DUN-2584

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PRODUCTION TEST-080

PHYSICS TESTING AT D REACTOR DEACTIVATION

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PRODUCTION TEST-080

PHYSICS TESTING AT D REACTOR DEACTIVATION

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PRODUCTION TEST-080

PHYSICS TESTING AT D REACTOR DEACTIVATION

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I. OBJECTIVE

The purpose of this test is to provide a set of experimental data to test a computer code frequently used in nuclear safety analyses and to explore certain experimental techniques which may prove extremely valuable in the future. In addition, some basic physics parameters which will be measured may be used in an assessment of the feasibility of using a deactivated Hanford reactor for space-dependent transient tests.

II. BASIS AND JUSTIFICATION

This test program (specifically Test E) will provide a unique opportunity to test computer program CLUMSY by providing a set of experimental data against which computed results may be compared. Program CLUMSY is frequently used in nuclear safety analyses and is the primary tool employed in computation of the spatial dependence of reactor transients. As more nonstandard loadings are charged into the reactors, the dependence upon the accuracy of computational tools such as this will increase, as will the need to reduce the conservative assumptions currently required to guarantee nuclear safety. An important step in this process is the evaluation of the accuracy of our calculational models, as is proposed in this test.

Furthermore, a new test procedure (Test F) is to be used. It is quite possible that this procedure could be used effectively at other times in developing data which will be useful in advanced applications of an on-line process computer, so that some initial experimentation with this method will provide the information necessary to assess its utility. Also, a new (to the DUN-operated reactors) analysis technique is to be used in the analysis of data from Test D. This technique, which has been successfully used at N-Reactor, involves treatment of flux traverse data in a manner similar to that used for exponential pile tests to determine the strength of the safety system. This could prove to be an extremely valuable technique for measurement of safety system strength in reactors loaded with nonstandard loadings, and investigation of its use will be beneficial to future planning.

Finally, a current need within the atomic energy industry is the ability to accurately calculate multidimensional space-dependent reactor transients.¹ It is possible that DUN may be able to assist in the resolution of this problem by performing a set of benchmark experiments in a deactivated reactor against which various calculational techniques could be tested. Measurement of certain physics parameters, as proposed in this test, will permit a better evaluation of the capability of the Hanford reactors for such an experimental program.²

¹ DUN-1461, "Feasibility Study of Space-Dependent Transient Tests in a Deactivated Production Reactor," G. F. Bailey, February 1, 1967.

² Letter, C. D. Harrington to William Devine, Jr., "Space-Dependent Transient Tests," February 10, 1967.

III. SCHEDULING

It is proposed that this test program be performed at D Reactor. The series of tests will be performed following a shutdown from equilibrium operation. It is expected that this specific shutdown will follow the final operating period before reactor deactivation. It would be possible to perform the test following shutdown after any equilibrium operation period; however, the tests include discharging fuel from the pile to a minimum critical size and, should an operating period follow, a significant amount of refueling would be necessary.

Because most reactor systems must be in operable condition during this test program, very little deactivation work will be possible prior to their completion. It will be necessary that any work on the reactor or its auxiliary systems planned concurrent with this physics test be reviewed and approved in advance by the Manager, D Processing, Manager, D Power, and representatives from both Physics and Reactor Engineering. If any problems develop, which have no direct solutions, they will be referred to the Managers, Physics and Reactor Engineering for resolution before the deactivation work is scheduled.

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IV. DESCRIPTION OF TESTS

The testing program has been devised to be within the intent of the Reactor Operating Limits and as such to pose no "unreviewed" nuclear safety problems. However, specific test procedures in certain instances, although within the intent of the Operating Limits, are not consistent with their present wording (as in the case of the maximum allowable reactivity ramp, for example). Special Operating Limits are being prepared for the test period.

This complete test program consists of six individual tests designed to measure the reactivity and flux distribution effects of various control geometries. Much data will be taken by measurement of stable rising periods with the configuration of interest in place in the reactor. Specifically, the tests are described below.

<u>Test A</u>	- Install all necessary instrumentation and make modifications to reactor and safety circuit. Complete initial discharge.	80 hrs.
<u>Test B</u>	- Calibrate and check operability of nuclear power level trip protection	6 hrs.
<u>Test C</u>	- Discharge to minimum critical size.	16 hrs.
<u>Test D</u>	- Determine maximum flux distortion possible.	12 hrs.
<u>Test E</u>	- Determine time lag in reactor response to a local perturbation.	12 hrs.
<u>Test F</u>	- Determine coupling coefficients	10 hrs.
Total		136 hrs.
		17 shifts
		~6 days

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The 80 hours specified in Test A is a lower limit. The major concern is that the reactor be xenon free (or nearly so) at the start of Test C. Thus, an extension of the 80-hour time would not influence the tests. Even though this 80-hour period is included in the test program authorization, much of the work (such as discharge of fuel) accomplished during this time is necessary to the deactivation of the reactor. The actual time by which final deactivation may be delayed is only about two days, representing the time involved in Tests B through F.

