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PRODUCTION TEST IP-372-K
URANIUM DISCHARGING DURING OPERATION
KE REACTOR

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This document consists of
8 pages.

PRODUCTION TEST IP-372-K
URANIUM DISCHARGING DURING OPERATION
KE REACTOR

by

C. E. FRANTZ

Mechanical Development "A"
Equipment Development
FACILITIES ENGINEERING

and

P. A. CARLSON

Reactor Engineering
Process and Reactor Development
RESEARCH AND ENGINEERING

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PRODUCTION TEST IP-372-K
URANIUM DISCHARGING DURING OPERATION
KE REACTOR

INTRODUCTION

Irradiated uranium slugs have been discharged and recharged from both P and C Reactors during reactor operation. At B Reactor, operational charging and discharging tests were conducted in 1954, using the poison column ball valves and poison charging machine. (Ref. 1, 2, 3, 4 & 5) Operational charging and discharging tests were conducted at C Reactor, using the 9 tube CG-609 test set-up (Ref. 6 and 9), and later using the CG-654 112 tube facility. (Ref. 7 and 8) The test facilities were located in the central zone of the reactor, and discharging and recharging was done at equilibrium tube power levels. This Production Test is to permit discharging of irradiated slugs from KE Reactor as a first step in an Operational Recharging Program for this reactor.

OBJECT

The purpose of this test is threefold; to test the workability of the flapper and/or ball cap - actuator combination under reactor operating conditions (Ref. 10 and 11); to determine the effect on the K Reactor operating parameters of the rapid discharge of a column of slugs; and to ascertain the radiation levels present at various locations in the 105 Building when a column of irradiated slugs is discharged during operation.

BASIS AND JUSTIFICATION

The economic justification for discharging ruptured slugs during operation is developed in reference 9, and that for operational charge-discharge is developed in reference 8. This Production Test is the first step in a planned program for reaching these objectives at a K Reactor.

As a matter of interest, the planned schedule will be approximately as follows:

- A. Test flapper and/or ball cap and actuator action during discharging in a reactor shut-down period, accomplished October 27, 1960.
- B. Discharge several columns of irradiated uranium during reactor operation, just prior to a scheduled outage, planned for the earliest scheduled outage following the successful conclusion of tests in part A, above, probably about the first of January; this is the subject of this Production Test.
- C. At the successful conclusion of part B tests, a new test authorization will be prepared to equip a single process tube with a special inlet valve, probably a flapper check valve, so dummy material may be charged into a reactor and discharged using the balanced hydraulic charging machine now being tested. This test is tentatively scheduled for about February 1, 1961.
- D. Upon proven feasibility of tests in part C, a Production Test will be written to permit routine charging and discharging of uranium metal under operating conditions. Plans call for starting these tests about March 1, 1961.

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As can be seen, this Production Test is but one step in a planned program to convert K Reactor to continuous operation through operational charge-discharge of the process metal.

SCOPE

The cap and actuator - slug deflector combination have been tested under reactor shut-down conditions, using full water flow to first flush dummy aluminum slugs to test the trajectory deflecting device on the actuator, and then to flush unirradiated uranium slugs as a further test of the equipment. The equipment performed satisfactorily during these tests. It is now planned to flush discharge irradiated uranium slugs from selected columns during an eight-hour period directly prior to a scheduled shut-down. These latter discharges are the subject matter of this Production Test. Up to three columns of metal will be discharged under this test.

Rupture suspect tubes may not be discharged under authority of this test.

EQUIPMENT

The equipment used in this test will be Mark V and/or VI Flapper Caps, Actuator Operated Ball Caps, the under elevator mounted cap actuator and an operating console for controlling the actuator. This equipment is fully described in Reference 10 and 11.

Three tubes, 1380 KE, 4780 KE, and 4880 KE, have been selected by the K Processing Operation for this test. These tubes have been equipped with Hoke valves on the front nozzle pressure taps to permit the use of pressure gages to monitor the front nozzle pressure following discharge of the metal column to verify that all fuel elements have been flushed from the tube.

Radiation detection instrumentation will be placed at suitable locations throughout the building so radiation levels during a discharge can be ascertained.

PROCEDURE

1. A pressure gage will be attached to the front nozzle pressure tap on the tube to be discharged and the Hoke valve opened.
2. The Panellit gage on the tube to be discharged will be electrically by-passed and the Panellit pressure will be visually monitored by a qualified operator from the time the Panellit gage is by-passed until it has been verified that all fuel elements are discharged. A high pressure reading which equals or exceeds the normal trip pressure on the Panellit gage of the tube being discharged shall require an immediate manual trip of the reactor's #1 Safety Circuit. During the time that the Panellit gage trips are electrically by-passed, and prior to the opening of the discharge cap, a lower than normal low trip pressure on the Panellit gage shall require an immediate manual trip of the reactor's #1 Safety Circuit.
3. The rear cap is opened and the metal column flushed.

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4. The pressure gage monitoring the tube inlet pressure is checked with the rear cap open. A reading which exceeds 20 psig indicates that fuel elements are lodged in the tube and requires immediate reactor shut-down.
5. The rear face radiation level instruments should rise to full scale immediately following the opening of the rear cap. Failure of the radiation level instrument to return to within 2 major divisions of pre-discharge readings within one minute indicates fuel has not entered the discharge basin. In this event, the fog spray system shall be activated immediately.
6. Monitor temperatures on the tube adjacent to the tube being flushed.
7. Close the rear discharge cap.
8. Recharge the tubes during reactor shut-down and remove the electrical by-pass jumpers.
9. The flexible front connector shall be replaced prior to the next reactor startup. The connector shall not be re-used on the reactor.

Flushing a natural uranium column should result in a reactivity loss of about 4 ih (10 cmk). This will cause a reduction of about 50 MW in the pile power level. Pile power level and the radial flux distribution may be readjusted at the discretion of the Reactor Specialist.

HAZARDS

The potential for uranium fires is increased by some small increment by performing discharge operations with no decay time. Since the ratio of heat generation due to fission product decay decreases exponentially as a fraction of time after "shut down" of the fission reaction, the heat generation ratio at the time of discharge of fuel elements in this test will be higher than for normal discharge operations. The higher heat generation is of no significance if the fuel element remains adequately cooled. The most probable source of an uncooled fuel element is associated with a damaged discharge guide which might permit the fuel element to become caught in the rear face piping. Calculations show the jacket melting temperature would be reached in a matter of 2-3 minutes, following such an incident. (Ref. 12.) The uranium would be expected to melt in the order of 6-10 minutes. With the use of the discharge guide the potential for such incidents is considered to be less than under normal discharge operations. Calculations also reveal that if the fog spray is in action prior to the discharge of the fuel element, jacket melting temperatures will probably not be reached. Initiation of the fog spray within a few minutes after such an incident would probably prevent uranium melting and ignition.

There will be no automatic flow protection for the time the tube Panellit gage is bypassed until such time that the fuel elements are flushed from the tube. Under conditions of routine operational charge-discharge operations instrumentation will be provided to give automatic high trip protection in this interval. Failure to initiate a manual scram in the event a tube plugging incident occurs in this interval during this test as shown by low or high Panellit gage reading could result in fuel element melting.

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RESPONSIBILITIES

KE Processing Operation will be responsible for selecting the channels and time for discharging, for monitoring Panellit pressure, and safeguarding the reactor.

Mechanical Development "A" personnel will be responsible for coordinating the test, for operating the equipment, evaluating results of the test and documenting the same.

Radiological Engineering will be responsible for measuring the radiation penetrating the shields during the discharge.

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