1 of 1

NOTICE

**CERTAIN DATA
CONTAINED IN THIS
DOCUMENT MAY BE
DIFFICULT TO READ
IN MICROFICHE
PRODUCTS.**

DECLASSIFIED

HW-31182

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Distribution:

RECORD CENTER FILE

1. [redacted]
2. RS Bell
3. WG Browne
4. VR Chapman
5. OF Hill
6. WN Mobley
7. T Prudich
8. 700 Files
9. 300 Files
10. Yellow Copy

~~This document consists of
20 pages, Not a
12 copies. Series 1~~

COPIES OF 1, [redacted]

March 18, 1954

O. F. Beaulieu
Process Sub-Section

BISMUTH PHOSPHATE PROCESS UNDER 215 MWD PROGRAM

In the Bismuth Phosphate process, 100 tons of 215 MWD uranium can be processed each month using the present equipment. The activation of equipment in spare cells, contemplated process improvements, and transfer piping changes could increase the capacity of the process by about 20%. As the program is inaugurated, dissolver and extraction sections will control productive capacity of the process and first efforts will be directed toward increasing the efficiency and flexibility of operations in these sections so that the full capacity of subsequent sections in the process can be realized.

Primarily the Bismuth Phosphate process capacity limitations are based on the amount of plutonium which can be allowed in each batch or run; however, the physical capacities of the equipment to dissolve uranium and handle the resulting dilute uranyl solutions become more limiting in the extraction step as the MWD of the uranium is lowered. When processing 215 MWD uranium, the maximum efficiencies in dissolving and extracting plutonium from the uranium metal solution will not allow the subsequent plutonium processing sections to realize their full productive capacity. To bring all portions of the process into better capacity balance, an investigation has been made of the capacity problems in the Bismuth Phosphate process and results are presented below in Table 1.

Classification Cancelled And Changed To:

DECLASSIFIED

By Authority of SE Gydesen,

CG-PR-2, 1-3-92

by DK Hanson, 2-27-92

Verified By TH BURSTON, 3-2-92

RECEIVED

JUL 10 1954

300 FILES
CLASSIFIED FILES

MASTER

DISTRIBUTION RESTRICTED TO U.S. ONLY

yes

DECLASSIFIED

HW-31182

[REDACTED]
F. Beaulieu

-2-

March 18, 1954

Dissolvers

Properly aged uranium slugs are transported from the 100 Areas in shielded cask cars and are charged to the dissolvers by an overhead crane in the 221-T Building. The two dissolvers, 3-5-R and 4-5-L, are operated in parallel, and can be charged alternately every 16-1/2 hours.

Each dissolver is charged with 3.3 tons of aluminum jacketed slugs, which are treated with caustic to remove the aluminum, and then dissolved in two 7500 pound additions of nitric acid. Total time cycle for the dissolver is 33 hours from charging to charging, which gives a theoretical capacity of 144 tons of uranium per month for the two dissolvers. In actual practice, the dissolver capacity will be about 115 tons per month because the net effect of three major variables will allow only about 80% operating efficiency.

Weather - In the past, dissolver operation has been limited by unfavorable weather conditions but present operation of the Redox Plant dissolvers is done under less rigid conditions than the rules observed at T Plant. It may be possible to approach the Redox Plant flexibility with the T Plant dissolvers but dissolver operation can still be limited by a wind direction which drives stack gas fumes into the 200 West main badge house, by rain, snow, or mist which causes localized ground contamination, or by stack gases which swirl back into the air conditioning intakes of the T Plant operating buildings.

Transportation - For maximum dissolver efficiency, the cask cars should be available for charging just as soon as the dissolver is empty and empty cars should be pulled out as soon as they are ready. Scheduling problems frequently delay cask car movements in both the 100 and 200 Areas and make charging operations very inefficient.

In the 100 Areas there are several miles distance between each Plant, and if cask cars are not ready to move on schedule the train crews must either wait out a temporary delay, or accept an assignment in some other area if the delay is expected to be longer than the round trip between two areas. When train crews must wait, the scheduled work load accumulates until it is sometimes impossible to avoid delaying deliveries to the 200 Area.

When cars are delivered to the Canyon Building in the 200 Area, it is not always possible to start the charging operation immediately; and if it seems that the delay may be longer than the time required for another train crew assignment, the train crew is rescheduled. If the train crew does not come back when charging has been started, the crane operator can only unload one car and only partially charge the dissolver.

