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PRODUCTION TEST IP-261-C
DETERMINATION OF POWER RATE METER RESPONSE

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PRODUCTION TEST IP-261-C

DETERMINATION OF POWER RATE METER RESPONSE

I. PURPOSE

This test will determine approximately the relationship between the power rate of rise indicated by the power rate meter and the actual pile power, rising period, and power rate. The actual pile power and power rate cannot be measured accurately during rapidly changing conditions; it is the intent of this test primarily to demonstrate that rate of rise protection offered by the power rate meter can be calculated to the same order of accuracy as the measurements of actual conditions.

II. BASIS AND JUSTIFICATION

The power rate measuring instrumentation which is being procured for all Hanford piles, the prototype of which is now operating at D Reactor, determines the power rate by differentiating the output current from resistance temperature detectors in the exit water stream of about ten selected process tubes. Because of the delay between a change in the pile flux level and its detection and measurement

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HW-60135

Page 2

II. BASIS AND JUSTIFICATION (Continued)

by the instrument, the indicated power rate may be significantly different from the actual existing rate in cases of a rapid change in rate. In order to make the most advantageous use of this equipment, operating procedures must be based on a knowledge of the relationship between flux rate of change and the instrument indication.

Two situations which might arise in practice are of concern: first, an initial startup period which is allowed to continue unchecked too long, and second, a fast rate of rise due to excessive rod withdrawal at fairly high power level. A reasonably accurate estimate of the power rate meter response is not too difficult in the first case, and this has been made (1). If the results can be confirmed experimentally the delay times used in the analysis will be substantiated and can be used in analog computations to find the meter response in the second situation. The combined results are expected to be sufficient to provide the bases for operational procedures and limits. Appropriate startup procedures using the power rate meter should result in improved reactor startup efficiency while reducing the chance of reactor damage or slug damage due to a combination of excessive power and power rate. To provide confirming pile data needed to specify these procedures, this document authorizes an experiment at D Reactor to compare the flux and instrument response to a startup period which continues to a power level of about 100 MW.

III. DESCRIPTION OF TEST

Prior to the test the pile will be started up using standard cold startup procedures, and power will be raised to the usual level for the first startup temperature map. After determination that tube flows and temperature monitoring are in order for further power increases, at least three Beckmans will be set to trip at about ten per cent above the amplifier reading existing at that time, and power will be raised until a Beckman scram occurs. This will show that proper protection against high flux level actually exists. All Beckmans in the number one safety circuit will then be set to trip at an estimated level of 200 MW. The pile will be started up on a period of about 20 seconds and no further rod movements will be made until the power rate meter indicates a rate of rise of 150 MW/min; the pile will be scrammed at this point by manual trip of the number one safety circuit. The expected peak power during the run is less than 100 MW.

IV. COSTS

A. Cost Code

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B. Outage Time

The only outage time involved is the time for recovery from the two scrams. This should require a total of less than one hour.

(1) HW-59975, "Power Rate Meter Response Characteristics," D. E. Simpson, 4-13-59.

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IV. COSTS (Continued)C. Manpower

The normal operations manpower for a cold startup is required. Additional assistance will be provided by Operational Physics.

V. SCHEDULING

The experiment will be performed at the first cold startup at D pile which is mutually acceptable to the Manager, D Processing Operation, and Operational Physics.

VI. INSTRUMENTATION

Recorded data from the power rate meter, the Beckman flux monitors, and perhaps the subcritical monitor will be used in analysis of the test results. In addition, the time between the opening of the number one safety circuit and indication of the scram by the power rate meter will be recorded. The timer will be started by the opening of a relay which will be energized through contacts clipped to the terminals of the SN relay bypass light. Opening of the number one safety circuit will interrupt the current through the light and also through the added relay. The timer will be stopped when the scram is indicated by the sudden change in power rate from a positive rate slightly above 150 MW/min to a large negative value; the actual point to be used is that at which the rate meter indication passes through 150 MW/min following the scram.

VII. PROCEDUREA. Initial Conditions

1. The subcritical monitor or the triple P.C., the power rate meter, and at least three Beckman flux monitors will be in service.
2. All preparations for an initial cold startup will be completed. Initially, the Beckmans will be set at their normal cold startup condition.

B. Test Procedure

1. The pile will be started up in accordance with Process Standards (2) for initial cold startups. Power will be raised to the usual level of 50-100 MW for the first temperature map.
2. After confirmation that tube flows and temperature monitoring are satisfactory for further power raises, three Beckmans will be set to trip at about ten per cent above the existing reading and power will be raised until the Beckman scram occurs.

(2) HW-46000-D, "Process Standards - Reactor."

