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IRRADIATION PROCESSING DEPARTMENT

April 25, 1961

REVISION TO OPTIMIZATION CONSTANTS

INTRODUCTION

The purpose of this document is to recommend several revisions to constants in the optimization model for use in routine calculations determining optimum operating parameters for the existing plant.

We assume the reader is familiar with the optimization model. Since the document is for reference by Process Technology personnel, no attempt is made to give comprehensive support to some of the recommended numbers; questionable points or changes are covered.

RECOMMENDATIONS

The constants shown in Table 1 below are recommended for calculating optimum operating conditions for the existing plant.

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TABLE I

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REVISED CONSTANTS

<u>Symbol and Item</u>	<u>B,D,DR,F</u>	<u>H</u>	<u>C</u>	<u>KE,KW</u>
CDI C-D Rate, Natural	360 400	600	500	700
CDE C-D Rate, Enriched	200	400	250	400
CDLINE, CDLENE, CDLSNE, C-D Non-equilibrium factor	1.35 1.1	1.1	1.1	1.1
DTR Tube replacement rate, tubes/day	30	30	30	30
EMISC Non P,M associated loss, days per equilibrium day	.14	.14	.14	.11
ELN Hours lost per rupture	24	24	24	24

DISCUSSION

The following supporting comments and data may be of interest. Items are discussed in the order of listing in Table 1.

Charge-Discharge Rates

The rates quoted in Table 1 are approximately those obtained in discussions between J. C. L. Chatten, L. J. Newell and the Analysts(1). With a few exceptions, the rates quoted are slightly lower than those agreed in the subject meetings. These rates do not apply for bumper charges. Bumper rates are rather uncertain and should be estimated at the time of calculation from the latest available information.

Charge-Discharge Non-equilibrium Factor

The overall charge-discharge rate -- non-equilibrium factor combination that should be used in the optimization model is one which expresses the incremental loss in efficiency for incremental changes in throughput. If one says there would be no more outages scheduled for charge-discharge for additional throughput, then the rates used would be those quoted since they are downtime rates. About ten per cent of our outages have been scheduled in the past and we believe additional throughput would call for a very occasional additional scheduled outage. If an additional outage has to be scheduled, the non-equilibrium on the outage should be largely

(1) Chatten, J.C.L. Bumper Fuel Program; Input Data For Optimum Net Return Calculations. HW-68955. March 23, 1961. (CONFIDENTIAL).

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charged to charge-discharge. Using reasonable numbers we worked out the following, which will give a feel for this effect. If a ten per cent increase in throughput required the scheduling of one additional outage per year, then the non-equilibrium factor should be 1.13. We think this is perhaps a little larger than would be required and therefore have chosen 1.1 for the factor.

Tube Replacement Rate

The tube replacement rate of thirty tubes per day is not a new rate. Process Analysis has been using this ever since receiving Plant Engineering's estimate of future rates⁽²⁾. What should be used here is a rate that would exist one to three years in the future. If goals are met, an even higher rate than 30 should be used. However, past experience leads us to be conservative here so we suggest 30. At the present time, certainty and timing of proposed zirconium replacements are too indefinite to justify using other than an equilibrium loss as a tube replacement rate.

Non-power-exposure-associated Loss (EMISC)

This number has little effect on optimum parameters and as such its accuracy does not concern us greatly. Calculations by L. J. Newell on 1960 data give the following best estimates for this number by reactor. B, .136; C, .149; D, .124; DR, .157; F, .151; H, .156; KE, .123; KW, .06. The number will undoubtedly vary considerably for numerous reasons from year to year for any reactor. We are inclined to conclude there is no difference between any of the older reactors but that the K reactors are definitely lower on the average. While KW is undoubtedly lower than KE, and will probably continue to be so on account of KER, the small effect on optimum parameters and the cost saving from making one computer run do for both K reactors is the reason we chose 0.11 for both.

Ruptured Slug Removal Time and Associated Non-equilibrium Losses

The 1959-1960 plant average ruptured slug removal time, plus current non-equilibrium losses, indicate 24 hours per rupture loss is still a good number for use in the optimization program. The plant average outage time loss for all rupture classifications (PT's and solids excluded) was 14.4 hours per failure. Projected non-equilibrium losses per cold startup are about 8.4 hours giving an overall average total loss of about 22.8 hours. For intangible losses, 1.2 hours is added, yielding 24 hours total.

Outlined in Table II is the total rupture removal time for each ruptured slug classification considered, and by individual reactors. This data was analyzed by the one-way-analysis-of-variance procedure to determine if there was a significant difference between the average rupture removal time at each reactor. The

(2) Chatten, J.C.L. Tube Replacement Rates for Forecast Purposes. Letter to H. G. Spencer. December 5, 1960.

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analysis showed that at the 95 per cent confidence level, the average rupture removal times at individual reactors are not significantly different. The conclusion reached from this analysis is that the plant overall average rupture removal time (14.4 hours) is the best estimate for each reactor, with these data.

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TABLE II

RUPTURED SLUG REMOVAL TIME FOR CY-1959 AND 1960
(PT's and Solid Metal Failures Excluded)

<u>Reactors</u>	<u>Types of Failures</u>	<u>Number of Failure</u>	<u>Total Time Charged (Hrs.)</u>	<u>Average Removal Time by Type</u>	<u>Reactor Average Removal Time</u>
B	Hole	3	25.2	8.4	13.9
	Side	9	99.9	11.1	
	Other*	6	124.5	20.7	
	SUB-TOTAL	18	249.6		
C	Hole	3	36.5	12.2	16.5
	Side	27	423.1	15.7	
	Other	3	86.3	28.8	
	SUB-TOTAL	33	545.9		
D	Hole	4	46.4	11.6	17.4
	Side	5	82.1	16.4	
	Other	3	80.8	26.9	
	SUB-TOTAL	12	209.3		
DR	Hole	1	9.4	9.4	14.6
	Side	13	208.9	16.1	
	Other	1	0.6	0.6	
	SUB-TOTAL	15	218.9		
F	Hole	2	11.1	5.5	12.0
	Side	10	137.6	13.8	
	Other	4	43.5	10.9	
	SUB-TOTAL	16	192.2		
H	Hole	4	26.4	6.6	10.5
	Side	14	152.0	10.8	
	Other	4	53.4	13.3	
	SUB-TOTAL	22	231.8		
KE	Hole	6	93.6	15.6	14.2
	Side	7	90.3	12.9	
	Other	2	28.4	14.2	
	SUB-TOTAL	15	212.3		
KW	Hole	6	65.0	10.8	15.9
	Side	12	205.0	17.1	
	Other	6	110.4	18.4	
	SUB-TOTAL	24	380.4		
<u>PLANT TOTALS</u>					
TOTAL	Hole	29	313.6	10.8	<u>Plant Average</u> 14.4 + 4.3**
	Side	97	1398.9	14.4	
	Other	29	527.9	18.2	
		155	2240.4		

* Unclassified and unknown failures.

** These are 95% confidence limits on a per reactor basis. The best estimate of the rupture removal time at each reactor is 14.4 hours, and we are 95 per cent confident that each reactor's true average removal time lies between 10.1 and 18.7 hrs.

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