Both the 100 Area work and the train crew assignments are based primarily on day shift work and although it is an economical method, its efficiency with regard to cask car deliveries is not very good after 4:00 PM. The 100 Areas load cask cars after 4:00 PM either on an overtime basis, or as men can be spared from the regular operating crews. The train crew work is assigned to one crew between 4:00 PM and midnight and after midnight, or on Saturdays and Sundays, the work is handled on an overtime basis.

[REDACTED]
DECLASSIFIED

DECLASSIFIED

HW-31182

HW-31182

F. Beaulieu

-3-

March 18, 1954

4. Equipment - Most of the equipment used in charging or in the dissolving operation has been in service for periods up to nine years, and it is only reasonable to expect that some equipment failures will result from the strain of handling 100 tons of uranium each month. Some of these failures will interrupt either the dissolver or charging operation and cause delay until repairs can be completed.

To increase the dissolver capacity and to guarantee continuous operation will make activation of the spare dissolver 3-5-L very desirable. Some small capacity gains could result from closer scheduling of the charging operation but regardless of how many slugs can be delivered, the ability to dissolve them will still control the productive capacity of the Bismuth Phosphate process, and loss of one dissolver would effectively cut production in half. Since the dissolvers have been in service approximately nine years, the potential for failure is high enough to use the spare dissolver 3-5-L as production insurance.

It is not anticipated that the actual dissolving operation will limit the capacity of the Bismuth Phosphate process except under very unusual circumstances; because the equivalent of 10 tons of uranium can be stored in the present metal solution storage tanks, and by keeping full storage tanks there will be quite a little operational flexibility. Low metal solution inventory combined with equipment failures or unfavorable weather conditions might cause lost productive capacity.

Storage Tanks and Batch Make-up

Metal solution from a dissolver is jetted to the 4-8 storage tank where it is held until it is properly "balanced" with water and sulfuric acid additions. The "balanced" solution contains 3.3 tons of uranium and is transferred to first the 4-7 storage tank and then to the 6-1 storage tank when it is sampled for plutonium content. Based on a plutonium batch limit and physical limitations of the equipment, calculated quantities of solution are jetted from the 6-1 to the 6-3 tank where a second sample and a reduction step prepare the metal solution for processing in the extraction step.

The capacity of the 4-8 and 4-7 tanks is adequate for holding all of the 3400 gallons of metal solution from one dissolver charge, but the 6-1 tank has a maximum capacity of 3100 gallons. This requires special precautions to prevent overflowing the 6-1 tank on a transfer from the 4-7 tank, and it decreases operational flexibility by requiring a heel in the 4-7 tank during make-up of the first batch in the 6-3 tank.

The three tanks, 4-8, 4-7, and 6-1, are agitated by means of an air sparger and considering the big differences in specific gravity between water at 1.000 and metal solution at 1.82 or more, the adequacy of the sparger in mixing these liquids is open to question. Operation of the air sparger for long periods of time has a tendency to remove contamination from the solution and make it a control problem in its gaseous state; so sparging periods are rather short on the theory that adequate mixing may occur in transferring the solution from one tank to another. 6-1-MS samples taken before and after the heel transfer from 4-7 indicate that the mixing which should have occurred is not an accomplished fact.

DECLASSIFIED

HW-31182

O. F. Beaulieu

-4-

March 18, 1954

To receive metal solution from the 3-5-L dissolver will require the installation of a transfer line from 3-5-L to the 4-8 tank. This job has been scoped and is to be completed.

To increase the operational flexibility through elimination of the 4-7 heels, to prevent the possibility of overflowing the 6-1 metal solution tank, and to eliminate the need for long sparging periods in the 4-8 and 4-7 tanks, a larger tank (now labelled the 10-1 tank) which is spare equipment will be moved to the 6-1 tank position. This tank will hold as much solution as the 4-7 tank, and is equipped with an electrically driven agitator which will give adequate mixing of the dissolver solutions prior to sampling in the 6-1 tank.

The present 6-3 batch make-up tank has a split water jacket and the tank will be replaced with a spare tank which is now stored on the 221-T Canyon deck.

With the few equipment modifications proposed, the storage tank facilities should be adequate for coping with all but exceptional problems in the metal solution transfer system.

Extraction Sections

Reduced metal solution is transferred from the 6-3 batch make-up tank to either the 7-1 or 8-1 tank of the two extraction sections. After precipitation of the bismuth-plutonium phosphate, the precipitate is separated from the solution by centrifugation and the centrifuge cake is dissolved in 60% nitric acid. The amount of nitric acid required for the cake solution determines the volume at which subsequent decontamination processing must be done.

