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SUPPLEMENT C - PRODUCTION TEST IP-64-CE
POISON COLUMN DISPLACEMENT DURING REACTOR
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June 16, 1959

SUPPLEMENT C - PRODUCTION TEST IP-64-CE
POISON COLUMN DISPLACEMENT DURING REACTOR OPERATION

OBJECTIVES

The objectives of this supplement are to test an improved prototypic slug column displacement winch and associated remote control equipment and to demonstrate the feasibility of exerting control over the front-to-rear neutron flux changes as an aid in controlling reactivity cycling. An array of poison displacement columns up to twelve in number is intended, each charge consisting of a center section of I and E natural uranium slugs with "mint" pieces on each end. Initially six such columns will be charged with the remaining six being added later if required for proper control.

BASIS AND JUSTIFICATION

The initial testing of the slug column displacement winch has established that the mechanics of the system are practicable and has indicated that the system would be feasible for controlling front-to-rear flux in the immediate region around it. The next phase of this test is to demonstrate the feasibility of controlling the front-to-rear flux changes over the entire reactor and to verify the improvement in equipment design.

The reactor temperature "cycling" problem has resulted in sizeable production losses in the past. At the K Reactors corrective measures have been taken to reduce this problem,

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BASIS AND JUSTIFICATION (Continued)

but the result has not been a complete success, some degree of cycling occurring most of the time even with restrictive measures employed. One of the major steps taken was to use "outboard" (i.e., further upstream and downstream) rods both to permit a greater poison moment effect and to increase the center flux peaking. This resulted in a somewhat more stable reactor but also increased the rupture potential because of higher center slug powers. The successful use of poison displacement columns will increase the degree of control over cycling and may eventually permit a return to the original K Reactor control rod configuration which should result in reduced rupture potential. Improved control over cycling tendencies should permit routine gains of one to two per cent in level within existing limits; the eventual possibility of flattening longitudinal flux distribution by major rod configuration changes poses potential gains in rupture control limits of several per cent.

For the displacement column to be useable and fully flexible, the position indicators for each column and the positioning equipment must be reliable and must be operated from the control room. New equipment has been designed to correct faults found during earlier tests.

The redesign of equipment involved replacing the moisture-sensitive potentiometers in the position indicator with a synchronous transmitter and receiver, installing a built-in cable shear to eliminate "hanging up" of the slug column on the rear nozzle and increasing the winch torque. In addition provision was made to move more than one cable at a time and for a slack-cable detector to prevent cable jamming.

To be effective in controlling front-to-rear flux changes, there should be poison displacement tubes available in each quadrant of the reactor. It is believed that a maximum of twelve such tubes will be sufficient to show effective control with six of these being charged initially and the others added if required.

PROCEDURE

Installation

Following approval of this supplement to Production Test IP-64-CE, six KW Reactor process tubes will be equipped with the slug column displacement equipment at the earliest convenient time with six more added if needed. The process tubes used for this test will be selected by mutual agreement between Operational Physics Sub-Section and KW Reactor Processing Sub-Section personnel, their locations to be compatible with those of the experimental traveling wire flux monitor columns. Standard front nozzles and pigtails will be used. Since it is planned that each initial charge will contain fifteen heat-generating slugs (although this may be varied) the tube power will be equal to approximately 57 per cent of the power generation of a regular uranium column. Venturis identical with those used on present process tubes will regulate and monitor the flow as specified by flow laboratory tests conducted previous to in-pile use. Aluminum mixing pieces will separate the mint and the uranium to insure proper flow.

A control panel will be located in the control room adjacent to the control console. Wiring of the control and read-out circuits may be accomplished during reactor operation and will be completed before installation of the displacement winch assemblies.

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PROCEDURE (Continued)

Operation

The system will consist of the following major components:

1. A D.C. power supply located in the "D" Machinery Room.
2. A control panel with a travel readout system located in the control room.
3. A relay panel located on the near side balcony level.
4. Winches located on selected inlet nozzles.
5. Interconnecting control cable and electrical wires.
6. A hydraulic charging tube.
7. Especially fabricated nickel-plated I and E natural uranium slugs.

To operate a selected winch (or selected winches) the operator will depress the appropriate pushbutton (or pushbuttons) and then select the direction of movement (in or out) at the control panel in the control room. The movement of the poison column will proceed at approximately 24" per minute until the operator releases the movement pushbutton or until the column completes its maximum allowable travel in either direction. This movement is read directly from counters mounted on the control panel. The Panellit gauge shall not be by-passed during this operation.