No work may be permitted while the tests are in progress which would alter the reactivity and/or safety status of the pile except, of course, the work in conjunction with the tests. During Test D, rear elevator work may be carried out by D Processing, if necessary, provided adequate rear face shielding has been placed in or on any dry channels and the area has been properly monitored. During Test E, however, poison will be periodically discharged making simultaneous rear face work not feasible. Consequently, the amount of time during which rear elevator work could be carried out is rather short. For this reason, it is considered infeasible to begin any major hardware disassembly during the physics test program.

For purposes of this test program, coolant water quality is important only as it relates to pile reactivity. Water quality specifications established for the deactivation outage will be sufficient, assuming that the water does not contain so much "crud" that it will act as a significant nuclear poison.

For purposes of this test program, reactor atmosphere is important only as it relates to pile reactivity (i.e., as regards N₂ content). In this regard, an air atmosphere is acceptable, provided the N₂ concentration is relatively constant. Under the tight procedural controls and at the scheduled low operating levels, no significant radiation control problems should develop during the test program; however, close monitoring surveillance will be maintained throughout the test by Radiation Monitoring, allowing immediate corrective measures if necessary.

It is intended that this test be conducted in a dry reactor with roughly one dollar (about 6.5 mk) of excess reactivity. Should the reactor be shut down with a major internal water leak, or should indications of such a leak develop during the first 80 hours, the test will require modification. This modification will involve a change in Test A to discharge all natural uranium above Row 39 (rather than Row 36) and below Row 08 (rather than Row 11). The test will then proceed normally to the determination of excess reactivity (Test C) or initial startup (Test B). If the available excess reactivity is less than 90 cents (about 6 mk), the test will be cancelled and the deactivation work will continue as planned.

The Production Test will go into effect immediately upon termination of Production Test-068³, following the last D Reactor operating

³ DUN-2331, "PTA-068, Experimental Determination of Reactor Heat Output Following a Reactor Power Failure," S. S. Jones (To be issued).

(production) period, presently scheduled for late June 1967. Since none of the subsequent startups and short "zero power" operating periods will produce appreciable power, they may be ignored for purposes of present DUN accounting practices.

Test A - This test will consist of discharging of reactor fuel to an estimated minimum critical size and installation of instrumentation. It will end at the beginning of the actual test portion of the program (Test B), which should be no less than 80 hours after shutdown. This test procedure supercedes Process Standard I-010 with respect to the discharge sequence. The following sequence shall be used:

1. Vertical Safety Rods 22 and 26 are to be locked out and the tips removed. Lock bars are to be placed on the ball 3X hoppers for these two channels. Two chambers to be supplied by Instrument and Electrical Development Unit will be placed in these channels and connected to the subcritical monitor instrumentation. Insofar as possible, these chambers are to be positioned to give a minimum of two counts/second while the reactor is shutdown and the top 10 rows of fuel unloaded. This will require that they be placed roughly even with Row 07 or 08.
2. The subcritical monitor chambers are to be removed from Test Holes A and B. Two Mark IV chambers are to be placed in the A Test Hole and connected to current Channels 1 and 2 of the Beckman system. Insofar as possible, the chambers will be positioned to give readings similar to those obtained on the underpile Beckmans. The trips will be set at 50 kw.
3. Discharge the following tubes for special pickup as per Production Test Authorization-065:⁴

3862	1165
3667	0863
3570	
4. Discharge all enriched uranium above Row 34 and below Row 13.
5. Discharge all natural uranium above Row 36 and below Row 11. Also, discharge 2360.
6. At this time, all fringe thorium above Row 34 and below Row 13 may be discharged.
7. Channels 0969 and 0978 are to be dried and chambers supplied by Instrument and Electrical Development Unit will be placed in them, with appropriate connections made with instruments to be placed in the control room.
8. A ball valve (PCCF) is to be installed on Process Channel 2360, with a source of high pressure water available to that channel so that the PCCF may be flushed rapidly.

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⁴ DUN-2214, "PTA-065, Unautoclaved Fuel Corrosion Test - D Reactor," D. W. Peacock, March, 1967.

9. The BX and BXA relays which trip the No. 1 safety circuit upon receiving signals from Beckman chambers are to be rewired to trip on one out-of-two coincidence. The ATP for this change comprises Appendix A.
10. A jumper will be installed on the SNM relays (Appendix C).
11. A thimble which has been made by cutting a K Reactor size process tube to the appropriate length (to reach from the far side to Column 58) and closing one end will be installed in Test Hole B so that it may be used as a flux traverse channel.
12. Twenty splines are to be in the reactor, uniformly distributed between Rows 13 and 34 and between the near and far side E rings. Specific locations will be selected later to obtain maximum utilization of splines inserted during operation.
13. Design Change 1169,⁵ which provides for installation of pressure trips in the primary safety circuit to scram the reactor if the TORP falls below 60 psi, is to be completed.

