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236-Z CANYON UTILIZATION STUDY

D. R. Dixon

March 8, 1977

PREPARED FOR THE U.S. ENERGY RESEARCH AND DEVELOPMENT
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D. R. Dixon

Plutonium Processing Section
Operations Department
Production and Waste Management Division

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The accompanying document, ARH-CD-908, "236-Z Canyon Utilization Study", is submitted in response to inquiries as to the available space for new canyon equipment.

The purpose of this document is to identify the new pieces of equipment, show how they fit into the flowsheet, and locate them in the canyon. The recommendations made are based on a consensus of opinion between Operational Process Engineering and Plutonium Processing, both having signed off below. Continued operation of the present solvent extraction processes is assumed.

DRD:j1

APPROVED BY:

CTB *[Signature]* 3 17 77
Manager - Operational Process Engineering Date

[Signature] *R. B. Gelman* 3-17-77
Manager - Plutonium Processing Date

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Introduction

The 236-Z canyon contains equipment for repurification of plutonium and recovery of plutonium from scrap material. To meet production requirements of Fast Flux Test Facility/Clinch River Breeder Reactor oxide with the existing plant, several new pieces of equipment will be needed in the future. More storage space and a better accountability system are needed to support this increased production. The available canyon space needs to be utilized to its fullest in order to accommodate the new equipment. The purpose of this document is to identify the new pieces of equipment, show how they fit into the flowsheet, and locate them in the canyon.

Summary and Conclusions

There are several new pieces of equipment and tankage replacements needed in the near future. These include:

- A new plutonium product concentrator
- An organic removal system
- A new tank for better material accountability
- Stainless steel replacement tanks

To accommodate this equipment, minimal rearrangement of existing equipment is necessary. The current plutonium product concentrator needs to be replaced because of lack of throughput capacity. Several tanks will need replacement due to corrosion problems. This equipment can be located where the existing equipment is now. The new organic removal system and material accountability tank will be located on the east side of the canyon. By removing the tank 31/41 assembly from the canyon, as it is no longer used, and moving Tank 26 above Tank 25 (see Figure A4), this new equipment can easily be situated. One of the slag and crucible dissolvers could be removed if additional space is needed on the east side of the canyon, as one dissolver will be adequate to handle future inventory.

Discussion

Present Canyon Equipment

The equipment in the 236-Z canyon is used to separate plutonium from various plutonium-bearing substances to produce a relatively pure plutonium nitrate solution. Solids containing plutonium are dissolved or leached in the slag and crucible dissolvers and miscellaneous treatment processes. Plutonium received in a liquid form is concentrated in the filtrate evaporator if necessary. These solutions go to the solvent extraction facility for primary recovery of plutonium. The aqueous waste is routed to the waste treatment columns for recovery of residual plutonium and americium. The plutonium nitrate product from solvent extraction goes to the product concentrator before

loading out. Subsequently, the nitrate product is used for feed in the plutonium conversion lines. A more detailed process and equipment description is included in Appendix A.

New Equipment

Plutonium Product Concentrator

The capacity of the existing product concentrator is limiting the purification of plutonium from rich feed sources such as the FFTF and CRBR programs. A new product concentrator is needed if the production requirements are to be met for these programs in the early 1980's and allow sufficient time for scrap recovery. Significant reduction in the scrap inventory is a primary goal at this time. Improved operational control and product quality would result from these changes while more than doubling the 1976 throughput capability. The present thinking is to simply replace the existing falling-film evaporator with one of increased capacity. Vacuum vaporization may offer a more economic resolution, but such an operation remains to be developed.

The existing product concentrator and associated feed and receiver tanks are located on the west side of the canyon. They occupy Sections WR, WS, and the two lower penetrations of WT (see Figure A2). Due to limited space on the west side of the canyon, the new concentrator and related tankage would have to occupy the same location as the old system as shown in Figure I. The present feed tank (TK-42) and receiver tanks (Tanks 45 and 46) are considered sound and should be used with the new concentrator.

Organic Removal System

An aqueous waste rework digester or other organic removal system is required to remove waste treatment organic and its degradation products from miscellaneous low plutonium feed for the solvent extraction system. The aqueous solution collected in Tank 16 normally includes product from the filtrate evaporator, canyon floor, access hood solutions, and rework solution from waste treatment. Before reaching Tank 16, most of the solution has been in contact with both the solvent extraction and waste treatment organics. If the entrained waste treatment organic is not removed prior to rework into solvent extraction, severe production problems will occur.

