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August 22, 1962

PRELIMINARY SURVEY
POTENTIAL EQUIPMENT IMPROVEMENTS
333 BUILDING

By

Facilities Engineering Personnel
FUELS PREPARATION DEPARTMENT

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INTRODUCTION

In order to provide advance direction for 333 Building equipment development work, a survey of potential areas of significant savings through equipment improvement has been made. The purpose of this report is only to indicate areas for investigation, not to define a program.

No effort was made, at this time, to refine numbers or check the validity of rough estimates. The numbers herein should not therefore be used for other purposes.

Four major classifications have been used for key indications. These are production continuity and safety, manpower, material costs, and maintenance costs.

SUMMARY

Equipment is adequate to maintain operating continuity and provide for safe operation of the building. Special attention should be given to "one-of-a-kind" pieces of equipment. These include the press, cutoff saw, beta heat treat facility, and autoradiograph film developer.

Manpower savings will result principally from refinement of each operation. There are no really outstanding areas for improvement.

The greatest potential for savings is in material costs. These are illustrated in Tables I&II

Maintenance costs provide for possible significant reductions at braze, vacu-blast, non-destructive test, autoclaves, and chemical processing equipment. See Tables I & V.

PRODUCTION CONTINUITY AND SAFETY

All equipment is now adequate to provide for 35 tons/month or more if some operations are performed on a second shift. The operations which currently require a second shift are:

Cutoff	Straightening
Chem Mill	Vacu-Blast
Pre-Weld Etch	End Closure Weld
Final Etch	UE-2B Testing

Of the above, all but Testing and Vacu-Blast are close enough to meeting one shift operation requirements that it may be possible to use overtime rather than a second shift if some improvements can be made.

In order to insure production continuity, back-up for "one-of-a-kind" equipment will be considered. This currently includes only:

- Press
- Cutoff
- Beta Heat Treat
- Autoradiograph Film Developer

[redacted]

TABLE I

SUMMARY OF EQUIPMENT IMPROVEMENT SURVEY - 333 BUILDING

Equipment	Operating Continuity and Safety	Manpower (45 T/Month Basis)	Material	Maintenance	Priority
Component Assembly			$2,500,000		1
Billet Preheat					
Extrude	One of a kind		$ 176,000(1)	$34,000	1
Cutoff	Improvement required to eliminate 2nd Shift One of a kind				
Chemical Processing	Improvements required to eliminate 2nd shift	13 people	$ 126,000	$46,000	2
Braze		4 people	$ 821,100	$18,000	1
Heat Treat	One of a kind			$10,000	1
End Machine				$ 800	3
Vacu-Blast	Improvement required to eliminate 2nd shift		$ 5,500	$14,000	3
End Weld	Improvement required to eliminate 2nd shift			$ 1,400	3
Non Destructive Test	Improvement required to eliminate 2nd shift			$30,000	3

(1) Includes press tooling - $132,000 for IT mandrels alone.

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Equipment	Operating Continuity and Safety	Manpower (45 T/Month Basis)	Material	Maintenance	Priority
Autoradiograph	One of a kind		$ 35,800	$ 3,000	2
Support Attachment			$ 73,400	$ 7,000	2
Autoclave				$20,000	3
Inspection		22 people			

Miscellaneous

1% yield improvement is worth	~ $32,500 per year
Reduction in cutoff thickness is worth	~ $412 per mil per year
Reduction in end cap thickness is worth	~ $1,200 per mil per year
Reduction in cladding thickness is worth	~ $120,000 per mil per year

Tooling Type Costs

Cutoff saw blades	$4,200 per year
Braze glass tubes	$5,700 per year
Vacu-blast nozzles and tubes	$4,000 per year
Support welding electrodes	$5,900 per year
Non-destructive test probes and crystals	$20,000 per year

[redacted]

The following assumptions were made for establishing production continuity and safety requirements:

1. Goal production is 35 tons per month through June, 1964, based on the Production Forecast for January, 1962, through June, 1967, HW-72393.

2. There are 21 working days per month, with seven working hours per day.

3. Outer fuels will be run on 11 days per month; inner fuels on 10 days per month.

4. Overall yield will be 73% for outers and 71% for inners.

5. Finished production will be composed of the following percentages:

Length	By Weight	By Piece
24"	84%	72%
18"	9%	12%
12"	7%	14%

6. Extrusions will produce the following pieces:

	Inners	Outers
24"	16	12
18"	1	0
12"	0	1

7. Fuel lengths and weights:

	Inners		Outers		Total
	Length (U)	Weight	Length	Weight	Weight
24"	22.74"	13.91#	22.80"	27.87#	41.78#
18"	16.94"	10.36#	17.00"	20.78#	31.14#
12"	11.14"	6.81#	11.20"	13.69#	20.50#

8. Adequate manpower can be provided to keep the machines operating full time.

On the basis of the above assumptions, equipment requirements are shown in Table II.

