1 of 1

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HW-36134
Page 1

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FROM: A. M. Platt - Process Studies *AMP*
Process Planning Unit
Chemical Development Sub-Section

200 AREA PROCESSING RATES

INTRODUCTION

Currently, two types of "feedstock"; i.e., irradiated uranium and uranium from underground storage, are processed by the 200 Areas. Future operations may add irradiated thorium as a supplementary feed material. In either case, the major portion of future feedstocks is presumed to be in the form of irradiated metal; i.e., uranium and/or thorium, resulting in an almost complete dependence of the required 200 Area processing rate on reactor power levels and metal irradiation history.

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HW-36134
Page 2

This document presents correlations by which predicted reactor power levels and production commitments for particular types of product may be easily converted to the required separations processing rates. Separations processing rates potentially resulting from low NGS plutonium and "23" commitments are given for the period through 1957.

SUMMARY

The required metal processing rates in the 200 Areas (exclusive of the U.R. Plant) are established by the rate of metal discharge from the reactors. These rates are, in turn, established by the reactor power level (MW), integrated exposure of the metal (MWD/T), and loadings of poisons such as thorium, lithium, etc.

The following tabulation itemizes the required uranium and thorium slug processing rates as a function of assumed product commitments and recent "best" estimates of anticipated reactor power levels. Power in excess of that required to meet the low NGS and "23" commitments is utilized to produce 800 MWD/T plutonium.

220 MWD/T Commitment, Kg./Yr.	1500 G./T. "23" Commitment, Kg./Yr.	800 MWD/T Production, Kg./Yr.	Reactor Power, MW	Uranium, T/M			Thorium, T/M
				Low G./T.	High G./T.	Total	
500	0	2550	10,000	205	381	586	0
500	0	4050	15,000	205	515	720	0
1500	0	1660	10,000	616	211	827	0
1500	0	3160	15,000	616	402	1018	0
500	1200	1097	10,000	205	139	344	66.7
500	1200	2600	15,000	205	330	535	66.7
1500	1200	210	10,000	616	27	643	66.7
1500	1200	1705	15,000	616	217	833	66.7

Processing rates resulting from other assumptions may be easily obtained by use of the attached nomographs, Figures 1 and 3.

DISCUSSION

Reactor Power Levels

Realistic estimates of the maximum equilibrium power levels that could be achieved by the sum total of the H.A.P.O. reactors vary from about 10,000 MW in the summer of 1955 to 16,000 MW in the winter of 1956-1957. "Blue sky" estimates of the maximum power levels for the same periods indicate 12,500 MW and 17,000 MW, respectively.

Estimates (see HW-33842) for the individual groups of similar reactors are as follows:

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HW-36134

Page 3

Date	Megawatts									
	B + D + DR		F + H		C		KW + KE		Total	
	Act.*	Max.	Act.*	Max.	Act.*	Max.	Act.*	Max.	Act.*	Max.
3/55	2720	3490	1890	2380	1850	1940	3240	6520	9,700	14,330
9/55	2730	2990	1890	2050	1610	1770	3480	5600	9,710	12,410
3/56	2730	3490	1950	2380	1850	1940	6550	7680	13,080	15,490
9/56	2910	2990	2030	2050	1720	1720	6600	6600	13,260	13,360
3/57	4600	4950	2410	2410	1850	1940	7000	7680	15,860	16,980
9/57	4260	4260	2280	2280	1720	1720	6600	6600	14,860	14,860

* Realistic estimate.

The operating conditions and restrictions which limit the power levels tabulated above may be found in the reference document (HW-33842).

It should be noted that the power levels given are instantaneous values. Effective power levels may be calculated by multiplying the instantaneous power by an operating efficiency (such as 90%).

Low NGS Plutonium

Low NGS plutonium commitments have been estimated at values ranging from 0 to 1500 Kg./yr. The pile power and uranium processing rates associated with these commitments may be found by using the nomograph attached as Figure 1. Typical values from this figure are as follows:

220 MWD/T Plutonium, Kg./Yr.	Uranium, T/M	Reactor Power, MW
0	0	0
500	205	1485
1000	411	2970
1500	616	4450

Uranium-233

"23" production commitments have been estimated at values ranging from 0 to 1200 Kg. of "23" per year. The reactor power consumption and thorium processing rate necessary to meet these commitments have been calculated using Figures 2 and 3. Figure 3 is a nomograph quite similar to Figure 1.

