APPENDIX 5F

REACTOR BUILDING INSTRUMENTATION

1 STRUCTURAL PROOF TEST AND INSTRUMENTATION

1.1 PURPOSE

Because of the importance of the containment structure to public safety, its integrity will be verified by a pressure test. As described below, this pressure test will permit verification that the structural response of the principal strength elements is consistent with the design. The test pressure level will be 63.3 psig (115 per cent of the design pressure). This pressure level is selected so as to impose, insofar as practical with a static pressur test, maximum stresses on principal strength elements which are reasonably consistent with those stresses imposed by a loss-of-coolant accident and the design earthquake.

1.2 GENERAL DESCRIPTION

The pressurization of the vessel will be done at 5 psi increments. Readings and measurements will be taken at 35 psig, 45 psig, 55 psig and the final test pressure of 63.3 psig. Except for the final pressure level, the vessel pressure will always be increased 1 psi above the level at which measurements will be made. The pressure will then be reduced to the specified value and observations made after a delay of at least ten (10) minutes to permit an adjustment of strains within the structure.

Because the structure is so large, displacement measurements (absolute or relative) can be made with precision and can be used as confirmation of previously calculated response. The test program will further include a visual examination of the vessel during pressurization to observe deformations and to demonstrate that no distortions occur of a significantly greater magnitude than those calculated in advance based upon the same analytical models used for the design of all structural elements for the loading combinations defined in Appendix 5B "Design Program for Reactor Building."

1.3 MEASUREMENTS

During the test at each specified pressure level a planned series of measurements and observations will be made at selected locations, generally as follo

a. Radial displacements of the cylinder and girder at a minimum of fiv elevations and at a minimum of three azimuths, as shown in Fig. 5-6 in order to ascertain if the response is symmetrical and verify the estimated response due to average circumferential membrane stresses

b. Vertical displacement of the cylinder at top relative to the founda tion slab at a minimum of three azimuths to determine the vertical elongation of the side wall and average tendon strains.

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c. Horizontal and vertical displacements of the reinforcing ring around the equipment access hatch opening.

d. Strain of reinforcing bars near the concrete surface around the equipment access opening, cylinder to girder and girder to dome transition. Small access ports to selected reinforcing bars will be left in the concrete so that strain gauges can be mounted just prior to the structural test. These gauges will be provided only in those places where this limited exposure of the steel reinforcement is not injurious to the behavior of the structure under test. Following completion of the structural test the access ports will be sealed.

e. The liner will be instrumented with electrical resistance strain gages in the region of several typical penetrations as well as a region unaffected by geometric discontinuities. Redundancy in strain readings will be accomplished by placing strain gage rosettes at several points about the penetration openings and by instrumenting approximately four penetrations which will be subjected to similar loadings and restraints.

To determine principal stresses, in magnitude and direction, gages employed will be in the form of 120 degree rosettes. In order to ensure correct functioning of the gages which have to contend with possible accidental damage and to minimize zero drift under effectively open-air conditions for periods in the order of 36 hours, a technique for gage encapsulation will be studied. This has previously been shown to provide protection against physical damage, and at the same time, by virtue of its moisture proofing properities ensures stability of insulation resistence under varying atmosphere conditions. Associated with the gages will be the application of a strain indicating brittle lacquer of qualitatively augment the local values indicated by the gages and to show the existence of a symmetrical, or otherwise, overall stress pattern.

In addition, to displacement data, cracks in the concrete will be observed in the following manner:

a. The vessel will be visually inspected for cracks and crack patterns.

b. At selected locations the surface will be white-washed for detailed measurements of spacing and width of cracks to verify that local strains are not excessive. These selected locations include:

1. Quadrant of reinforcing ring for large opening

2. Cylinder to girder and girder to dome transitions

3. The cylinder where circumferential membrane stresses are maximum and where flexural stresses are maximum

In addition, the movable (top) anchor heads of the tendons will be inspected for wires which have failed. A ruptured wire will be readily evident since the energy release upon rupture will cause the wire to noticeably rise and remain loose. Also a limited number of anchor heads will be coated with brittle lacquer to observe stress patterns.

Instrumentation for making these measurements will include dial gages, scales and theodolites used to read prepositioned targets. All gages and targets will be installed immediately prior to the test. As presently contempleted, the locations of the targets, dial gages, etc. are depicted on Figure 5-6.

All measuring devices including theodolites and dial gages will produce measu ments of sufficient precision to ascertain satisfactory structural response. For a theodolite located approximately 150 feet from the targets it will be possible to measure within 0.01 inches. For a maximum expected measurement of radial deflection of 0.22 inches a precision of 0.02 inches (twice the expected measuring accuracy) should be satisfactory. Where it is practical to use dial gages for greater accuracy, they will be used to make displacement measurements.

2 ACCEPTANCE CRITERIA

Prior to the test, a table of predicted strain and deflection values based upon the same analytical model used in the design calculations will be develo for an internal pressure of 63.3 psig, the pressure of the structural proof test, as well as ...ose lower pressure levels used to take measurements. No prediction will be made as to the anticipated strain readings for the liner. Values obtained, however, will be analyzed and evaluated to determine magnitu and direction of principal strains. If the test data include any displacemen which are in excess of the predicted extremes, such discrepancies will requir resolution including review of the design, evaluation of measurement errors and material variability, and conceivably, exploration of the structure. Pri to the test maximum anticipated crack widths will be predicted. If any crack widths occurring during the test are in excess of predicted values, such discrepancies must be satisfactorily resolved in a similar manner as for displac ments.

The objective of the final testing program, which is now being studied, is to produce data which when evaluated will result in a reliable confirmation of the response of the structure.

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