The calculated machine requirements are based on the time required to process full length fuels. Inasmuch as the finished production may consist of 26% of shorter pieces, the processing times for certain steps would be considerably shorter.

The number of pieces to be processed at each station was calculated back from the required production and the predicted reject rate for that station. (See Table III)

Most of the gross production figures were calculated from "theoretical maximum machine capacities" in HW-73274, by L. L. Samford. Assumption on fuel weights and lengths were obtained from the same source.

MANPOWER

Manpower figures at present do not indicate any outstanding areas for improvement. The most promising areas are chemical processing, end closure braze, and inspection.

Manpower requirements for 45 ton/month operation indicate areas similar to those with 35 ton/month, and since the 45 ton/month figures are the most recent available they are used below:

Component Preparation	4	
Extrusion	3	
Cutoff	2	
Copper Strip	2	
Pre-Braze Etch	2	
Final Etch	1	
Pre-Weld Etch	1	
Chem Mill	3	
Miscellaneous Degrease	1	
Lead Operator	1	
End Facing	1	
End Closure Braze	4	
End Ring Crimp	1	
Beta Heat Treat	1.5	
Straighten	1	to be done by coverage people
Machining	1	
Vacu-Blast	1.5	
ND Test	3	
End Closure Weld	3	
Clad & Bond Test	3	
Support Welder	3	
Support Test & Degrease	2	
Locking Clip Weld & Test	1	
Coverage	4	
Press Room Operator	1	
Autoclaving	1	
Rails Handling	2	
Inspectors	22 (2)	

(1)HW-73775, Manpower and Equipment Requirements for the NPR Fuel Cladding Facility at Throughput Levels from 45 to 91 Tons Per Month, By J. P. Keenan, May 28, 1962.

(2)Approximate only at present.

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MATERIAL COSTS

The most significant potential for savings in material costs is in the reduction of zircalloy costs. Other areas which may provide a smaller return more easily are press tooling (inner tube mandrels, $132,000 per year), end closure materials (>$800,000 per year), support cost reduction (>$70,000 per year), and autoradiograph materials (>$35,000 per year).

The roughly estimated cost per 24" fuel element of the various materials required is shown in Table IV.

In addition to the materials costs of Table IV, there are fairly expendable tooling type costs which are currently running about as shown.

	Cost	Unit	Cost/f.e. 1 Unit	Factor Use	Yield	Net Cost Per f.e.	Cost/[illegible] At 35 I/M
Cutoff Saw Blades(1)		ea					
3 OT/Blade(2)	4.28		.36	3	.85	.14	$ 2,900
5 IT/Blade(2)	4.28		.27	5	.85	.06	1,300
Total Saw Blade Cost							$ 4,200
Braze Glass Tubes	46.00	ea	46.00	200	.85	.27	$ 5,700
Vacu-Blast Nozzles & Tubes	--	-	--	--	--	.19(3)	$ 4,000
Lathe Tooling	--	-	--	--	--	.05	$ 1,050
TIG Welding Electrodes							$ 1,000
Support Welding Electrodes	50.00	ea	50.00	200	.90	.28	$ 5,900
Non-Destructive Test Probes							$ 20,000

(1)Rough Estimates - Courtesy of K. K. Grittner, 8-21-62
(2)Assumes 16 tubes/IT, 12 tubes/OT
(3)Rough Estimates - Courtesy of D. C. Lehfeldt, 8-21-62

[redacted]

A cost which does not show up directly in FPD costs except for freight, is the cost of uranium reprocessing. For purposes of this report, this is considered to be $2.30/lb.[1]

No attempt has been made at this point to establish the value of increased uranium in the fuel elements.

The value of a 1% yield improvement has been previously estimated at $32,500 per year.[2]

Three significant materials values are discussed below. These are the value of (1) a reduction in cutoff cut thickness; (2) a reduction in end cap thickness, and (3) a reduction in clad thickness.

The value of a reduction in cutoff cut thickness is estimated at $412/mil/year at 35 tons/month:

Uranium Cost = 22 lbs/ft. ÷ 12 in/ft. ÷ 1,000 mils/in. X $2.30/lb. X 2 cuts/fuel element (assume one extra cut per fuel element for samples) X 50 fuel elements/ton X 35 tons/month X 12 month/year = $177/year/mil.

Direct Labor Cost ~ $3.00/fuel element through extrusion ÷ 24 in./fuel element ÷ 1,000 mils/in. X 2 cuts/fuel element X 50 fuel elements/ton X 35 tons/month X 12 months/year = $5.00/year/mil.