The solution in Tank 16 is used to dilute feed rich in plutonium before going to feed makeup. Solvent extraction feed can contain 50 to 75 percent Tank 16 solution. If waste treatment organic is introduced into the solvent extraction system, it causes low product recovery efficiency and plugging of the organic treatment

FIGURE 1 PROPOSED WEST SIDE 236-Z

columns and piping due to precipitation of plutonium fluoride. Potentially high waste losses would result with organic cleanup nearly impossible. Once the waste treatment organic is introduced into the system it remains there causing continuous operating problems. A complete plant shutdown occurred in 1974 due to these problems. Another shutdown of this nature could result in failure to meet production commitments.

Laboratory work is underway to find a method to separate the organic from the aqueous and recover the plutonium in the organic phase. The equipment design will follow. After the unused column and tank, Tank 31 and Tank 41, respectively, are removed from the east side of the canyon, Sections EE and EF will be empty. In addition, if one of the slag and crucible dissolvers were removed, three canyon sections would be available for the organic removal system (see Figure II).

Feed Measurement Tank

To improve material accountability and provide increased storage space, a new feed measurement tank will be installed. This tank (TK 145) will be used for miscellaneous treatment solution storage and measurement prior to entering solvent extraction feed makeup. It will be a four bank 220 liter tank. Two cylinders are independent 55 liter measurement tanks while the remaining two cylinders form a 110 liter storage tank.

Tanks 25 and 26, now used for miscellaneous treatment solution storage, can be used for either miscellaneous treatment or slag and crucible storage after the new tank is installed. Tank 145 will need one canyon section on the east side. In order to accommodate it, Tank 26 will be moved above Tank 25 and the new tank placed in Section EM (see Figure II).

Tankage Replacements

Several tanks in the canyon have either failed beyond repair, are no longer used because of flowsheet changes, or are suspected leakers. Due to the corrosive nature of the solution involved in the solvent extraction system, many of the stainless steel tanks leak solution to the canyon floor. Most of these tanks are original equipment.

Tank 41 has failed beyond repair and along with the unused CR column (TK-31), which is on the same dunnage, has been moved to the east side of the canyon. The Tank 41 function has been replaced by Tank 28, which is not required for normal operation. A stainless steel tank will be built to replace Tank 28 on the east side of the canyon (see Figure II). The tank 31/41 assembly will be removed from the canyon and discarded. A spare 50 liter bank tank will be fabricated in the event another tank should fail. Two 200 liter

LOCATION FOR ORGANIC
REMOVAL SYSTEM

spares already exist, but one will be used to replace Tank 39 which has been a chronic leaker.

Slag and Crucible Dissolvers

Presently, there are two slag and crucible dissolvers, two associated off-gas scrubbers and one receiver tank, for processing slag and crucible material. When both dissolvers are operating, feed solution for solvent extraction is usually produced at a rate greater than the solvent extraction facility can handle. Only one dissolver is necessary to produce a sufficient quantity of feed. The current inventory of slag and crucible, plutonium aluminum alloy, and incinerator ash could be processed using one dissolver prior to receiving additional scrap. Removing one of the dissolvers would be advantageous as space in the canyon is rapidly diminishing. Placing the equipment discussed in this document is not contingent upon removing a dissolver if the organic removal system can be fit into two canyon sections. The addition of any more equipment may necessitate a move of this nature. The assumptions and results that led to these conclusions are shown in Appendix B.

Tank 08 is the older of the two dissolvers and should be the one that is removed. The other dissolver (TK-124) could be moved to canyon Section ED where Tank 08 is now located if additional space for waste treatment storage is needed (see Figure II). This would depend upon the number of sections needed for the organic removal system. The two dissolvers can be interchanged without changing the hood piping. With only one dissolver operating, one scrubber would be adequate if space for other equipment is needed in Sections EG or EH.

APPENDIX A

Solvent Extraction

The solvent extraction (reclamation) facility separates the plutonium from the nitrate salt impurities to produce a relatively pure plutonium nitrate solution. The feed consists of an impure plutonium nitrate solution that can be produced by dissolving solid compounds containing plutonium by various processes (Miscellaneous Treatment, Slag and Crucible Dissolution). Briefly, the process equipment consists of six solvent extraction columns, their associated pump tanks and appropriate feed and discharge vessels.

