0.76-7.6	30	
DOV							2						
Rotameter									2				
Nozz.(S) TK-F7			2							25	8.7-87	35	
Nozz.(N) T-K2				2		2				25.7	3.45-34.5	40	1 Splr.
Nozz.() T-H3				1				1					
T8			1	1		1		1		1.60	0.55-5.5	30	
DOV							2						
Rotameter									2				
Nozz.(U) T-H2			1	1									
Nozz.(K) T-H3				2									
Nozz.(M) TK-J3				2									
Nozz.(Z) E-H4-1				2									
T17				2									
T51				2									
Nozz.(D & E) E-F11-2				2	1								
Nozz.(BB) E-F6			1		1								
Nozz.(W) TK-J1				2								J-J1-1	
Jet			2										
Nozz.(B) T-J4 1			2										
Jet			2										
Jet													
F) to TK-F3 Nozz.(A)			2	1									
G) to TK-F3 Nozz.(W)			1	1									
Nozz.(B) TK-J2			1	1									
Nozz.(C) TK-J2							2						
-J2									2				
Nozz.(D) TK-J2				1					1				

(Cont'd Table III)

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<u>No.</u>	<u>Stream Designation</u>	<u>Type of Jumper</u>	<u>New Or Existing Routing</u>	<u>Hot Pipe Trench Line No.</u>	<u>Connect</u>
38	Sump, J2	{ Process Instrument Instrument	New	-	{ J-G-152 }
39			New	-	{ J-G-153 }
40	WF & Splr., TK-J2		New	-	J-G-155 t
41	Elec. Pump TK-J2	Service	New	-	J-G-154 t
42	Chem. Add. TK-J2	Service	New	-	J-G-157 t
43	Vessel Vent, TK-J2	Service	New	-	J-T84 to
44	Coil Outlet, TK-J2	Service	New	-	J-T69 to
45	TK-J3 to TK-J2	Process (Jet)	New	-	Nozz.(J), TK-J2 to
46	TK-J2 to TK-J3	Process (Jet)	New	-	Nozz.(U), TK-J3 to
47	1BSU }	Process	New	-	Nozz.(H), TK-J2
48	1BSU }	Process	New	-	(Via TK-J jumpers i

Total Connectors Required Exclusive of connectors for spare exclusive of connectors to seal off nozzles used for three-c

ions	Number of New Connector Heads Required								Rated C _v For New D.O.V.	New Rotameter		New Jet Spec. No.	Other	
	Process(M)		Process(F)			3- $\frac{1}{2}$ " P		Elec.		Range G.P.M.	Δ P Max. In. H ₂ O			
	2"	3"	2"	3"	4"	M.	F.	M.						F.
to Floor and														
Nozz.(E), TK-J2			1	1			1					J-SJ-2		
Nozz.(F), TK-J2				1			1							
P-J2									2					
Nozz.(G), TK-J2			1	1										
Nozz.(L), TK-J2			1		1									
Nozz.(N), TK-J2			1	1										
TK-J3 to Nozz.(V), J-G138			1	2								J-J3-1		
TK-J2 to Nozz.(K), J-G148			1	1	1							J-J2-1		
T-J4 to Nozz.(W), 1			1	1	1									
3) 2 separate in canyon				2										
jumpers and cycle routings. 2	1	33	37	5	7	12	5	11						
		(14V)	(18V)	(3V)		(5V)								
		(19H)	(19H)	(2H)		(7H)								

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TABLE IV
REQUIRED NEW MINOR COLD SIDE EQUIPMENT FOR
TWO-CYCLE OPERATION AT 2.75 CAPACITY FACTOR

<u>Stream Designation</u>	<u>2DS</u>	<u>2DIS</u>
<u>Process Solution</u>	Demin. H ₂ O	Demin. H ₂ O
<u>Line Number</u>	K-056	K-166
<u>Instrument</u>		
<u>Type</u>	D.O.V.	Rotameter
<u>Number</u>	K2-6	FT-K2-2
<u>Range, GPM</u>	-	0.63 - 6.3
<u>Rated C_v</u>	2.93	-