Test B - This test consists of calibration of the Beckman chambers and appropriate setting of safety circuit trips. At the beginning of this test, two chambers are to be in the A Test Hole and the galvanometer chamber is to be in the D Test Hole. Subcritical monitors installed in Step A-1 will be in service. Prior to reactor startup, normal startup checks are to be made. In addition, it will be necessary to ascertain that TORP is greater than 60 psi, and that the newly installed pressure monitors are properly set and unbypassed.

The response of the Beckmans in the A Test Hole is expected to be similar to that of the under-reactor Beckmans (when the reactor is loaded). By positioning the Beckman chambers in the test hole so that the readings, while the reactor is shut down, are similar to those of the under-reactor chambers, a rough calibration is obtained. The reading, however, results primarily from the gamma flux rather than the neutron flux, so an implied assumption in this approach is the similarity of the neutron/gamma ratio in the two locations. It is extremely unlikely that an error greater than a factor of 20 could be associated with this assumption. In fact, the probable error is less than a factor of two. Therefore, setting the trips at 50 kw should prevent the reactor from exceeding 1 MW.

1. Startup the reactor using normal cold startup procedures as defined in Standards C-060, C-070, and C-090. When a rising period is observed the power level will be raised to 25 kilowatts and held. The power level is to be determined using the galvanometer calibration and is to be confirmed using the subcritical monitors in VSR Channels 22 and 26. By observing the response of the Beckmans in the A Test Hole, the calibration curve for these Beckmans is to be constructed. The reactor is then to be shut down by inserting horizontal control rods.

⁵ DC-1169, "Safety Circuit Revision for Low Water Pressure During Production Test-080," R. K. Gange, June, 1967.

2. Based on the new Beckman calibration, trip limits are to be set at 500 kilowatts. A Beckman chamber is to be installed in the D Test Hole behind the galvanometer and connected to Channel 3 of the Beckman instrumentation.
3. The reactor is to be restarted and power raised to 100 kilowatts and held. By observing the response of the third Beckman, the calibration curve will be constructed for it. The trip for the third Beckman will now be set at 500 kilowatts based upon the calibration curve obtained.
4. The reactor power level is then to be increased to a maximum of 600 kilowatts. If the Beckman trips are properly set, and the electrical connections properly made, a reactor scram should occur at 500 kw. Observation of this scram will constitute a "proof test" of the flux monitor primary safety system arrangement, which is required prior to performance of the remaining tests.

This completes Test B.

Test C - In this test the final loading configuration will be obtained.

1. From the operating data obtained during Test B, an estimate of the reactivity status of the reactor will be made. This will be compared with theoretical predictions and, should a discrepancy of more than one-half percent $\Delta k/k$ exist, further testing will be halted until the reason for the discrepancy has been ascertained.
2. The reactor will be started and a stable rising period no faster than 60 seconds will be obtained. Control rod configurations will be noted and the reactor shut down by inserting horizontal control rods.
3. A spline located centrally within the reactor will be withdrawn, the reactor will be restarted, and the control rods will be returned to the configuration obtained in Step 2. The difference in period will be noted thus determining the worth of a spline in this configuration. The reactor will then be shut down.
4. Step 3 will be repeated with another spline located away from the first one.
5. From the determination of the spline worth and the operating data from Test B, reevaluation of the reactivity status of the reactor will be made. Based upon this data, discharge of fuel will be recommended, if necessary, to reduce reactor reactivity to less than that required for the attainment of prompt criticality. It may be necessary to discharge fuel in more than one segment. In any event, a reactivity determination will be made after each fuel discharge step.

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6. By alternately withdrawing splines and inserting No. 5 HCR, a calibration curve for that rod will be determined. Splines withdrawn are to be in the general vicinity of the tip of the rod, so that errors introduced by flux distortions will be minimized.

Test D - This test is intended to determine the maximum flux distortion which can be achieved in an operable reactor with excess reactivity not exceeding one dollar. It is expected that No. 5 rod will be sufficient to hold the reactor subcritical with no other controls inserted. All splines are to be withdrawn from the reactor.

1. With the reactor just critical and the power level sufficiently high to provide the desired sensitivity to the flux traverse instrumentation, a flux traverse will be made with the reactor controlled by 5 rod.
2. The reactor will be shut down with the horizontal control rods and VSR 21 will be inserted. The reactor will again be brought to critical and the reactivity status determined.
3. The reactor will be shut down and VSRs 28 and 15 will be inserted. Again the reactor will be started up and the reactivity status determined.
4. This procedure will continue using the following groups of VSRs: 34 and 10; 29 and 16; 35, 23, and 11; 30 and 17; 36, 24, and 12; 31 and 18; 37, 25, and 13; etc., until further addition of VSRs would prevent attainment of criticality. It is expected that at least 10 VSRs (and possibly 15) will be required to prevent criticality. At this point, the reactor will be brought up to power (approximately 10,000 w) and a flux traverse made. Then the reactor will be shut down, completing Test D.