The centrifuge effluent containing the soluble uranium salts is sampled, neutralized and complexed with bicarbonate, and then jettied to underground tanks for storage until the fission product decay will allow recovery of the uranium by the TBP process.

The extraction section time cycle is 16 hours per run when 600 MWD uranium is processed and it will be 18-1/2 hours per run when 215 MWD uranium is used. The difference in time requirements is based on the chemical addition rates and centrifugation rates used for processing the volume of metal solution associated with 300 units of plutonium. (See table below).

DECLASSIFIED

DECLASSIFIED

HW-31182

F. Beaulieu

-5-

March 18, 1954

EXTRACTION SECTION TIME REQUIREMENTS

<u>Operating Procedure</u>	<u>600 MWD Uranium</u>			<u>215 MWD Uranium</u>		
	<u>Lbs. of Solution</u>	<u>Rate</u>	<u>Time Required</u>	<u>Lbs. of Solution</u>	<u>Rate</u>	<u>Time Required</u>
Receive Metal Sol'n. In 7-1, (8-1)	11281	760 #/Min.	15 Min.	27371	760 #/Min.	36 Min.
Heat 7-1, (8-1) to 85°C	Received at 85°C.		--	Received at 85°C.		--
Add BiONO_3	117		--	286		--
Add H_3PO_4	322	7-1/4 #/Min.	45 Min.	784	17-1/2 #/Min.	45 Min.
Add H_3PO_4	322	2-1/2 #/Min.	129 Min.	784	5-3/4 #/Min.	137 Min.
Add NaNO_2 Sol'n.	139	7 #/Min.	20 Min.	339	17 #/Min.	20 Min.
Add BiONO_3	18	3/4 #/Min.	24 Min.	43	1-3/4 #/Min.	25 Min.
Cool 7-1, (8-1) to 50°C.			75 Min.			105 Min.
Centrifuge at 200 Lbs./Min.	12400	200 #/Min.	62 Min.	29800	200 #/Min.	149 Min.
TOTAL			370 Min.			517 Min.

517 Minus 370 = 147 = 2 hours and 27 minutes or 2-1/2 hours.

The two extraction sections operate in parallel at about 90% operating efficiency; so the effective time cycles for the extraction step would be about 10-1/4 hours or seventy runs per month. The plutonium content of 100 tons of 215 MWD uranium is equivalent to 67 runs per month; so the extraction sections should have just the right amount of capacity to handle 100 tons of 215 MWD uranium per month.

The amount of cake solution acid required by the 215 MWD program was experimentally determined on Runs T-54-01-F-25 and T-54-01-B-29, and it was discovered that runs should proceed at 63% volume in the decontamination sections although 49% volume runs may be possible. Data are tabulated below:

DECLASSIFIED

DECLASSIFIED

O. F. Beaulieu

-6-

HW-31182

March 18, 1954

EXTRACTION PROCEDURE USED ON RUNS T-54-01-F-25 and B-29

1. Reduction normal in 6-3.

2. Volume normal in 7-1.

3. 286 Lbs. BiONO_3

4. 340 Lbs. H_3PO_4 1st shot

Amounts required
for 215 MWD

5. 340 Lbs. H_3PO_4 2nd shot

6. 139 Lbs. NaNO_2

7. 43 Lbs. BiONO_3

T-54-01-F-25

Cake Removal

1. Add 500 # acid via scale tank.
2. Agitate 7-4 30 min. and take two samples.
3. Add 200 # acid via scale tank.
4. Agitate 7-4 30 min. and take two samples.
5. Add 200 # acid via scale tank.
6. Agitate 7-4 30 min. and take two samples.
7. Add 810 # acid to 7-1 -- spray normally.
8. Jet 330 # 7-1 to 7-2.
9. Agitate 7-4 30 min. and take two samples.
10. Jet 330 # acid 7-1 to 7-2
11. Agitate 7-4 30 min. and take two samples.
12. Jet remainder 7-1 to 7-2.
13. Agitate 7-4 30 min. and take two samples.

Total 1710 # = 63% volume +
cheating acid.

T-54-01-B-29

Cake Removal

1. Normal procedure used in cake removal, with acid weights varied.
2. Add 500 # acid to 7-2 via scale tank instead of 330.
3. Add 820 # acid to 8-1 and spray instead of 810.

Total used 1320 # = 42% Volume
+ cheating acid
4. Sampled at normal time.

