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Regulatory File Cy.

Dr. Peter A. Morris, Director
Division of Reactor Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Subject: Request to perform reactor dynamics tests on Dresden Unit 3, DPR-25, AEC Dkt 50-249

Dear Dr. Morris:

Pursuant to 10 CFR 50.59a, Commonwealth Edison Company requests permission to perform dynamics tests on Dresden Unit 3. Permission is being requested to perform these tests since the stability margins discussed in the Safety Analysis Report and Amendments 9/10 thereto will be reduced during the testing.

The purpose of the dynamics tests to be performed on Dresden Unit 3 is to obtain experimental data to verify reactor dynamics models. Similar tests have been performed at Big Rock Point, KRB and SENN. Dresden Unit 3 represents one of the first large boiling water reactors employing jet pumps. Therefore, it is desirable to obtain dynamics information on this unit. These tests will determine the response of the reactor to small disturbances in reactivity, core inlet temperature, pressure, and recirculation flow.

Pursuant to 10 CFR 50.59(d), a Safety Analysis in support of this test is attached. These tests have been reviewed and approved by Commonwealth Edison's Nuclear Review Board.

In addition to three signed originals, 19 copies of this request are also submitted.

Very truly yours,

Byron Lee Jr

Byron Lee, Jr.
Assistant to the President

SUBSCRIBED and SWORN to
before me this 12th day
of August, 1971.

Patricia A. Nelson
Notary Public

3652

Dresden Unit 3
Reactor Dynamic Test
(Rod Oscillator)

I. SUMMARY

In the dynamic or oscillator tests, the dynamic response of the reactor system to various disturbance parameters will be measured. The small disturbances (sinusoidal of various frequencies or step) will be introduced by four parameters:

1. Reactivity (control rod)
2. Core inlet temperature (feedwater)
3. Pressure (BPV)
4. Core flow (recirculation flow)

The responses to be measured are:

1. Radial and axial neutron flux (LPRM) distributions
2. Various pressures and flows relating mostly to the steam flow from the reactor core to the steam turbine. At each reactor test condition, the tests will last about eight (8) hours. This includes all four disturbance types.

II. INTRODUCTION

The dynamic or oscillator tests are concerned with the performance of the reactor system in non-steady state conditions. The measurements determine directly the stability of the plant in the neighborhood of the test condition. An unstable plant would either be very sensitive to controls at that condition or may generate oscillations itself which may grow to some limiting amplitude at which point the reactor may scram if the amplitude is sufficiently great. A reactor system with a low degree of stability leads to operational problems.

Analytical models are used to predict the behavior of reactor systems. Numerous startup transiets are run on a reactor system. These are usually of large amplitude. These can be used to check and improve analytical models but this method suffers from two disadvantages:

1. Noisy signals mask some information
2. The large disturbance complicates the analysis by the constantly changing operating point.

The large transiets must be handled by dynamic codes but in the detailed check-out of various components of analytical models it would be better if these mathematical complications were eleminated.

INTRODUCTION (CONT.)

The oscillator test then has these advantages over transients for detailed model evaluation:

1. The operating condition is relatively constant
2. The repetitive nature of the experiment (many oscillations in series) allows the use of mathematical tools to increase the signal to noise ratio.

In particular, the current analytical models use distributed or spatial models for the steam formation and distribution and a point model for the reactor kinetics. The oscillator tests measure a sufficient number (20) of radial and axial neutron fluxes (LPRM) to determine the need for a much more complex spatial hydrodynamic and reactor kinetics model.

The small disturbances will be introduced through four parameters:

1. Reactivity (1 control rod)
2. Core inlet temperature (feedwater)
3. Pressure (bypass valve)
4. Recirculation flow

The responses of the reactor system will be measured by about 20 neutron flux signals and 10 reactor system flow and pressure signals. The neutron flux signals to be measured consist of 2 APRM signals and 18 LPRM signals. The LPRM signals consist of 4 axial strings at 5 different radial locations. The radial locations are selected to determine if any radial mode or azimuthal mode responses exist. The plant parameters that will be measured are pressures in the plenum between the core and the steam separators, the vessel head pressure, the main steam header pressure and flows in the steam lines, feedwater lines and recirculation lines.