Test E - This test is designed to measure the time lag between the two sides of the reactor when a significant perturbation occurs on one side of the reactor. This is of particular importance in determining the magnitude and duration of flux distortions which can occur without detection. The primary instrumentation for this test will be the two chambers located on VSR channels 22 and 26.

Generally, the test will involve flushing a PCCF loaded with poison. Five measurements may be made, each with an increased reactivity insertion. Although the flux distortion will occur far from the location of the safety circuit detectors (the far side Beckmans), exceeding limits is unlikely because the flux will actually go from a distorted shape (with the PCCF loaded) to a normal shape. Furthermore, the reactivity insertion will be increased during each step of the test, so that estimates of the period resulting from the next step can be made. If it is determined that a step will result in a period shorter than 20 seconds, that step (and all others involving larger reactivities) will be deleted.

The reactivities and periods expected are as follows:

<u>Pieces of Poison</u>	<u>Reactivity Insertion</u>	<u>Period</u>
6	38 cmk	172 sec.
13	76 cmk	72 sec.
21	114 cmk	40 sec.
27	133 cmk	31 sec.
42	152 cmk	25 sec.

Parameters to be determined include time for the far side subcritical monitor to indicate a flux increase, time for the period (and consequently the flux distribution) to stabilize, and magnitude of the flux distortion created.

1. With the PCCF column loaded with a centered charge of six poison (PbCd) elements, the critical condition will be obtained and held. The PCCF will then be flushed and the resulting transient observed on the two subcritical monitors. The reactor will be shut down with horizontal control rods as soon as an accurate determination of the period has been made.
2. The preceding will be repeated, first with 13 pieces of poison, then with 21 pieces of poison, and finally with a full column (42 pieces) of poison. At each step calculations necessary to insure that periods shorter than 20 seconds will not be achieved will be made. An intermediate step of 27 pieces of poison may be used to improve the estimate of the period resulting from the full column flush.
3. The chambers in VSR Channels 22 and 26 will be interchanged without disrupting the electrical connections to the instrumentation. In other words, the instrumentation which formerly indicated neutron level in Channel 22 will now indicate neutron level in Channel 26 and vice versa.
4. Steps 1 and 2, above, will be repeated, using 13, 21, and 42 piece charges. This is necessary to insure that the observations made during Tests 1 and 2 were truly indicative of reactor events and were not influenced by the instrumentation.

Test F - This test is designed to measure a type of coupling coefficient which may be used in a crude simulation of the reactor. In it, the reactor is assumed to be divided into four regions, each of which is monitored by a single neutron sensitive instrument. By selective manipulation of control elements in each region and measurement of the resulting changes in flux distribution, it will be possible to determine these coefficients. To a large extent, the test details will be developed at the time of the test, taking advantage of information obtained by that time. The following procedure is typical.

1. With the reactor just critical, record the control configuration (rods and splines) and the readings on the four zone chambers. (These are, starting from the near side, Zone 1 - near side subcritical monitor, Zone 2 - Channel 0969, Zone 3 - Channel 0978, and Zone 4 - far side subcritical monitor.)
2. Withdraw a spline from Zone 1 and adjust rods in Zone 2 to reestablish the critical condition.
3. Again record the control configuration and the readings on the four zone chambers.
4. Withdraw a second spline from Zone 1 and again adjust rods in Zone 2 to reestablish critical.
5. Record control configuration and instrument readings.

Flux Traverses - Analysis of the data gathered during this testing program will be greatly enhanced by flux traverse data taken at selected times. A thimble will be installed in the B far side test hole for this purpose. It appears that a total of approximately six flux traverses will be desirable during the above program, as the optimum number for the best data and least test time used. The time to take any traverses in excess of those specified will be picked by the physicist in charge at the time. It is estimated that each traverse will take about one hour; this time is already allotted in the total test time estimates.

The objective of traversing is to gather flux distribution for use in the later analysis of the tests. The data taken will consist of relative flux levels every 1-1/2 to 2 feet throughout the length of the test hole (Test Hole B runs from Lattice Unit 58 on the near side through the far side shield).

1. Traverses will be made in those places specified in the program plus perhaps one or two others where the physicist in charge feels that a traverse would be useful. The reactor will be taken to a low power level (approximately 50 kw) and the power level held constant.
2. The traverse chamber will be fully inserted in the B Hole (full-in will be at approximately Lattice Unit 58).
3. After the necessary data for the first traverse point has been taken, the chamber will be moved 1-1/2 to 2 feet as determined by the physicist in charge and another data point taken.
4. This will be continued until the last meaningful data point at the far side of the pile is recorded.
5. The traverse chamber will be removed from the test hole.