The solvent extraction system (see Figure A1) employs a heavy phase organic to extract the plutonium from the aqueous feed solution. This extraction takes place in the CA column (TK-32) and the aqueous waste (CAW) is routed to waste treatment. The plutonium-rich organic phase (CAP) gravity flows to Tank 120 before entering the stripping column (CC column, TK-33). Organic leaving the CC column (CCW), containing residual plutonium, gravity flows to the CO column (TK-34). Most of the plutonium-rich aqueous phase (CCP) is butted with nitric acid in Tank 36 to convert Pu (III) to Pu (IV) and is pumped back to the CA column. The remaining aqueous is routed to the product concentrator. During plutonium/uranium partitioning, the aqueous from the CC column that is not recycled gravity flows to Tank 121 before being pumped to the CP column (TK-122). Residual uranium is stripped in the CP column prior to the aqueous going to the product concentrator.

The stripped organic leaving the CC column (CCW) is treated to remove residual plutonium and degradation products before reusing it in the CA column. The CO column (TK-34) removes the trace amounts of plutonium with a dilute acid solution. Acid left in the organic is removed using water in the CU column (TK-123). The acid waste (CUU) is routed to Tank 41 before being measured in Tank 39 and discarded or recycled via Tank 16. Organic from the CU column (CUW) is pumped to the CX column (TK-69) where it is contacted with a dilute carbonate wash from Tank 70 to remove the degradation products. The carbonate solution is recycled through Tank 70, then discarded to D-5 Tank by way of Tank 40. The organic is scrubbed of entrained carbonate solution and reacidified in the OA column (TK-48) before recycling to the CA column.

The location of the solvent extraction equipment in the 236-Z canyon is shown in Figure A2. Tanks 17, 18, and 19 are used for feed makeup. Plutonium nitrate solutions from miscellaneous treatment, slag and crucible dissolvers, waste treatment or other sources are eventually routed to TK-17. Each batch of feed has various salting agents added to promote plutonium extraction, then is pumped through Tank 18 before entering the CA column. Tank 19 is normally kept empty for receiving and recycling aqueous waste from the CA column, as required. Organic to be used in the C. column is stored in Tanks 37 and 38. A dilute

FIGURE A1

CA AND CC COLUMNS **Pu-IV FLOWSHEET**

CO, CU, CX, & OA COLUMNS Pu-~~IV~~ FLOWSHEET (ORGANIC TREATMENT)

FIGURE A2 CURRENT WEST SIDE 236-Z

* SERVING AS TK 41 (WAS TK 28)

acid wash is stored in Tank 29 to scrub impurities from the plutonium-rich organic (CAP) leaving the CA column. The stripping solution (CCX) used in the CC column is stored in Tank 30.

Waste Treatment

The waste treatment facility (see Figure A3) recovers americium and residual plutonium from the aqueous waste stream (CAW) of the solvent extraction facility. The basic equipment consists of three solvent extraction columns and one feed and neutralization tank. The effluent streams include a plutonium-rich recycle stream going back to solvent extraction, an americium nitrate product going to ion exchange for concentration and a low level aqueous waste stream.

Effective extraction of americium is dependent upon a low acidity in the aqueous waste treatment feed. The aqueous waste stream (CAW) is relatively high in acid and must be partially neutralized before use as feed. Neutralization and mixing takes place in the WM-1 tank. Plutonium and americium are coextracted into the waste treatment organic in the WE-1 column and routed to the first of two stripping columns, WS-1. The organic entering the WS-1 column is stripped of its americium by dilute nitric acid. The americium product goes to the ion exchange column while the plutonium-rich organic enters the WS-2 column. In the WS-2 column, the plutonium is stripped from the organic and recycled back to solvent extraction for recovery. The organic, stripped of americium and plutonium is washed as necessary for reuse. The waste treatment equipment is located on the east side of the 236-Z canyon (see Figure A4).

Miscellaneous Treatment

Miscellaneous treatment is the name for several operations used to prepare feed for the solvent extraction facility from various solids containing plutonium. Presently, four processes are available; oxidation of plutonium metal by burning, electrolytic dissolution, recovery of plutonium from polystyrene cubes, and leaching. The plutonium nitrate solution formed is routed to Tanks 25 and 26 (see Figure A4) for sampling before going to feed makeup.