The tests will be conducted at 8 different conditions. The flow and power at these conditions are shown below:

STARTUP TEST CONDITION NO.	POWER (%)	FLOW (%)
4	25	35
10	75	100
11	39	30 (NC)*
13	70	55
14	100	100
15	54	30 (NC)
15	54 (may be reduced)	30 (NC)
15	54 (may be reduced)	30 (NC)

*NC - NATURAL CIRCULATION

At the last two conditions, the operating conditions will be non-standard. At one condition the subcooling will be twice the normal value. This will be obtained by shutting off some of the feedwater heaters. At the other condition, the power shape will be deliberately concentrated towards the bottom of the core by rod pattern manipulation. These two test conditions were selected because the analytical model showed sensitivity to subcooling and power shape.

The MCHFR at these non-standard conditions will be calculated using the standard procedure for calculating the MCHFR. The minimum MCHFR will be set at 1.9 x 1.15 = 2.2. This includes a 15 percent of point allowance for the oscillation component. This is quite conservative since no credit is taken for the attenuation of the fuel on heat transferred to the surface.

III. DESCRIPTION OF TESTING

A. Control Rod Oscillation

In the control rod oscillation tests, one rod will be oscillated. There is a choice between M8 and N7, depending on which has the greater reactivity worth. Before the rod oscillation tests start, the operator will move the selected rod to various notches to calibrate the position measuring system. At that time the trip circuit will be calibrated so that the rod cannot approach the index tube notches closer than 1/2 inch.

A portable control unit will be installed in the reactor control room and will be operated by a test engineer. When the reactor system is ready for the tests, the reactor operator will give permission to start the test. The oscillator tests cannot be run without the reactor operator's knowledge and consent since the permissive switches are contained in the reactor control room in this unit. The steady state reactor conditions are controlled by the reactor operator. Only the oscillating signal is controlled from the Reactor Dynamic Instrument Room. This room is located just outside the dry-well on the first floor. The oscillating signal can be cut out manually from either the reactor control room or from the Reactor Dynamics Instrument Room.

The control rod oscillator, which is similiar to the one used previously in the KRB and SENN reactor oscillator tests is a multiple cylinder (3) hydraulic servo unit which varies the pressure in the insert and withdraw lines of a control rod system. Control rod M8 (46-31) or N7 (50-27) can be oscillated but only one at any time. The control of the drive to be oscillated is through the valves. The control for oscillating only one rod is procedural. The Isolation valves to the oscillated control rod will be open while the valves to the other control rod are closed. The closed set of valves will be tagged "Out of service". The rod motion will be limited to 5 inches maximum.

The rod oscillator system has a safety circuit which will close valves isolating the rod oscillator system from the control rod drive system for any of the following reasons:

(1) Reactor Scram
(2) Withdraw pressure riser above 1700 psi or below 400 psi.
(3) Insert water pressure riser above 1700 psi or below 400 psi.
(4) Control rod position approches within 0.5 inches of notch.
(5) Isolation valve air operating pressure falls below 75 psi.
(6) Loss of power to rod oscillator safety circuit.

A magnetic field detector type rod position indicator will be installed between the housings of control rods M8 (46-31) and N7 (50-27) to provide a feedback signal to the servo system. The electrical connections will be made through the drywell penetration, 202Q, made for the vibration tests. The drive signal can be generated by either the computer or a function generator located in the Reactor Dynamics Instrument Room. The drive signal operates a feedback hydraulic system to provide high pressure water alternately to the insert and withdraw lines of the control rod. The type of control rod motion (oscillatory or step) is controlled by the drive signal waveform.

Pretest calibration will take about two hours. Each rod oscillator test will last about one to one and a half hours. The steady state test conditions will be maintained constant by the reactor operator.

B. FEEDWATER OSCILLATION

The feedwater oscillations are obtainable by a relatively simple addition to the feedwater control circuit. A second input will be added to the normal steady-state input by introducing the oscillation signal at spare terminals of the Manual Automatic Station 640-19A or B. This controller has provisions for two inputs. One imput is used for the normal feedwater control valve signal, the second can be used for the socillatory signal provided that the manual automatic station is set for AUTO. The master controller must be set in MANUAL.

