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**Title:** Pt-IP-249-C

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**Issuing File:** Circulating Copy

**Received Copy:**

**File Area:** Richland, Washington

**Date:** May 25, 1959

**Signature and Date:**

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**General Electric RECORD COPY**

**Indefinite Retention**

**Disposal Date**

C-3193-MB (7 - 55) A.E. Authority

**Authority**

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The purpose of this production test is to provide a standard method of obtaining scram transient reactivity information at the eight reactors, under conditions conducive to valid data. These conditions include the bypassing of the Panellit system at a low power level for a short, controlled period of time.
BASIS AND JUSTIFICATION

Failure to recover after a scram from equilibrium conditions results in an outage of 30-36 hours at all reactors. This outage time, plus an additional production loss during subsequent approach to equilibrium, results in total differences ranging from 2800 MWD at B, D, F reactors to 6800 MWD at K reactors. Under current safety standards, the probability for recovery from an equilibrium scram is increased by the availability of a reliable reactivity transient curve. This curve, to be valid, must be based on observations of reactivity transients under actual scram conditions. The alternative to accurate scram transient knowledge is a more conservative startup procedure which shortens the effective scram time and thus reduces the probability of recovering.

Following a scram in a reactor, there occur significant changes in pile reactivity, whose magnitudes are dependent upon operating history, reactor loading, and shutdown level. These reactivity changes are strong functions of three transient effects:

1. A prompt gain in reactivity due to metal cooling which results in decreased resonance capture by U-238;
2. A loss in reactivity due to the cooling of the graphite moderator, which is largely due to a decrease in the thermal utilization with a lower neutron energy; and
3. A loss in reactivity due to Xe-135 buildup.

Xenon concentration can be quite easily calculated from existing tables; the other two effects may be predicted theoretically, but accurate values must be derived from empirical observation. A scram transient test presents data describing both effects.

The metal coefficient, "Cm" (inhours/MW), can be determined directly from scram transient data with good accuracy. The relaxation or cooling period of the graphite can also be estimated by fitting xenon calculations into the observed transient decay. Thus, knowledge of both power coefficients of reactivity can be significantly improved, based on a single observation under scram conditions.

Attempts to obtain necessary transient information have usually been thwarted by premature trips of the safety circuit (by the Panellit system); this event makes additional tests necessary to gather required data. For economical and technical reasons it is desirable to assemble all necessary data from only one test; test frequency could then be reduced to one or two per year. Bypassing of the Panellit system during a short period of minimum risk would generally make repeat tests unnecessary.

DESCRIPTION OF TEST

Except for minor adjustments for maintaining proper Panellit pressures, full flow is maintained at all times. Power level is reduced at a rapid rate to 1-10 MW. After power is reduced to 50 per cent of equilibrium level, Beckman trips are set at this level, and the Panellit system is bypassed. The target level of 1-10 MW must be reached in no more than ten minutes after the beginning of the power reduction, or the Panellit system must be immediately unbypassed. Upon reaching target level, the Beckmans are reset for the low level operating point. The entire pressure monitoring system is closely monitored during the entire test; a gage reading which remains at a high trip point for greater than from two to five seconds will be cause for an immediate scram. The Panellit system shall be unbypassed at the earliest practical moment.
DESCRIPTION OF TEST (Continued)

The low level is maintained by careful manipulation of the control rods (under the direction of the assigned physicist) so as to hold a constant, predetermined galvanometer reading corresponding to the target level. A plot of the inhour values of the horizontal control rods, versus time, will in effect be the scram transient curve. Exact criticality is maintained until the unit is sub-critical with all rods out. Total time of the test is about one hour (simultaneous with the normal reactor "cooling-off" period).

Power reduction rate and rod movements will be under the direction of the assigned area physicist or other authorized individual from Operational Physics Operation; the physicist will also designate whether or not the reactor gas system is to be purged with CO₂ during or prior to the power cut. The No. 1 Galvanometer will be maintained at a target reading determined by the physicist.