Slag and Crucible Dissolution

Two continuous thermal siphon recirculation dissolvers (Tanks 08 and 124) were designed to process slag and crucible (S&C) fragments for use as solvent extraction feed. Slag and crucible is a mixture of magnesium oxide crucible chips, magnesium oxide sand, calcium metal, calcium fluoride, and calcium iodide produced in the process of making plutonium metal buttons. Incinerator ash, plutonium-aluminum alloy, and other approved plutonium-bearing solids may be processed through the S&C dissolvers with minor changes in flowsheet. All feed materials to the dissolvers are sealed into special untinned steel cans to facilitate charging.

FIGURE A3 WASTE TREATMENT SOLVENT EXTRACTION

FIGURE A4 CURRENT EAST SIDE 236-Z

Dissolver off-gases are vacuum transferred to two recirculating scrubbers (Tanks 10 and 12) for removal of acid fumes and iodide. Plutonium nitrate from the dissolvers goes to Tank 15 for sampling before going to feed makeup. The dissolvers, scrubbers, and receiver tank are located on the east side of the 236-Z canyon (see Figure A4).

Filtrate Concentration

The filtrate from the button line precipitation process is concentrated in the filtrate evaporator to reduce the volume of solution before going to feed makeup for solvent extraction. Rework from waste treatment, floor solutions, and other solutions needing concentration are also run through the evaporator.

Filtrate is received into Tank 20 before being pumped to the concentrator (Tank 21). Vapor from the evaporator enters a shell and tube heat exchanger (TK-22) while the filtrate flows into two concentrate receiver tanks (Tanks 23 and 24). When a full tank of concentrate is accumulated, it is sampled for accountability and eventually pumped to feed makeup. The condensate from Tank 22 is normally routed to the D-4 waste system. The location of the filtrate concentrator equipment is shown in Figure A4.

Product Concentration

Plutonium nitrate solution from the solvent extraction facility (CC column) is concentrated before loading out in PR cans. Subsequently, the concentrated solution is used as feed for the conversion lines.

Product is received in feed Tank 42 prior to entering the evaporator (TK-43). The volatile liquid passes through a shell and tube condenser (TK-44), then is recycled to solvent extraction feed makeup. Evaporator product flows by gravity from a bottom outlet to one of the parallel operated receiver Tanks 45 and 46 (see Figure A2). The product can be reconcentrated if required.

APPENDIX B

Slag and Crucible Dissolver-Removal DataAssumptions:

1. Only one dissolver will be used.
2. An average of ten weeks per year the reclamation facility will be down for maintenance.
3. An XYZ shift schedule will be followed.
4. Reclamation repurification and metal production schedules will conform to that of the Production and Waste Management Long-Range Plan, ARH-CD-776.
5. Current inventory of S&C, PuAl and incinerator ash will be processed during fiscal year 1978-1979 prior to restarting the button line.
6. The following rates for reclamation repurification were used:

<u>FY</u>	<u>Rate (Kg/Wk)</u>
1978	50
1979	50
1980	75
1981	75
1982	75
1983	75

7. No scrap will be processed in fiscal year 1977.

TABLE B1
CURRENT INVENTORY

<u>Material</u>	<u>Quantity (Lard Cans)</u>	<u>Cans/Lard Can</u>	<u>Cans</u>	<u>Rate (Cans/Hour)</u>	<u>Total Time (Hours)</u>
S & C	146	11	1606	2	803
Pu A1	148	5	740	1 1/3	555
Ash	273	6	1638	1 1/3	<u>1228.5</u>
					2586.5

TABLE B2

DISSOLVER USAGE

<u>FY</u>	<u>Plutonium For Repurification (Kgs)</u>	<u>Time For Repurification (Weeks)</u>	<u>Time For Scrap Recovery (Weeks)</u>	<u>Time Needed To Process Scrap (Hrs)</u>	<u>Percentage of Time Dissolver Must Run (Dissolver Efficiency)</u>
1977	1035	21	0	2587	37.8
1978	890	18	15*		
1979	0	0	42		
1980	930	13	29	436	12.5
1981	500	7	35	132	3.1
1982	1300	18	24	126	4.4
1983	1000	14	28	441	13.1

* Reclamation will run in sequence with the oxide line during the first two quarters of fiscal year 1978, thus only 15 weeks will be available for scrap recovery.