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HANFORD ATOMIC PRODUCTS OPERATION RICHLAND, WASHINGTON

DATE
February 15, 1962

TITLE

RESULTS OF TEN TUBE OPERATIONAL FUELING
ON FEBRUARY 9, 1962

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RESULTS OF TEN TUBE OPERATIONAL FUELING
ON FEBRUARY 9, 1962

February 15, 1962

By

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Process Component Development

P. B. McCarthy, Engineer
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NOTICE

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RESULTS OF TEN-TUBE OPERATIONAL FUELING
ON FEBRUARY 9, 1962

INTRODUCTION

Production Test IP-429-AK authorizes the discharge-recharge of uranium columns from KE Reactor during operation. On February 9, 1962, ten columns of ripe uranium were discharged and recharged from KE Reactor during operation. This was the first large scale operational refueling test done at KE Reactor with Operational Fueling Facility gear. However, for the last year many tests have been performed in preparation for the ten tube discharge. A general outline of these steps is as follows:

1. Ball caps and flapper caps were developed to allow remote opening of the rear face nozzle.
2. A rear face actuator was built to remotely open flapper caps or ball caps.
3. Columns of aluminum and uranium fuel elements were flushed during shutdown at full flows.
4. Aluminum and uranium fuel elements were flushed during operation.
5. A front face charging facility was developed.
6. Aluminum was discharged and recharged during shutdown at full water pressure.
7. Aluminum was discharged and recharged during reactor operation.
8. Uranium was discharged and recharged during shutdown at full water pressure.
9. Uranium was discharged and recharged on a single tube basis at startup and again just before shutdown.
10. Ten uranium columns were refueled during reactor equilibrium operation.

This report presents data collected during the ten-tube refueling operation.

SUMMARY

The objectives of the production test have been met. The system has been proved to be feasible and no reactor control problems were encountered by refueling during operation.

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DISCUSSION

During the discharge of the ten tubes, data was collected for a definitive descriptive record and to determine the changes which could be anticipated if the system were routinely used. Data on pressures, temperatures, radiation, reactor control, and time were gathered and are listed in abbreviated form in this report.

Pressure

Pressure data collected was very similar to that collected in previous lab and reactor tests, with the expected changes caused by hot water. The most unusual occurrences noted were the increased pressures encountered during perf charging of the first and third tubes. Two types of square perfs were used in each tube at the downstream end. The first type was perforated with four rows of holes and the second type with eight. Other pressure deviations were eliminated by charging the eight hole perf first.

Pressure Data

Tube	Nozzle Pressure		Panellit Fluctuation While	
	Before (Refueling)	After	Charging Last Slug*	
			High	Low
4785	298	305		
4783	297	298		
4883	302	304		
4782	301	301		
4881	302	307		
4880	302	305		
4780	302	304	45	54
4779	304	305	48	58
4878	305	306	45	65
4877	308	309	53	61

*Shows dual trip protection provided.

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Nozzle Pressure

<u>Condition</u>	<u>Charging Data, Pressure in psi (Average for all Ten Tubes)</u>
Cap open	16
Cap closed	81
1st perf	102
14th perf	130
1st uranium	155
2nd uranium	177
3rd uranium	192
5th uranium	216
15th uranium	262
27th uranium	285
32nd uranium	292
38th uranium	304

Front Header Pressure - 370
Rear Header Pressure - 25

Temperature

Temperature data for tube outlet water was continuously recorded. The tube outlet temperatures were normal at the beginning of each discharge. When the rear cap was opened the temperature dropped (or rose) to rear header temperature. Then when the cap was closed the temperature fell to about inlet water temperature. No temperature change occurred while perfs were charged.

The first metal piece charged caused an immediate rise in temperature, and then the temperature dropped slightly. The temperature overshoot is attributed to two factors. The slug travels through a high flux zone to arrive at the downstream end of the tube; and there is little relative motion between the coolant and the slug as it flushes down the tube. Note that the temperature overshoot decreased by the time the last half of the column was charged. The following Table shows the average temperature after charging the listed number of slugs.