V. REACTOR HAZARDS (and Applicable Process Standards)

The potential hazards associated with this testing program should not be greater than the potential hazards in conjunction with normal pile operation and/or previous startup testing programs. It is not intended that standard safety criteria will be violated under any circumstances; however, specific procedural changes to Process Standards are necessary in order to perform the tests without needless time delays due to unwarranted conservatism.

A. Reactor Atmosphere (B-010)

These standards set the requirements and specifications for the reactor atmosphere during reactor operation.

The basis for this group of standards is threefold: prevention of high moderator burnout rates, heat removal from the stack, and moisture removal from the stack. These points become increasingly important in the high moderator temperature ranges associated with normal reactor operation. Since no significant heat will be generated in the moderator during this physics test, allowing the gas system to be in a reactor shutdown status, although constituting a standards waiver, would not compromise the intent of the Process Standards.

B. Reactor Coolant (A-010 through A-080)

These standards are all those specifying normal and emergency water flow through the unit.

From a heat removal standpoint (namely that of residual fission product decay heat), both normal and emergency requirements during this physics test are identical with a regular shutdown. For this reason, this physics test program may be considered to be a shutdown when interpreting reactor coolant standards.

In addition, trips in the primary safety circuit will be provided to rapidly shutdown the reactor in the event of a significant reduction in flow, as indicated by a decrease in TORP to below 60 psi.

C. Panellit System Bypass (A-050)

This standard requires that the Panellit be unbypassed if the reactor power level is above 2 MW. This requirement is not waived.

The Panellit trip system will be bypassed during the test; however, pile power level will never exceed 1 MW. The maximum tube power expected under distorted conditions would be approximately 1 kw; however, ample cooling is provided at TORP of 75 psig to cool tubes at 50 kw power per tube. The Panellit-Beckman interlock will be set to unbypass the Panellit board if the Beckmans are ranged to

allow a higher power level than the 1 MW test limit. With the specified 1 MW calibration point on the Beckmans (between one and two major divisions from the top of the scale), it is estimated that 5 MW would be the maximum attainable power level in the fully loaded reactor if the trips were inadvertently moved to the top of the scale (this would correspond to approximately 1-1/2 MW in the minimum critical slab reactor). This would, of course, result in an automatic scram. If the Beckmans were ranged to permit a higher power level, this would unboass the Panellit and would also result in a scram. This Panellit-Beckman interlock setting with the test TORP of 75 psig gives added protection against exceeding the planned test maximum power level in case of error in the Beckman trip settings.

D. Beckman Trip Settings (C-030)

This standard specifies the Beckman trip settings during reactor startup.

Process Standards relating to cold startup procedure will apply for the first startup period and rise to power (1 MW). After this initial period the Beckman trip points must be set so that the power level will never exceed 1 MW. All of the subsequent test periods will be obtained while the Beckmans are set at this limit. This does not represent a waiver of the present standard.

E. Flux Monitor and Safety Circuit Interlocks (C-030)

This standard requires that at least three Beckmans be in the No. 1 Safety Circuit on a two-out-of-three coincidence trip. This requirement is not relaxed; however, equivalent alternate requirements are specified.

During this test, at least three Beckmans will always be available and connected to the No. 1 Safety Circuit with at least two of them unbypassed at all times in a one-out-of-two high or low trip matrix. The neutron chambers which supply the signal to the Beckman amplifiers will be installed prior to initial criticality and initial readings from both the galvanometer and subcritical monitors will be used to calibrate chamber sensitivity. Three Beckman chambers in the far side test holes will be used for power level trip protection. The test procedures (Test B) have been designed to provide adequate trip protection, and to provide a "chamber to VSR" test of the system.

F. Startup Requirement Before VSR Withdrawal (C-060)

This standard requires that the reactor be 0.15 percent $\Delta k/k$ subcritical, exclusive of the VSR system, should the VSR system be withdrawn at any time during an outage. This requirement would preclude the use of any VSRs as planned for the test. Special procedures are specified in the test to ensure that the reactivity

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status of the reactor will be well known at all times, that criticality will be approached with more precise knowledge than normal, and that total control and speed-of-control requirements will be met with Standard C-060 waived for this test program.

Normal startup procedures (including a check of the newly installed pressure (TORP) monitor) will be followed to obtain the initial period and to test the Beckman safety circuits. After the safety systems have been set and tested, one or several vertical safety rods will be left in the pile (depending on the amount of potential reactivity), and a rising period will be obtained by pulling the remaining vertical controls and the horizontal controls. The specific test procedure calls for removal of all of the VSRs except those being used, with criticality attained by fine adjustment of two or three horizontal control rods.