A switch arrangement allows selection of either feedwater flow control valve or both together for flow oscillation; normally only one valve will be selected. The controls for switching are in the portable control unit in the reactor control room.

The feedwater oscillation will be limited to a magnitude of such that the core inlet temperature oscillation is less than 20 degrees F.

The controls for the feedwater oscillation are in the portable control unit.

The main selector and the permissive switch operation are the same as for the control rod oscillation.

The master feedwater controller will be switched into MANUAL mode and each of the Manual/Automatic Stations will be in AUTO. The steady-state signal for the feedwater valves will be under the control of the master controller. The oscillation signal will be controlled from the Instrument Room; however, the loop selection, A, B, or A + B will be made from the feedwater loop selector on the panel.

C. BYPASS VALVE OSCILLATION (PRESSURE OSCILLATION)

The reactor pressure will be oscillated by controlling steam bypass valve number 9. The oscillation signal will be imposed thru the test position of the bypass valve control switch. This control is in the portable control unit in the reactor control room. The turbine load limiter will be adjusted to open bypass valves 1 and 9 to the 30 percent position. Then additional bias will be added to the BPV 9 to position the valve at its midpoint. The valve oscillation will be limited to 40% of its total stroke by limiting the oscillatory drive signal to ± 1.0 volt. This will insure that the BPV will not be slamming against the seat. A telephone handset will be installed near the BPV valve to monitor the valve sounds in the instrument control room during this test.

Pressure swings will be limited to ± 10 psi. The expected pressure oscillation will be about ± 3 psi or less.

On the control unit, the procedure is the same as for the control rod oscillator. The reactor operator will switch Bypass Valve No. 9 to the TEST position with the normal reactor controls only when the Bypass Valve is closed. The reactor operator will adjust the load limiter to open BPV 1 and 9 to the 30 percent position. The dynamic test engineer will then use the Bypass Valve Bias Control to reposition BPV 9 to the 50 percent position. The bypass valve will be positioned at the mid-point of its travel by using the Bypass Valve Bias Control and will be oscillated from the Instrument Room.

D. RECIRCULATION FLOW OSCILLATION

Recirculation flow will be oscillated by oscillating the scoop tube position of the hydraulic coupling of the recirculating system M/G set. Either drive loop or both may be oscillated.

For the test an auxiliary manually controlled signal will be used as the driver flow control signal. A balance meter arrangement, similiar to that used for switching from manual to automatic control will be used to effect smooth transfer from the normal system to the test system. These controls are contained in the portable control unit in the reactor control room during the test.

The steady flow through the two loops will be kept equal to avoid any vibration conditions in the jet pumps. Either one or both of the recirculation loop flows may be oscillated.

RECIRCULATION FLOW OSCILLATION (CONT.)

The desirable procedure is to oscillate both loops simultaneously. The oscillation is limited to ± 9 percent if one pump is oscillated. There are no limits for two pumps; however, the ± 9 percent for one pump will also be observed for the two pumps.

E. INSTRUMENTATION

1. Neutron flux signals for these tests will be obtained from the LPRM signals into the process computer. Tee electrical connectors are placed in the signal path and the signals required for test data will be taken from these tees.

2. To monitor pressure and flow oscillations high speed pressure transducers will be installed on normal plant instrument lines. The connections will be made placing a tee in the instrument vent and adding the test instrument.

IV. SAFETY EVALUATION

A. Control Rod Oscillation

1. Failure of a Rod Oscillator Hydraulic Line

In the event of a line break outboard of the control rod oscillator isolation valves, the isolation valves will close on low hydraulic pressure (400 psig) and the control rod drive system will be restored to normal operation.

If the line between the control rod oscillator system isolation valve and the insert or withdraw lines of the normal control rod drive system should break, the low pressure switches will sense the resulting reduction in pressure and isolate the control rod oscillator from the drive. Then, the response of the control rod system is the same as if any control rod line had broken which was analyzed in the FSAR. The inherent design features of the control rod drive will limit the motion of the control rod and are described below.

