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TITLE

OPERATIONAL FUELING INCENTIVES

CURSORY ESTIMATE

AUTHOR

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By

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September 15, 1961

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OPERATIONAL FUELING INCENTIVES - CURSORY ESTIMATE

Reference: (1) HW-69898, Charging Fuel During Reactor Operation
C. E. Frantz, et al, June 19, 1961

INTRODUCTION

Equipment Development is testing a system of operational fueling at 105-KE. The system is fully described in reference (1). This cursory review is made for assurance that the program continues to merit risk of small production loss and development priority. Production Test IP-429-K, which is now circulating for approvals and which provides for up to 150 tubes fitted for operational fueling, is an indication of the immediacy with which, presuming due diligence and barring unforeseen circumstances, the system can be available for production.

SUMMARY

The minimum incentive arrived at for operational fueling is exhibited in the following table:

Gross Incentive	
283 reactor hours/year @ \$3750/hour	= \$1,061,000/year
Less two scrams - 34.4 hours each	= 258,000
Net Incentive	\$ 803,000
Project Cost Approximation	\$1,000,000
Return Loss During Installation	675,000
Gross Project Cost	\$1,675,000

Payout - Approximately 2 years

The assumptions used and the method of arriving at the numbers are detailed in the discussion. Effort has been made to understate the incentives and overstate the costs in order to provide a conservative basis.

It is concluded that, with a net incentive on the order of \$800,000 per year and payout time indicated at about two years, the concept remains well worth developing with vigor and applying with speed.

INCENTIVES

Incentives for operational fueling were a topic of considerable debate throughout the long development period of the 105-C operational charge-discharge equipment. One of the objectives in developing the new

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technique was so far to reduce the cost that the most controversial claims would not have to be made in order to support the justification. Accordingly, this estimate of gross incentive was made in a manner intended to understate it.

The gross incentive is estimated to be \$1,061,000 per year per K Reactor, and this is derived entirely from reduced lengths of outages amounting to 283 hours per year per reactor.

The analysis starts with Table I, provided by the Production Operation, which indicates for each of the 45 outages on which charge-discharge was done at the two K Reactors the total time, the time used for charge-discharge, and the time claimed for the hypothetical case where the reactor was fueling in operation. The table covers the twelve months just ended. The claimed time was arrived at by assuming that the length of each individual outage would be reduced by the time used for charge-discharge or by the amount it exceeded a minimum outage, whichever is less. Outages of less than 36 hours duration were assumed to have been minimum outages, and their average -- 34.4 hours -- was used as minimum length of longer actual outages. The time thus arrived at was divided equally between reactors and converted to dollars at the rate of \$90,000 per day -- \$3750 per hour.⁽¹⁾

This gross estimate makes, and will make, no allowance for shutdowns that might not have occurred with operational fueling. Also, two kinds of additional shutdowns might occur for maintenance, malfunction, or misoperation of the operational fueling equipment itself. First is the situation which results if for some reason it is not possible to open the rear face valves -- the television has failed, the actuator is broken, elevator frozen, etc. This requires no immediate shutdown but eventually would require a reactor shutdown when it became necessary to discharge fuel. It should be possible under these circumstances, however, to delay the actual outage up to a week, plan it, and make use of it as one of the 20 or more outages which are assumed to occur per reactor per year anyway. For ordinary maintenance of this equipment, no additional outage time need be allowed either, since manipulation of the figures in Table I will show that about 217 shutdown hours per reactor are available per year by virtue of the fact that charge-discharge need not be performed during the minimum length outage.

The second situation occurs when, through malfunction or error, the reactor is scrambled by the equipment. This has already happened once in test due to a design error in auxiliary equipment provided to delay a scram because the testing was being performed with aluminum. It can occur in operation if through error the wrong Panellit gage is bypassed or the wrong rear face valve is opened. Either of these errors will produce a Panellit low trip on the unmonitored tube. These events are inevitable,

(1) These figures were provided by H. G. Spencer.

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but the annual rate at which they are to be expected is, at this point in time, anyone's guess. The high cost of them will lead to great care to avoid them. Arbitrarily, we assume two per year, producing two additional outages over those assumed at arriving at the gross incentive, each of 34.4 hours duration. This reduces the net incentive by \$240,000 per year.

COST

Briefly, the equipment required is the remote rear face equipment of Project CGI-824, new front nozzles, three or four charging machines, monitors, and monitor test benches per reactor. The rear face equipment, as the subject of an approved project, is included in this estimate at the project authorization of \$420,000. Equipment Development has purchased 150 front nozzles for the demonstration at something under \$100 apiece. This is the basis for a \$325,000 estimate. The charging machines, monitors, testers, each of which have been built, can easily be provided within \$50,000. Using \$205,000 as allowance for contingency, installation, administrative expenses and upward round-off, we arrive at a cash outlay of \$1,000,000 for the system.