Achieving a controlled critical state with selected vertical safety rods in the reactor will in no way be permitted to compromise speed-of-control or total control criteria. Throughout the data taking period the lockbars will be off the ball 3X system; that system will be available for immediate insertion. All VSRs and HCRs that are out of the pile will also be available for immediate insertion by either an automatic safety circuit trip or a manual scram. At the most reactive test condition, after all of the xenon has decayed away, at least 12 vertical safety rods plus four horizontal control rods will be immediately scrammable. Between test measurements the rising periods will be stopped by fully inserting the two or three HCRs being used for fine control and at least four VSRs. Once the HCRs have been repositioned for a test configuration, the rods not being calibrated will be withdrawn no faster than two-at-a-time. (This is accomplished automatically through interlocks presently installed on the reactor.)

The xenon transient, if any, will be continuously calculated and known throughout the tests so that a critical prediction will exist for each test position. Scrammable poison will always be ready and available so that the amount insertable will always exceed the potential reactivity of the pile. The amount of control being withdrawn per unit time will never exceed what is permitted for normal startup operations currently allowed by Standards, with the possible exception of the PCCF Flush (Test E) which is covered in Part "K" of this section.

G. VSR-HCR Interlock (C-060)

This standard requires that an HCR-VSR interlock be in operation before the reactor startup in order to eliminate the possibility of withdrawing any VSRs with some HCRs out of the reactor.

In order to permit the removal of any HCRs before all of the VSRs have been removed from the reactor, SNM relay must be jumpered. Waiving of Standard C-060 to permit this jumpering has been normal

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procedure for control rod calibration and other production tests when the critical transient was being continuously monitored throughout the test and special monitoring procedures were in effect to ensure that the rate of approach to critical was correspondingly conservative.

H. Startup Period Limitation (C-070)

This standard requires that any rising period shorter than 30 seconds be slowed to a minimum of 30 seconds by HCR insertion and that the reactor be manually scrammed in event of any rising period shorter than 15 seconds. Since a continual reactivity transient will be calculated and checked by observations during the test, the available excess reactivity will be accurately known at all times.

The shortest planned periods for the test will be 20 seconds or greater, and the reactor will be manually scrammed if the period becomes less than 15 seconds. Required testing time will thus be minimized and the number of test cases increased within reasonable conditions.

I. SN Relay Bypass (C-070)

This standard requires that the SN relay be unbypassed for reactor startup, thereby causing all VSRs and HCRs to scram if one VSR starts into the reactor. The primary reason for this standard is to ensure that the VSRs are removed from the reactor prior to HCR withdrawal, a condition which would prevent VSR calibration. This standard requirement will, therefore, be waived in order to avoid insertion of superfluous VSRs and HCRs between period measurements.

Four VSRs and the two or three HCRs will be more than sufficient to stop any planned period, whereas any more would only delay the next test because of excessive removal time and depressed background level. Any excessively fast periods (<15 sec.) will be stopped by inserting all available insertable control rods with a scram of the No. 1 Safety Circuit. That the bypassing of the SN relay will not compromise rod system scrammability will be verified when testing the Beckman trips under Test B.

J. Ball 3X Hopper Out-of-Service During Operation (C-090)

This standard requires that any ball 3X hopper which is out-of-service during the first 30,000 MWH of any operating period (i.e., low xenon and residual fuel heat inventory coupled with hot moderator), be compensated for with specified supplementary poison.

At no time during this test program will sufficient heat be generated due to reactor power level to cause an observable temperature rise in the moderator. Normal shutdown total control measures will be sufficient to ensure that Standard C-100 is complied with. The above

C-090 requirement will therefore not apply for the duration of the testing program. The total system strength of the ball 3X system will be reduced an appropriate amount in total control calculations to compensate for Ball 3X Channels No. 22 and No. 26 (for instrument access holes) being out-of-service.

K. Reactivity Insertion Rate

During Test F it will be necessary to simulate a step reactivity insertion of roughly 0.15 percent $\Delta k/k$ by flushing poison from a PCCF. Although this is contrary to the wording of the Reactor Operating Limits in that it produces a ramp of 0.15 percent $\Delta k/k$ per second, it is considered to be within the intent of the Limits because it is not a continuous ramp. Furthermore, the maximum insertion will be approached in steps, so that estimates of the reactivity insertion and corresponding period for the next step can be made. Finally, the fastest period in the test will be slower than the 20 second minimum allowed.

VI. SPECIAL INSTRUMENTATION

Three additional neutron-sensitive chambers must be inserted in the far-side test holes before Test C. These will provide neutron flux level signals to the Beckman amplifiers and give nuclear power level trip protection. This will allow the operation-proven Beckman system to be used for power level protection and involve only chamber relocation. From a detection point of view, the far-side chamber location will be equivalent to the present bottom location. To provide space for these chambers, and to improve the subcritical monitoring during the test program, two subcritical chambers will be installed in VSR Channels Nos. 22 and 26 prior to the tests. These chambers will be compatible with the present SCM amplifiers which will be available for use. In addition, two neutron sensitive chambers are to be located in Process Channels 0969 and 0978. These will be used during Test F and will be connected to scalers in the control room. Finally a special traverse chamber, connected to a scaler in the control room, will also be provided.