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VII. PROCEDURE (Continued)B. Test Procedure (Cont'd)

3. All serviceable Beckmans will be set to trip the pile at a power level of approximately 200 MW as estimated from the power level and Beckman readings observed while the temperature map was being taken.
4. All VSR's will be withdrawn and the HCR's will be pulled without delay until the pile is 80 ih supercritical as determined by the predicted xenon decay curve, the rod calibration charts, and the pile reactivity as determined on the initial startup. The period may then be adjusted to a value of about 20 seconds, but no faster than 15 seconds. The SN relay will remain bypassed; if the run is interrupted by a drop of one or more VSR's it will be resumed by withdrawal of VSR's without changing the HCR position.
5. The pile power will be allowed to rise on this period until a rate of rise of 150 MW/min is indicated by the power rate meter; at this point the pile will be scrammed by a manual trip of the number one safety circuit. Figure 1 shows the predicted power level as a function of time and the anticipated power rate meter response. The maximum power expected is less than 100 MW. Should this be grossly in error the Beckmans will scram the pile at about 200 MW, and even if no scram occurred the maximum power which would be reached before the metal coefficient slowed the rate to virtually nothing would be about 700 MW.
6. The contacts connected across the SN relay bypass light will be removed, and Beckman trips will be reset for the secondary cold startup.
7. This completes the test; the following startup will be made in accordance with Process Standards for an initial or secondary cold startup, as applicable.

C. Concurrent Production Test

If this test is performed in conjunction with PT-IP-188-C (3), the rod withdrawals and rising periods on the initial startup (Para. VII.B.1) and the startup following the test (Para. VII.B.7) may be in accordance with the provisions of PT-IP-188-C rather than Process Standards. The provisions of this test terminate, however, when the first Beckman range or trip setting change is made and all Process Standards must be observed thereafter.

VIII. PROCESS STANDARDS

The following Process Standards (2) relaxations will apply during the test run only. The test run is that startup which is to be terminated by manual scram upon an indicated 150 MW/min rate of power rise (Para. VII.B.4 and 5).

- (2) HW-46000-D, "Process Standards - Reactor."
- (3) HW-56681, "PT-IP-188-C, Test of Startup Procedures with Subcritical Monitoring," D. E. Simpson, 5-19-58.

VIII. PROCESS STANDARDS (Continued)Beckman Trip Settings, Cold Startups, Standard C-030

For the test run, the Beckman ranges and high trips will be set to scram the pile at an estimated 200 MW. On this range the readings prior to startup will be zero, and the low trips will, therefore, be set at zero or less.

Horizontal Rod Withdrawal, Standard C-070

For the test run, horizontal rods may be withdrawn to a predicted 80 ih supercritical without waiting periods. Not more than two HCR's may be withdrawn at a time.

Rising Period and Power Rate of Rise, Standard C-070

On the test run, a rising period of about 20 seconds will be held until the indicated power rate reaches 150 MW/min. The expected maximum power level is about 100 MW, and the expected maximum actual power rate is about 210 MW/min.

SN Relay Bypass, Standard C-090

During the test run the SN relay will remain bypassed and a drop of one or more VSR's will not scram the HCR's or the remaining VSR's. Bypassing the SN will permit quicker recovery in the event of a partial rod drop, and provide a safe and easily accessible source for a signal to start the timing device.

IX. HAZARDS

The procedures outlined in this document may raise questions concerning possible reactor hazards. These possibilities are discussed below.

1. Fuel element damage due to high rate of power rise.

The specified rate of power rise is higher than normal, but the maximum rate of about 210 MW/min is not greatly above the maximum of 150 MW/min which is the limit established by Process Standards at which the pile must be scrammed. Also, the total power increase during the test run (about 85 MW, nearly all of which will occur in the final minute) is less than the increase during a one-minute interval at the maximum rate permitted by Standards. Therefore, there is no indication that the fuel elements will sustain any damage significantly greater than on a normal cold startup, particularly in view of the low power level to be reached during the test.

2. Failure to manually scram the pile.

A manual scram of the reactor upon indication of the specified 150 MW/min power rate was chosen as more desirable than modifying the number one safety circuit so as to have an automatic scram. In case of failure to scram the pile at the proper time, either because of power rate meter failure or personnel error, the Beckman flux monitors will scram the pile at a power level of about 200 MW. It will have been shown that the Beckmans

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HW-60135
Page 6

IX. HAZARDS (Continued)

2. Failure to manually scram the pile (Cont'd)

were operating on the previous startup; however, on the range at which they will be set for the test run the initial reading will be zero so no continuous check on their operability is available. In the virtually inconceivable situation of complete failure to scram for any reason, the power rise would be temporarily stopped at a power of about 700 MW by the effect of the negative metal temperature coefficient of reactivity.

3. Effect of timer connection to circuitry related to the number one safety system.

The relay to be used to start the timer will be connected by alligator clips to the terminal contacts of the SN relay bypass light. Since the relay is in parallel with a low resistance, its failure either to open or close as intended can have no effect whatsoever upon the operation of the safety system. A short circuit in the added relay wiring would have the same effect as a short in the safety circuit; that is, it would cause a fuse to blow, thus scrambling the pile. A break in the circuit would have no effect.

X. RESPONSIBILITY

For the safety and production continuity of the reactor: D Processing Sub-Section.

For planning the test, assisting operating personnel, analyzing the results, and issuing the final report: Operational Physics Sub-Section, D. E. Simpson.

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Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

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Page 7

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HW-60135
Page 8

FIGURE I

POWER RATE, INDICATED RATE, AND POWER RESPONSE TO
A 20-SECOND RISING PERIOD

Zero Time = Time actual power reaches 1 MW

Curve 1: Actual Power Rate (MW/min)

2: Indicated Power Rate (MW/min)

3: Actual Power (MW)

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