DETAILED PROCEDURE

A. Preparation

1. The test must originate from equilibrium operating conditions.

2. A thorough survey of tube outlet temperatures and Panellit pressures must be made immediately prior to the test to determine if prohibitive conditions exist.

3. Water plant personnel will be notified of the test, and will be directed to make timely and rapid pressure decreases to maintain normal Panellit pressures, even though the system is to be bypassed. Note: Effectively, full flow is to be maintained throughout the test.

B. Test Procedure

1. When it is ascertained that normal operating conditions exist, power reduction will begin, using a rod insertion order recommended by the assigned physicist. As soon as practical after reaching 50 per cent of equilibrium level, Beckmans will be set to trip at 50 per cent of equilibrium trip points.

2. Immediately after Beckmans are reset, the Panellit system and Panellit grounding trip will be bypassed. Power level reduction will continue to the target level recommended by the assigned physicist. Level at any time will be determined by "instantaneous" instrumentation; that is, Galvanometers or Beckmans, rather than by the routinely used bulk power level indicator, which lags actual power level by several seconds. Final target level will be determined and held according to a Galvanometer reading selected by the assigned physicist.

3. All Beckman trip settings are to be reset to trip at 100 MW or less by use of range switches; the new settings are to be made as soon as possible after the reactor level decreases to 100 MW.

4. The Panellit pressure monitor system will be continuously monitored during the entire test; any gage whose behavior differs markedly with
neighboring (adjacent) gages will be especially observed. Any gages rapidly approaching high trip point or which are observed to be residing at high trip for greater than two seconds will require an immediate reactor shutdown. The Panellit system will be unbypassed at the earliest practical moment; that is, as soon as pressures are normal and stable at the lower level.

5. Tube outlet temperatures will likewise be continually monitored. The reactor will be shut down if any tube temperatures are unexpectedly high.

6. The selected Galvanometer reading is to be held as closely as possible by rod withdrawal in the specified order. Rod positions are to be recorded every two minutes from equilibrium to sub-criticality, or such time as the test is terminated by the area physicist.

**RELAXATION OF PROCESS STANDARDS**

This test authorizes relaxation of the following standards only within the restrictions previously specified.

1. Standard A-050, EW-46000, requires that the Panellit system be in the safety circuit during operation.

2. Standard C-070, EW-46000, requires that a maximum level of two MW be set for unbypassing the Panellit system.

**HAZARDS**

The hazards connected with Panellit bypassing as described above occur primarily during the period after the system is bypassed and before reaching the target level; it is only during this time that individual tubes produce sufficient power to cause boiling and flow instability under unfavorable conditions. Under test conditions, the Panellit system is constantly monitored during this period, and every effort is made to maintain gage readings in the operating range; questionable gages require immediate shutdown. In this manner, flow blockage may be detected by gage increases before reactor damage occurs; however, spurious Panellit trips which would negate the results of an entire test by premature VSR insertion will be avoided. The principal justification for permitting the temporary bypass of the Panellit system during the power reduction is that the shutdown takes place following several days of continuous operation during which no flow trouble was experienced.

Consequences of any flow reduction at the extremely low target level are comparable in magnitude to flow reductions possible under normal post-shutdown conditions. (For the first hour after shutdown fission heating at one to ten MW is only a small fraction of the heat generation resulting from radioactive decay of the fission products which were produced at full power level.)

* As compared to neighboring gages.

** Based on letter, Comments on Scram Transient Production Test, F. W. Van Wormer to R. O. Brugge, 2-6-59.
HAZARDS (Continued)

Thus, it is feasible to bypass the Panellit system under test conditions described herein, with hazards very little if any more significant than under outage conditions, where Panellit bypassing is allowed.

COSTS

Production loss will be approximately 40 minutes of shutdown time per reactor; there are no requirements for special processing or maintenance manpower.

RESPONSIBILITY

Reactor safety and continuity of operation will be the responsibility of the Reactor Processing Operation; planning and direction of each test, analysis of data, and issuing of a report will be the responsibility of the assigned pile physicist.

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