The original samples were both $>.3$ g./l of turbidity. By adding 220 # of "cheating" acid, the next two samples had $<.1$ g./l. of turbidity.

DECLASSIFIED

DECLASSIFIED

W. Beaulieu

-7-

HW-31182

March 18, 1954

T-54-01-F-25

SAMPLES TAKEN DURING CAKE REMOVAL

<u>Sample</u>	<u>Lbs. Nitric</u>	<u>Added via</u>	<u>% Product</u>	<u>Appearance</u>	
7-4P-A1	300	7-2C			Broken Pipette
A2			62.16	0.2	
B-1	200	7-2C	79.92	.2	
B-2			80.69	>.2	
C-1	200	7-2C	90.35	.2	
C-2			89.19	.2	
D-1	810	7-1	92.28	<.1	
D-2	1st Shot		91.89	<.1	
E-1	2nd Shot	7-1	93.82	<.1	Regular Cake removal acid of 810 # which had been sprayed
E-2			96.53	<.1	
F-1	Remainder	7-1	101.54	<.1	
F-2			99.61	<.1	
Total	1710				63% + Cheating Acid
7-3WS			5.68		Within Limits

T-54-01-B-29

SAMPLES TAKEN AFTER CAKE REMOVAL

<u>Sample</u>	<u>Lbs. Nitric</u>	<u>Added Via</u>	<u>% Product</u>	<u>Turbidity</u>	
	300	7-2C			Normal cake removal requires 330 Lbs.
	820	7-1			Normal cake removal requires 810 Lbs.
	1st Shot				
	2nd Shot	7-1			
	Remainder	7-1			
7-4P-#1				>.3	
#2				>.3	
#1	220	7-2C	97.71	<.1	Was necessary to add 1 shot 220 Lbs. 49% Vol. + cheating acid Below Limits
#2			97.71	<.1	
Total	1540				
7-3WS			3.73		
			3.04 RS		
			Average 3.89		

DECLASSIFIED

DECLASSIFIED

HW-31182

HW-31182

F. Beaulieu

-8-

March 18, 1954

To increase the extraction section capacity, additional equipment must be made available and process modifications must be adopted.

The standard cell equipment in section 10 could be used as an extraction section if a transfer line between the 6-3 tank and the 10-1 tank and a metal waste line from the 10-3 to the 9-1 tank, were installed. Some spare equipment is available in the 221-B Building, so the major expense for this conversion would probably involve the labor and transportation phases.

Process modifications could include an investigation of problems involved in processing at higher UNH concentrations for the extraction section. Appreciable savings in time and chemicals could be realized not only in extraction, but in subsequent sections which depend on the volume determination of the extraction section if the volume of solution which is transferred, heated, cooled, and centrifuged, could be decreased. A production cost investigation of this item is being prepared.

Although many of the time consuming variables of the extraction section have been investigated, there are still a few changes that could be controlled a little more closely.

Approximately 2 hours could be saved in the extraction section time cycle if a run could be brought into the precipitator as soon as the cake removal acid has been jettied to the centrifuge, and if the cake removal procedure is shortened a little.

At present there is a line from the 7-3 to the 8-1 tank, and if a line from the 8-3 to the 10-1 tank were modified so the line went from the 8-3 to the 7-1 tank, any high waste in either of the effluent tanks (7-3 or 8-3) could be reworked in the opposite section. This would mean that a run could enter the precipitator tank before the waste analysis of the extraction section effluent on the previous run were known. By changing the cake removal procedure slightly, the run can be brought into the precipitator about 30 minutes earlier than at present, so about 2 hours of time could be saved on each run, exclusive of the time lost in reworking high wastes.

Extraction waste solutions are normally neutralized in the 9-1 tank and then jettied to underground storage tanks for fission product decay prior to hydraulic mining and uranium recovery in the TBP process.

Some storage and mining costs could be saved if a portion, or all of the 215 MWD metal waste solution could be transferred directly to the TBP feed tanks via blending operation at the UR tank farm. Transfer lines could be made available with a few jumper changes to take advantage of these savings.

Because of the volumes involved, the extraction section will be critical to productive capacity for the entire Bismuth Phosphate process. There is a possibility that as much as 10% improvement in capacity might be attained; but when a section is working at maximum capacity, there is always a danger that equipment failure will be critically important. For production insurance, it would be very desirable to activate section 10 as either a spare or an operating extraction section.