This auxiliary instrumentation will be provided by and installed under the direction of the Instrument and Electrical Development Unit. This unit will also operate the special instrumentation systems and provide maintenance and consulting services on this instrumentation throughout the tests.

VII. COSTS

A. Production

Since these tests are scheduled to take place after the final shut-down of D Reactor, they represent no real production loss.

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B. Manpower

The tests are scheduled to take approximately two days (other than the initial 80 hours). Very little of the planned deactivation work may proceed during this period. When the reactor is turned over to the deactivation crew at the completion of the tests, it will be approximately one-half discharged and the discharged metal will have been picked up. Manpower requirements will be essentially the same as for normal operation, including the complete D Processing roster (or equivalent) on a shift basis.

Subject to later scheduling by D Processing, it appears that discharge and metal pickup operations scheduled during parts of the test would require outside manpower assistance to minimize time taken for Processing work and, thereby, permit fullest use of the available test time.

Each physics crew will consist of a Technical Crew Leader and two assisting physicists, supplied by Research and Engineering (largely by Physics Subsection); it is possible that some assistance may be requested from the N-Reactor Department (GE). Because of the short duration of the tests, it is anticipated that only three physics crews will be requested to provide around-the-clock physics coverage; substitutions will be made within the crews to permit coverage at other reactors.

Instrument and Electrical Development Unit will provide around-the-clock instant coverage during the test program.

C. Equipment

The only special items of equipment needed for this test program are the instruments and thimble to be fabricated by D Reactor Maintenance and those being supplied by Instrument and Electrical Development Unit. All major components of the instrumentation are already on plant. The three Mark IV Beckman chambers are also available without need for purchase.

G. F. Bailey
Physics Subsection
Research and Engineering Section

GFB:ls

VIII. RESPONSIBILITIES

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A. Manufacturing Section

D Processing Unit shall be responsible for:

1. Safe operation of the reactor according to Process Standards and Standard Operating Procedures and to instructions with modifications as authorized by the test.
2. Scheduling and conducting the test according to normal shut down and start up practices with modifications as dictated by the test.
3. Coordinating the test work with deactivation work.
4. Ensuring adequate radiation monitoring coverage throughout the test program.
5. Operating all safety instrumentation and reactor controls plus any special instrumentation as requested by the physicist in charge.
6. Preparing in advance special processing procedures required for the safe conduct of the test and any special procedures specifically assigned in the test document.
7. Interruption of the test if such action is justified in the judgment of the ranking Processing representative in attendance.

J. J. B. B.

D Maintenance Operation shall be responsible for:

1. Installation of all special equipment except those instruments to be installed by FES.
2. Any normal maintenance requirements during the test program.
3. Preparing in advance any special schedules or procedures as required in the test document.

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Manufacturing Engineering Subsection shall be responsible for:

1. Reviewing all planned changes to the safety circuit to assure their compatibility with the hazards connected with the test.
2. Preparing Acceptance Test Procedures of all safety circuit changes.
3. Observing all acceptance tests and certifying the adequacy of the system before physics testing proceeds.

RK Gange for JW Green

B. Facilities Engineering Section

Instrument and Electrical Development Unit shall be responsible for:

1. Supervising the installation of all special instrumentation and checking its operability.
2. Scheduling any manpower assistance which will be required from D Maintenance to support the Instrument Program.
3. Ensuring the availability of spare parts for the special instrumentation.
4. Maintaining a close surveillance over the operation of all special nuclear instrumentation used during the tests.

E Karcher

C. Research and Engineering Section

Physics Subsection shall be responsible for:

1. Providing technical leadership and manpower during all phases of the test program (including recommendations to halt the test when such action is warranted in the judgment of the physicist in charge).
2. Assuring that all the proposed tests are covered by Hazards Analyses and procedures authorized in this production test and its supplements, and/or by Process Standards.
3. Auditing adherence to total control and speed-of-control requirements.

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4. Continuously monitoring pile reactivity status both existing and potential, and calculating planned periods in advance of rod withdrawals.
5. Supplying detailed physics procedures to be used for test planning by D Processing.
6. Reviewing procedures in advance as required in the test document.
7. Detailed test planning, collection and analysis of test data, and final test reporting.

W. A. C. C. C.

Reactor Engineering Subsection shall be responsible for reviewing and approving any special procedures specifically mentioned in the test document.

P. A. C. C. C.

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APPROVALS

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1912
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FIGURE 1

REACTOR LOADING AT END OF TEST A

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APPENDIX A

ATP FOR SAFETY CIRCUIT COINCIDENCE MODIFICATIONS

The purpose of this appendix is to provide instruction and an Acceptance Test Procedure for removing the two-out-of-four coincidence matrix in the flux monitor portion of the No. 1 Safety Circuit, D Reactor, and for replacing it with a one-out-of-one coincident trip circuit. This will allow any one of the four flux monitors to trip the No. 1 Safety Circuit. No revision is to be made out of of the two-out-of-four matrix of the bypass switches.