Direct Material Cost ~ $131.13/fuel element through extrusion ÷ 24 in/fuel element ÷ 1,000 mils/in. X 2 cuts/fuel element X 50 fuel elements/ton X 35 tons/month X 12 months/year = $230/year/mil.

Total cost per year per mil of cut = $412

Two hundred mil cut costs approximately $80,000 per year.

The value of a reduction in end cap thickness includes all of the above costs for cutoff thickness reduction plus a portion of the chem mill labor and materials costs (relatively insignificant) plus the value of a mil of end cap. The additional cost for end cap thickness is:

Present end cap thickness = 260 mils

Present end cap cost = $15.00/fuel element.

End Cap Cost = $15.00/fuel element ÷ 260 mils/fuel element X 50 fuel elements/ton X 35 tons/month X 12 months/year = $1,200/mil/year/

(1)HW-55969, Fuel Element Fabricating and Cladding Processes and Economics, 12-29-58
(2)Project Proposal, Consolidated 303 Area Service Facility, Phase I, Project CAF-961, March 30, 1962.

The cost of end caps would probably not be directly proportional to thickness, but the theoretical value of a one mil reduction in thickness of $1,600 obtained above is within reason. On this basis, a 50 mil reduction in end cap thickness would be worth $80,000 per year.

The value of a reduction in cladding thickness is approximately $114 zircalloy cost/fuel element ÷ 20 mils cladding thickness X 50 fuel elements/ton X 35 tons/month X 12 months/year = $120,000/mil/year. Here again a directly proportional reduction is assumed, which is not strictly the case. However, this indicates the tremendous incentives for improvements in heat treating and surface preparation.

An area not mentioned above whose significance is heightened by these calculations is that of end defect reduction. The potential here is obviously several hundred thousand dollars per year.

MAINTENANCE

Maintenance costs to date have been distorted in many cases by startup or development. However, the summary in Table V indicates that the non-destructive tester, extrusion press, autoclaves and chemical areas offer a considerable potential.

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TABLE II

EQUIPMENT REQUIREMENTS - 333 BUILDING
35 TONS/MONTH SINGLE SHIFT OPERATION

		Machine Capacity Gross Pc./Hr.	Machine Eff.(%)	Net Pc./Hr.	Required Goal Pc./Hr.	Mach. Req'd	Mach. Avail.	Machine Shortage
Billet Weld	NIT	6.25	90	5.63	2.20	2	2	—
	NOT	5.75	90	5.18	2.58			
Can Weld	NIT	5	90	4.5	2.56			
	NOT	4.63	90	4.17	2.96			
Lid Weld	NIT	12.4	90	11.2	2.56			
	NOT	10.5	90	9.45	2.96			
Billet Evac.	NIT	7.5	90	6.75	2.20	1	1	—
	NOT	7.5	90	6.75	2.58			
Billet Assy.	NIT	9.63	90	8.67	2.20	1	1	—
	NOT	9.63	90	8.67	2.58			
Cleaning U	NIT	6.88	90	6.19	2.56	1/2 line	1/2	—
	NOT	6.88	90	6.19	2.96			
Cleaning Cu	NIT	27.8	90	25.0	2.8	1/2 line	1/2	—
	NOT	27.8	90	25.0	3.2			
Cleaning Zr	NIT	27.8	90	25.0	2.20	1 line	1	—
	NOT	27.8	90	25.0	2.58			
Cutoff Extr.	NIT	2.5	90	2.25	2.20	1 +	1	10%
	NOT	2.63	90	2.37	2.58			
Cutoff Reprocess	NIT	49.1	90	44.2	8.8	1	1	—
	NOT	40.8	90	36.7	7.1			
Copper Strip	NIT	92.3	90	83.0	37.5	1 line	1	—
	NOT	64.9	90	58.4	33.4			
Chem. Mill	NIT	42.8	80	34.2	36.2	1+line	1	10% (NIT)
	NOT	42.3	80	33.8	32.0			
Pre-Braze Etch	NIT	130	90	117	36.2	1/2 line	1	—
	NOT	91.5	90	82.3	32			
Pre-Weld Etch	NIT	42.5	90	38.3	32.9	1+line	1	10% (NOT)
	NOT	30.0	90	27	29.6			
Misc. Degrease	NIT	81.3	90	73.2	28.7	1 line	1	—
	NOT	57.5	90	51.8	26.1			
Final Etch	NIT	25.0	85	21.3	28.7	1+line	1	30%
	NOT	25.0	85	21.3	26.1			
End Face	NIT	85.8	98	84.0	36.2	1/2	1	—
	NOT	75.0	98	73.5	32			
End Closure Braze	NIT	17.1	85	14.6	36.2	3	3	—
	NOT	17.1	85	14.6	32			
Heat Treat	NIT	40.6	85	34.5	35.4	1	1	—
	NOT	45.0	85	38.3	31.5			

[redacted]