Figure 2 correlates "23" concentration in the thorium slugs with reactor power consumption. As indicated in Figure 2, this relationship varies with the type of reactor loading and the subsequent conversion ratio. An irradiation level of 1500 g. "23"/ton thorium and J-Q loading was assumed for the example given below.

Loading	G."23"/T.	"23", Kg./Yr.	Thorium, T/M	Reactor Power, MW
J-Q	1500	1200	66.7	4850

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High NGS Plutonium

It is anticipated that all excess reactor power available (after meeting low NGS plutonium and "23" commitments) will be utilized in the production of high NGS plutonium. The irradiation level of this material will probably fall in the range of 600 to 1000 MWD/T. Tabular data indicating reactor power, plutonium production, and uranium processing rates for 800 MWD/T material are given below for total effective reactor power levels of 10,000 and 15,000 MW.

Total Power - 10,000 MW

220 MWD/T Plutonium, Kg./Yr.	"23", Kg./Yr.	Reactor Power to High NGS, MW	Uranium, T/M	800 MWD/T Plutonium, Kg./Yr.
0	0	10,000	381	2990
500	0	8,515	324	2550
1000	0	7,030	268	2100
1500	0	5,550	211	1660
0	1200	5,150	196	1542
500	1200	3,665	139	1097
1000	1200	2,180	83	651
1500	1200	700	27	210

Total Power - 15,000 MW

0	0	15,000	571	4490
500	0	13,515	515	4050
1000	0	12,030	458	3600
1500	0	10,550	402	3160
0	1200	10,150	386	3040
500	1200	8,666	330	2600
1000	1200	7,180	273	2150
1500	1200	5,700	217	1705

Uranium Processing

The total quantity of irradiated uranium which must be processed is the sum of that utilized for both low NGS and high NGS plutonium processing. The maximum uranium processing rate will occur when (a) a high reactor power level is developed (15,000 MW), (b) a high commitment of low NGS plutonium is involved (1500 Kg./yr.), and (c) no "23" production is required. A uranium processing rate of 1018 tons U per month must be achieved in this case (in addition to the processing of any uranium from underground storage). A minimum processing rate is achieved when the reactor power level is low (10,000 MW), no low NGS plutonium commitment is involved, and a high (1200 Kg.) "23" commitment must be met. In this case, the uranium processing rate drops to 196 tons per month.

Other cases, as well as the minimum and maximum situation described above, are cited in the summary of this report.

MWD/T
1,000

g./t.
1,000

100

900

900

800

800

700

700

600

600

500

500

400

400

300

300

200

200

100

100

20,000

15,000

10,000

9,000

8,000

7,000

6,000

5,000

4,000

3,000

2,000

1,500

1,000

900

800

700

600

500

400

300

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NOTE:

Diagonal lines shown correlate
MWD/T and Pu, g./t. for natural
uranium loadings only.

1,000

900

800

700

600

500

400

300

200

100

g./Yr
 0,000
 1,000
 2,000
 3,000
 4,000
 5,000
 6,000
 7,000
 8,000
 9,000
 10,000
 11,000
 12,000
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EXAMPLE PROBLEM

Calculate pile power level and uranium processing rate associated with 1000 Kg./yr. of 200 MWD/T plutonium production.

Travel from the MWD/T scale at 200 MWD/T parallel to the diagonal lines to 186 g./t. on the g./t. scale. Locate second point on the Kg./yr. scale at 1000 Kg./yr. Connect the two points (with straight edge) and read 448 tons uranium per month from the T/M scale. Connecting this last point with 200 MWD/T on the MWD/T scale indicates a reactor power requirement of 2950 MW on the MW scale.

FIGURE 1

REACTOR POWER VS. REQUIRED METAL PROCESSING RATE

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d. "23" / T vs. MTD / T

Kg./Yr.

T/M
100

HW-36134

Page 7

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EXAMPLE PROBLEM

Calculate pile power level and thorium processing rate associated with 1000 Kg./yr. of 1500 g. "23" ton of thorium if J-Q loading is used.

Figure 2 indicates an irradiation of 2210 MWD/T will produce 1500 g./t. material. A straight line drawn through 1500 g./t. on the g./t. scale and 1000 Kg./yr. on the Kg./yr. scale indicates 55.6 tons of thorium per month on the T/M scale. A straight line drawn through this point and 2210 MWD/T on the MWD/T scale indicates a reactor power requirement of 4030 MW at the intersection on the MW scale.

FIGURE 3

REACTOR POWER VS. METAL PROCESSING RATE

10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,500
1,000
900
800
700
600
500
400
300
200
100

90
80
70
60
50
40
30
20
10

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