PROCEDURE

1. Remove power from XX-1-2 circuit (No. 1 Safety Circuit power) by removing fuse XF-8 in Cabinet 3, Electrical Equipment Room No. 2.
2. Remove all wires from the contacts of BK-1, BK-2, BK-3, and BK-4 relays that are in the No. 1 Safety Circuit. (Figures A-1 and A-2).
3. Mark and rewire with 14-gauge switchboard wire as shown.
4. Restore power to the XX-1-2 circuit.

ACCEPTANCE TEST PROCEDURE

- 1.0 Energize the No. 1 Safety Circuit. Bypassing of components may be used where necessary with the exception of the flux monitors. _____
- 2.1 Trip the No. 1 Flux Monitor. Observe that only the BK-1, BX-BXA and IXX-IXXA de-energize. _____
- 2.2 With No. 1 Flux Monitor still tripped attempt to reset No. 1 Safety Circuit. Observe that safety circuit does not reset. _____
- 2.3 Reset No. 1 Beckman. Observe relays BK-1, BX-BXA energize. _____
- 2.4 Reset No. 1 Safety Circuit. _____
- 3.1 Repeat steps 2.1-2.4 with Flux Monitor No. 2 and observing BK-2. _____
- 3.2 _____
- 3.3 _____
- 3.4 _____

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ACCEPTANCE TEST PROCEDURE (Continued)

4.1 Repeat steps 2.1-2.4 with Flux Monitor No. 3 and observing BK-3.

4.2

4.3

4.4

5.1 Repeat steps 2.1-2.4 with Flux Monitor No. 4 and observing BK-4.

5.2

5.3

5.4

6.0 Perform normal safety circuit startup checks, and, by tripping the instruments and observing that the annunciator lights come on, ascertain that all trip functions (Panellit, Rate-of-Rise, Seismoscope, etc.) will operate normally to trip the LXX Safety Circuit.

Witnessed and Approved:

D Processing

Manufacturing Engineering

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FIGURE A-1

EXISTING FLUX MONITOR TWO-OUT-OF-FOUR MATRIX

NEW FLUX MONITOR ONE-OUT-OF-FOUR MATRIX

REFERENCE: H-1-11190

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FIGURE A-2

Existing

New

Remove

REFERENCE: H-4-10401

APPENDIX B

ATP FOR FAR SIDE SAFETY CHAMBERS

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The purpose of this appendix is to provide a continuity check on three neutron monitor chambers to be installed on the far side. The chambers will be calibrated after installation.

PROCEDURE

1. Provide and install three shielded signal cables from the far side of the reactor to the panel behind the flux monitors. Existing signal cables may be used where possible.
2. Mark cables at both ends for connection to flux monitors, identifying both the flux monitor and the chamber.
3. During outage attach each of the chambers to signal cable and the signal cable to the flux monitor.

ACCEPTANCE TEST PROCEDURE

1. With the far side chambers connected through the signal cable, observe signal on flux monitor to signify cable continuity.

Witnessed and Approved:

D Processing

Manufacturing Engineering

APPENDIX C

ATP FOR VSR-HCR SAFETY CIRCUIT MODIFICATIONS

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The purpose of this appendix is to provide instruction for bypassing the VSR-HCR interlock function in order that horizontal rods may be moved with not all vertical safety rods withdrawn from the pile. With the SNM bypass switch in bypass position both HCRs and VSRs may be moved.

PROCEDURE

1. Prior to installation, physically trace wires 40-1-14 and 40-1-14A on contacts 2-C and 2 of VSR trip and HCR bypass switch to terminal board TB "A" on the control desk.
2. Remove power from XX-1-2 circuit.
3. Place jumper (14-gauge switchboard wire) between 40-1-14 and 40-1-14A on terminal board TB "A" (Figure A-3).
4. Restore power to XX-1-2 circuit.

ACCEPTANCE TEST PROCEDURE

1. Make up No. 1 and No. 2 Safety Circuits with the VSR trip and HCR bypass switch in normal position. _____
2. Partially raise one VSR*. Observe VSR withdrawal. _____
3. Attempt to move one HCR*. Observe that HCR does not move. _____
4. Place SNM bypass switch in bypass position. Observe that VSR does not scram. (No. 1 Safety Circuit remains energized). _____
5. Attempt to move one HCR. Observe that HCR moves. _____
6. Perform normal safety circuit startup check. _____

Witnessed and Approved:

D Processing

Manufacturing Engineering

* Note: The particular HCR and VSR are to be determined by the Reactor Physicist.

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FIGURE A-3

PARTIAL NO. 1 SAFETY CIRCUIT ELEMENTARY

REFERENCE: H-1-11190

BYPASS SWITCH PANEL - PARTIAL