(a) If the withdraw line should break, then the pressure above the seals of the index tube will drop. This will cause the control rod to begin insertion and drop the pressure on the insert side. The ball check valve at the insert part of the control rod drive flange will then close (i.e., the ball will lift) and reactor pressure will be normal scram action of the drive in the event of loss of scram pressure. The result of the failure is insertion of the control rod and reduction in reactivity.

(b) If the insert line should break, then the ball check valve at the insert part of the control rod drive flange will close (i.e., the ball will lift), reactor pressure will be applied to the insert side and prevent full withdrawal of the control rod. This accident is no more severe than if one of the other drives developed the same problem.

2. Failure of Rod Oscillator Control Circuit

The worst case accident involving the rod oscillator controls will result from the following coincident failures.

a. Failure of the control rod position limit switch. (This control normally isolates the control rod from the oscillator if the rod travels beyond the five (5) inch test limit thus stopping rod motion at the next notch.)

b. Failure of the rod oscillator servo control in such a manner as to demand the maximum withdrawal rate.

These combined failures result in a rod withdrawal of 47 inches at a rate of 57.4 inches per second which is less than the maximum withdrawal rate of 60 inches per second analyzed in chapter 14 of the FSAR.

B. FEEDWATER OSCILLATION

Malfunction of the feedwater control valve oscillation circuit could result in a maximum or zero feedwater flow. These feedwater system transients were presented in section 11.3 of the FSAR.

C. BYPASS VALVE OSCILLATION (PRESSURE OSCILLATION)

Pressure oscillations will be performed using only one bypass valve (#9). Transients involving all nine bypass valves are more severe than those involving one valve and are reviewed in chapter 11 of the FSAR.

D. RECIRCULATION FLOW SYSTEM

Malfunction of the flow controller can cause either a recirculation flow increase (insertion of positive reactivity or a decrease (high power to flow ratio). Inadvertent recirculation flow increases are milder than the transient caused by starting a recirculation pump in a cold loop, and inadvertent recirculation flow decreases are less severe than a trip of one or two recirculation pumps. These malfunctions are discussed in Section 4.3.3 of Reference 1.

In this test, control of recirculation flow is transferred to a portable control unit located in the reactor control room. The circuit is designed to automatically transfer control back to the normal reactor system in case of:

(1) Power loss to the portable control until Reenergizing the control unit after power loss does not transfer control automatically back to the control unit from the reactor controls.

(2) Operator errors in switch operation. Any switching operation that would lead to loss of signal to the recirculation flow control system results in the automatic transfer of control back to the normal reactor system.

In addition the reactor operator can manually switch control back to the normal reactor system.

The normal reactor recirculation flow control system has a control signal delivered to the function generator from the speed controller. When using the portable control unit, a bias control signal is adjusted to match the speed controller signal, control is then transferred to the portable control unit, This operation is the same as transferring the normal reactor controls between the automatic and manual modes.

If automatic switching from the control unit to the normal reactor controls should occur, the transient generated will be proportional to the unbalance existing at the time of transfer. This unbalance depends on the amount of manual adjustment that had been performed after transfer to the control unit had taken place. Normally, no, or very little adjustment would be done.

These switching type transients are less severe than transients due to electrical malfunctions which in turn are still less severe than the accidents for the recirculation flow system covered in Reference 1.

The possibility of causing vibrations in the jet pump system are minimized by operating the two loops at equal flows and oscillating both loops simultaneously.

The possibility of setting up resonant vibrations between the pump oscillation and the jet pump riser braces was reviewed. The maximum recirculation system oscillation frequency will be about 1 cycle per second. The resonant frequency of the jet pump riser braces was about 25 to 30 cycles per second. The probability of exciting such a high harmonic is very unlikely.

Vibration instrumentation has been installed for many measurements in the plant. Some of these instruments are connected to the jet pump riser brace. To cover the remote possibility of excitation of the jet pump riser brace, the vibration will be monitored during the flow recirculation oscillation tests.

V. CONCLUSION

The proposed reactor dynamics tests should be approved. The test equipment is designed to minimize the probability of system transients and all possible transients have been analyzed in the FSAR.