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Outlet Water Temperature Data

<u>Slug Number</u>	<u>Temperature, Degrees C</u>
0 perf to 14 perf	10
1st uranium	10.4
2nd uranium	10.8
3rd uranium	11.6
4th uranium	12.5
7th	16.2
13th	28.0
19th	44.2
20th	48.6
21st	52.2
24th	58.0
31st	80.0
34th	88.5
36th	93.5
38th	97.5

The incremental temperature rise per slug, corrected for flow variations during charging, was plotted against slug position to obtain a flux curve. The curve shows the effect of the No. 2 rod and provides an excellent flux traverse. However, the non-poisonous spline probably produces a more accurate traverse.

Radiation

Radiation readings taken at various locations around the discharge area were low, as expected. The highest reading obtained was taken in front of a plugged rear face access hole. The exposure in the occupied rear face areas was about 1 MREM per tube discharged.

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Reactor Control

The tubes selected on rows 47 and 48 were immediately above and below the No. 2 rod. The first tube discharged resulted in the largest reactor power loss, but the experience of the first few discharges enabled operators to anticipate shifts and to hold the level relatively constant. The following Table shows the drop in power level per discharge.

	<u>Tube</u>	<u>MW Loss Per Discharge</u>
1st tube	4785	55
	4783	29
	4883	17
	4782	11
	4881	5
	4880	11
	4780	12
	4779	15
	4878	6
	4877	0

The Reactor had operated thirteen days and was at a power level of 4400 mw. The Reactor was scheduled to operate seventeen more days before shutdown, and was operated seven of these seventeen days before an unscheduled shutdown occurred.

No cycling or control problems were encountered. One spline was added after the ten tubes were discharged and recharged. The reactivity loss on discharge of the tube was very close to the handbook figure of 12 cmk. The rod measured reactivity change between the start of charging of the first tube and the end of charging of the last tube was so small, about 2 cmk, that it had no significance.

Charging Times

As usual, the most time was used in getting ready to start working. The first six columns were discharged in three hours and the last four columns were discharged in less than two hours, however, most of the day shift was used in preparation, charging the ten tubes, and equipment removal. A time breakdown follows:

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<u>Tube</u>	<u>Complete Cycle Time</u>	<u>Refueling Times - Charging</u>		
		<u>Time Between Attaching Monitor and Removing (Mins.)</u>	<u>Charge Time (Mins.)</u>	<u>Set-Up Time Between Tubes (Mins.)</u>
4785	31	24	19	7
4783	27	21	18	3
4883	42	26*	19	3
4782	32	24	20	4
4881	30	20	18	2
4880	22	22**	18	4
4779	28	21	17	4
4878	28	24	19	5
4877	25	24	17	7

*Photographer recorded all facets of operational fueling.

**One hour and forty minutes used to check Charge Monitor trip points, eat lunch, dress, collect slugs, etc.

Equipment

The nozzle used in this test is the short-barrel O.F.F. nozzle, which does not project beyond the rest of the nozzle pattern. The Charge Monitor and Charge Machine have built-in extensions for use with the shortened nozzle. All other equipment had been used many times in previous reactor tests. The modified nozzle, Charge Monitor, and Charge Machine had been used in one previous test.

One of the two television monitors lost its picture just before the operation, so the modified Mark VI flapper caps were opened with only one television 'eye'. All other equipment functioned as designed.

Personnel

The ten tube discharge was conducted by the following Equipment Development personnel:

R. S. Hammond, Supervisor, Process Component Development
P. B. McCarthy, Engineer
K. G. Hawkins, Engineer
F. E. Haun, Engineering Assistant
R. L. Woodward, Engineering Assistant

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The design and early testing of the flapper caps, actuator, Charge Monitor, and Charge Machine was primarily the responsibility of Senior Engineer, C. E. Frantz.

Equipment Development personnel were very pleased with the cooperation of the KE Processing personnel, and particularly with the help given by Reactor supervisors G. N. Brown and W. A. Crossman.

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