The work required for installation is controlled by the job of stripping and re-installing nozzles. This was estimated according to the present method figures of Table II, assuming six crews at work on the reactor. Time loss is 180 reactor hours, valued at \$675,000.

The combined outlay and money equivalent of production loss thus amounts to the gross cost of \$1,675,000.

PAYOUT AND VARIABILITY

Simple division of the two figures arrived at shows a payout time of about two years. This figure is sensitive, however, to the assumptions about the number of minimum outages that will occur. The reader can inject his own bias by adjusting the net incentive in increments of \$129,000 for each outage he wishes to add on account of error or malfunction, or subtract because a planned outage wasn't necessary, or a rupture was discharged without shutdown. If, for example, he wishes to assume 10 scrams per year in addition to the outages that did occur, there is no incentive at all; while on the other hand if he cares to consider that perhaps 10 of the 20-odd outages that did occur would not have, a payout time of substantially less than one year results. The simplicity of the equipment and the procedures, and the ready ability to test the equipment for proper function frequently leads the writer to suppose that scrams will be much less frequent than the two assumed on account of equipment malfunction, and an assumption of two such errors per reactor per year may unjustly malign the skill and care of the processing operations.

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TABLE I

K's OUTAGES IN WHICH CHARGE-DISCHARGE WAS ACCOMPLISHED

<u>Date</u>	<u>KE REACTOR</u>			<u>KW REACTOR</u>		
	<u>Total Hours</u>	<u>No. Hrs for Chg-Dischg</u>	<u>Creditable Hours</u>	<u>Total Hours</u>	<u>No. Hrs for Chg-Dischg</u>	<u>Creditable Hours</u>
1960						
Sept	39.7	23.4	5.3	35.6 45.5	19.5 33.1	0 11.1
Oct	55.1 47.8	40.5 27.4	20.9 13.4	35.2 39.3	9.3 3.4	0 3.4
Nov	46.6 71.7	23.3 25.4	12.2 25.4	68.8	39.4	34.4
Dec	34.7 31.0	8.8 8.0	0 0	41.1 60.6	20.8 28.7	6.7 26.2
1961						
Jan	76.5	39.3	39.3	72.5	38.6	36.8
Feb	47.7 53.0	12.0 36.7	12.0 18.6	41.5	25.5	7.1
Mar	60.3 34.4 34.9 32.0	21.4 1.4 4.3 3.9	21.4 0 0 0	56.7 34.7	29.3 10.0	22.3 0
April	46.7 34.2 35.2	31.8 16.8 12.2	12.3 0 0	68.9 34.6	48.9 5.0	34.5 0
May	40.8 56.5	28.2 31.6	6.4 22.1	34.7 56.1	5.8 39.2	0 21.7
June	35.6 61.1	14.7 22.4	0 22.4	35.0 87.2	16.7 35.2	0 35.2
July	83.2 40.9	39.1 15.9	39.1 6.5	35.3	18.1	0
Aug	41.3 40.5	4.3 33.1	4.3 6.1	79.9 40.7	36.1 3.8	36.1 3.8
	<u>1181.4</u>	<u>535.9</u>	<u>287.5</u>	<u>1003.9</u>	<u>464.6</u>	<u>279.3</u>

Total Creditable Hours = 566.8

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TABLE II

COMPARISON OF CONTROLLING REACTOR OUTAGE HOURS^(*)
(Based on a typical 35-tube outage)

<u>Description of Direct Work Operations in Sequence Performed</u>	<u>Location of Controlling Work</u>	<u>Present Method DF 1.87</u>	<u>Phase I Method DF 1.20</u>	<u>Phase II Method DF 1.20</u>
2. <u>Stripping</u> - Disconnect pigtail from header, cap header, remove nozzle from gunbarrel, cut Van Stone, install shield plug, install jack bolt. - Similar work on front elevator.	Rear	3.23	2.08	2.08
8. <u>Installation</u> - Two crews, install nozzle with air wrench, uncap header, install pigtail with hand wrench. Rear finish installation of nozzle, pigtail, thermocouples, and clean up.	Front	4.54	2.92	2.92
9. <u>Pressure Test</u> - Hydrostatic testing of each installed tube, one crew on front and rear.	Front-Rear	2.45	1.59	.79
10. <u>Leak Repair</u> - Inspection of nozzle, pigtail and thermocouples for leaks and leak correction. Similar work on front.	Rear	1.39	.89	.22

(*) Abstracted from "Engineered Standards Program - Reactor Process Tube Replacement 105-F - Part I, Interim Report", B. C. Benediction, August 12, 1960.

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