APPENDIX C - SPECIFICATION OF NEW JETS

Item No. (Flow Diagram Symbol)	J-J1-1	J-J2-1	J-J3-1	J-SJ-2
Service	Jet Out	Jet Out	Jet Out	Sump Jet Out
Location	TK-J1	TK-J2	TK-J3	J2 Sump
OPERATING CONDITIONS				
Fluid	3WB	LBSU / HAO	HSP - LBXF	Sump Fluids
Corrosive Compounds	40% HNO ₃	Dilute HNO ₃	Dilute HNO ₃	Dilute HNO ₃
Operating Temperature, °F	122	95	104	75-100
Design Temperature	185	150	150	150
Steam Pressure, psig	90	90	90	90
Back Pressure, psig (Min. Discharge Pressure)	* 12.5	2.0	2.0	1.0
Design Pressure, psig	150	150	150	150
Suction Head at Norm. Flow, Ft.	-16	-16	-16	-10
Suction Head at Max. Flow, Ft.				
Suction Head at Min. Flow, Ft.				
LIQUID				
Norm. Flow at Oper. Cond., gpm	75	75	75	75
Devia. From Norm. Flow, Norm. Plant Oper.	Batch Transfer	Batch Transfer	Batch Transfer	Batch Transfer
Specific Gravity at Oper. Cond.	1.25	0.87	0.96	0.9 to 1.25
Viscosity at Oper. Cond., cp Approx.	1.0	1.5	0.85	0.85 to 1.5
Vapor Pressure at Oper. Cond., psia Approx.	1.1	0.6	1.0	0.6 to 1.1
GENERAL				
Line Size, Inches	2	2	2	2
Jumper				
Special Requirements	Remote	Remote	Remote	Remote

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* 3" line size required for routing in Hot Pipe Trench.

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(Cont'd Appendix C)

Item No. (Flow Diagram Symbol)	J-H3-1
Service	HSR
Location	H-Cell
OPERATING CONDITIONS	
Fluid	UNH Solution
Corrosive Compounds	HNO ₃
Operating Temperature, F	140
Design Temperature	200
Steam Pressure, psig	* 90
Back Pressure, psig	11.23 Max. 9.55 Min.
Design Pressure, psig	150
Suction Head at Norm. Flow, Ft.	5.2 (Pos.)
Suction Head at Max. Flow, Ft.	5.2 (Pos.) **
Suction Head at Min. Flow, Ft.	0
LIQUID	
Norm. Flow at Oper. Cond. Gpm	9.9
% Devia. From Norm. Flow, Norm. Plant Oper.	40, -75
Specific Gravity at Oper. Cond.	1.2
Viscosity at Oper. Cond., cp	1
Vapor Pressure at Oper. Cond., psia	2.7
GENERAL	
Line Size, Inches	2
Special Requirements	Remote

* 60 psig minimum motive steam pressure.

** Maximum allowable positive suction head at indicated flow.

NOTE: Flow is controlled by throttling upstream of jet. To insure necessary system flow rangeability, jet supplied must meet both maximum and minimum conditions noted. The variation in jet motive steam pressure allowed is to permit jet manufacturer to fulfill these specifications.

APPENDIX C - SPECIFICATION OF NEW PUMPS

PROCESS PUMP SPECIFICATIONS

Location - J Cell
Service - 1 BSU / HAO from TK J-2 to T-H2
Item - P-J2
Type - Deep-Well Turbine
Driver - TEFC Motor*
Installation - Vertical

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Required Performance

Liquid Pumped	1BSU / HAO
Total Liquid Rate, Gpm @ C.F. = 4.0	11.2
Pumping Temperature, °F	95
Liquid Specific Gravity	0.87
Liquid Viscosity, Cp	2
Suction Conditions	
Pressure, psig	0
Maximum pressure, psig	9.8
NPSH available, Ft.	25
Discharge Conditions (referred to suction elevation)	
Pressure, psig	22.6
Maximum pressure, psig	36.9
Hydraulic Conditions	
Differential Pressure, psi	22.6
Differential pressure, Ft. pumped liquid	60.1
Maximum differential pressure at shutoff, psi	27.1
Hydraulic horsepower	1.48

* Motor shall be non-overloading for full capacity range of pump.

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CONSTRUCTION

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Pump must meet Specification HWS-5522 for canyon pumps.

Design Pressure, psig	100
Design Temperature, °F	150
Connections	2" Remote male
Process	32" O.D. Remote Flange (23" I.D.)
Setting Height	9' 2-3/4" ($\neq$ 0", - $\frac{1}{2}$ ")
Purex Pump Std. Group No.	1

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APPENDIX D

Cost Estimate

A. Direct Costs

1. Mechanical	
a. Spare HA Column, complete	\$ 65,000
b. Conversion of T-H3-O.S. into new HS Column	8,500
c. Spare HS Column	52,000
d. Storage Boxes	67,300
e. Jumpers	52,700
f. Minor Equipment	16,500
2. Electrical	2,200
3. Instrumentation	<u>12,000</u>
4. Semi-Total Direct Construction Cost	\$276,200
B. G. E. Forces Indirect Costs	42,300
C. Construction Engineering	19,000
D. Project Startup	10,000
E. Contingencies at 25%	83,900
F. General Overhead at 5%	<u>21,600</u>
G. Total Construction Costs	\$453,000
H. Total Design Cost	82,000
I. Total Project Cost	\$535,000

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END

**DATE
FILMED
11/10/1993**