DECLASSIFIED

DECLASSIFIED

HW-31182

EW-111

J. F. Beaulieu

-9-

March 18, 1964

General Capacities

Although runs may enter the first decontamination cycle at 63% volume, every attempt will be made to reduce this to 49% volume (present standard) or to reduce the run to 49% volume before it is sent to the 224 T Concentration Building. Time cycles anticipated under the 215 MWD program are compared with present time cycles, in the table below:

BISMUTH PHOSPHATE TIME CYCLES

<u>Operational Step</u>	<u>Present Effective Time Cycle</u>	<u>215 MWD Effective Time Cycle</u>
Batch Make-up and Pretreatment	4-1/2 hours	5 hours
Extraction	8 hours	10-1/4 hours
First Decontamination - By-Product	7 hours	7-3/4 hours
First Decontamination - Product	6-1/3 hours	6-3/4 hours
Second Decontamination - By-Product	7-1/4 hours	7-1/3 hours
Second Decontamination - Product	7-1/4 hours	7-1/2 hours

Concentration Building time cycles will be the same as at present, with a maximum effective time cycle of 7-3/4 hours for any one cell.

When 215 MWD plutonium is processed at T Plant, the only recycle which will be received from the Isolation Building will be from the 215 MWD plutonium runs. To prevent contamination by plutonium produced in other plants, the PR and RC transfer cans should be separated for special T Plant usage. Based on the estimated production data a minimum of 15 PR-RC cans will be required, with 20 PR-RC cans being a more desirable total.

Operating Limits

The capacity of the Bismuth Phosphate plant will be somewhat dependent on the batch size allowed by Nuclear Safety calculations. The basis used in this report was 10% less than present limits, based on the 10% increase allowed when the MWD level was changed from 200 to 600 MWD. Calculations are being made, with some possibility that the 10% decrease may not be required.

Waste loss limits have been set up on the basis of previous limits which were used when 200 MWD uranium was being processed. The limits are tabulated below:

WASTE LIMITS - 221-T and 224-T 215 MWD PROGRAM

<u>Sample</u>	<u>Percentage of Run Upper Limit</u>	<u>Percentage of R. Lower Limit</u>
7-3-WB or 8-3-WB	0.77	0.17
13-4-BP or 16-4-BP	1.12	0.50
14-3-WB or 17-3-WB	0.26	0.10
18-4-BP	0.37	0.13
19-3-WB	0.33	0.11
A-4-MP	0.25	0.08
B-3-WB or E-1-WB	0.21	0.07
2-1-BP	0.03	0.02
2-1-WB	0.03	0.02

DECLASSIFIED

DECLASSIFIED

HW-31182

EW-1

F. Beaulieu

-10-

March 18, 1964

Cleanout Procedures Prior to 215 MWD Processing

To obtain the maximum purity of low MWD plutonium on the first runs processed through the 221 and 224-T Buildings after discontinuing the use of 600 MWD plutonium will require a cleanout of all product heels in the Bismuth Phosphate equipment.

It is proposed that four acid washes be used to remove these product heels, with each acid wash starting in a dissolver section. AW-1 will start in 3-5-R, and AW-2 will start in 4-5-L. 3000 lbs. of 60% nitric acid will be added to each dissolver and will be brought to boiling, refluxed for 15 minutes, then cooled to room temperature and sparged for a minimum of four hours. AW-1 and AW-2 will be combined in the 4-8 storage tank, diluted to 38,000 lbs. volume, sparged a minimum of 4 hours and then be transferred to 4-7 and then to 6-1, with a minimum of 4 hours sparging in each tank. The acid wash solution will be divided and reduced in the 6-3 tank for normal acid wash processing of AW-1 through the section 7 and AW-2 through the section 8 side of the parallel 221-T equipment.

Samples will be taken to determine the product picked up in each section and the information will be used to determine the agitation times required for AW-3 and AW-4, which are scheduled to follow the same pattern as AW-1 and AW-2.

The 5-9 tank has been used to settle out plutonium from high floor drainage wastes; so prior to the acid wash cleanout of equipment, a 3000 lb. 60% nitric acid flush of this 5-9 tank should be made and processed as a Kitten Run through the first decontamination cycle.

The E-4 and B-6 tanks in 224-T should be cleaned out prior to the acid wash. The acid wash material recycled from the 231 Building and processed through the E-4 and B-6 tanks must be followed by an additional cleanout.

FR-RC transfer cans used in the 215 MWD program should either be new cans or should be cans which have been thoroughly flushed and visually inspected prior to being used on the low MWD plutonium.

Special flushes may be required after AW3 and AW4 to remove heels.

Willis G. Browne

Process Control Unit

W. G. Browne:lm