It is desirable to test the tubes in situations where front-to-rear control is required either for redistributing the flux for better control or to aid in stopping flux shifts or cycling. During the initial part of the test, operation of the winches and position indicators will be observed by the authors to check proper functioning of the equipment. Actual use of the facility for reactor control will be under the direction of the Pile Physicist and Reactor Specialist.

If no cycles occur within a reasonable time whereby the value of the facility for cycle control can be demonstrated, a deliberate attempt will be made to induce a front-to-rear flux shift several hours before a scheduled outage with the approval of the Processing Manager. No adverse effect on tube outlet temperature distribution is expected in the interval of time between promoting the flux shift and the scheduled outage time. However, it is expected that data obtained before this phase of the test will help determine the probable magnitude of the flux shift.

Residence time of the initial charge will correspond to the goal exposure. Inspection of the facility components and a preliminary evaluation of results at this time would indicate whether or not the equipment should be relocated.

Data Required

The following data should be recorded before, during, and after use of the facility:

1. Position of the column before and after movement.
2. Temperatures of several selected graphite thermocouples before movement, and at intervals of 0.5, 1, 2, and 4 hours after movement.
3. Reactivity effect of the movement in terms of the compensating HCR movement required.

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PROCEDURE (Continued)

Data Required (Cont'd)

4. Any immediate (within 15 minutes) change in the Octant Monitor Deviation Recorder caused by movement of the columns.
5. If the Traveling Wire Flux Monitor (TWFM) is in service, flux distributions should be measured before and after movement of the columns at the discretion of the Pile Physicist.
6. An evaluation by the Reactor Specialist and/or the Pile Physicist of the results of the movements, whether effective or not and any undesirable effects obtained. Since some effects will not be apparent for several hours after movement, an attempt should be made to limit moves to the early part of a shift.

Column Discharge

The rear nozzles of the tubes will be equipped with "droop-snoot" discharge tubes. After the reactor has been shut down and the water pressure lowered, the caps will be removed and the cable cut in such a manner that the least amount of cable is left with the charge. The charge may then be flushed by raising water pressure unless development of flushing equipment using shutdown flow is successful. Water flow reduction, on discharge of these tubes shall be made in accordance with Process Standard A-030. Shielding under the droop-snoot shall be provided.

It is expected that the system installed under this test will be a valuable operational aid which will be continued indefinitely. This test will be terminated either when authorizing process standards have been prepared and approved on the basis of published test results or if continued testing should demonstrate untenable drawbacks in the system's use not presently foreseen.

Process Effects

In order to reduce the coefficient of friction between the I and E slugs and the tube ribs, the slug jackets will be plated with nickel to a thickness of approximately one and one-half mils. Previous experience and laboratory tests with this coated jacket have shown minimum process tube wear, particle deposition on rear face fittings, and difficulty with stripping of slug jackets (1).

Reactor Safety

The equipment will be fail-safe in that the charges will be arranged so that in the event the support cable fails, the upstream poison will move into the high-flux zone and thus increase the poison effect.

Costs

Cost Code - The cost code of the installation and removal will be charged to 5461-61100.

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- (1) HW-51412, "Supplement A - Production Test IP-64-CE - Poison Column Displacement During Reactor Operation," W. E. Cawley, et al, January 31, 1958.

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PROCEDURE (Continued)

Reactivity

About four inhours of reactivity will be absorbed by the "mint" on the ends of each column in the centered position with a charge consisting of 15 I and E natural uranium with 23 pieces of mint at each end. Spike enrichment of two to three columns of E-metal may be required for each displacement column with this loading. This loading may be varied to obtain better control. Proper location of compensating enrichment should not increase reactor total control requirements.

Shutdown Time Required

Front Face - Installation of the charge and electric winch assembly for each tube will require an estimated one-half hour. Removal after completion of test should require ten minutes.

Rear Face - Installation of the "droop-snoot" assembly will require five minutes, and removal will require five minutes.

Responsibilities

KW Processing Operation will be responsible for operational safety and for monitoring production continuity. Mechanical Development A Unit will provide all required equipment and operating instructions, and will be responsible for initial inspection of the uranium and "mint" pieces.

Operational Physics Sub-Section will be responsible for evaluating and reporting the process effects, and Mechanical Development A Unit will be responsible for determining the suitability of the mechanical equipment and methods of charging and discharging the columns.

J W Hedges

Mechanical Development A Unit
Equipment Development Sub-Section
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IRRADIATION PROCESSING DEPARTMENT

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