DUKE POWER COMPANY

OCONEE NUCLEAR STATION

UNIT 1 ONLY

LICENSE APPLICATION



Docket Nos. 50-269, -270, and -287

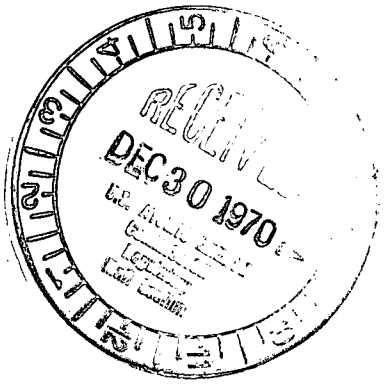
# REACTOR BUILDING STRUCTURAL INSTRUMENTATION REPORT



Submitted with Amendment No. 25

December 30, 1970

REGULATORY DOCKET FILE COPY




Regulatory File Cy.

Received w/Ltr Dated 12-30-70

DUKE POWER COMPANY

OCONEE NUCLEAR STATION

UNIT 1 ONLY

LICENSE APPLICATION

Docket Nos. 50-269, -270, and -287

# REACTOR BUILDING STRUCTURAL INSTRUMENTATION REPORT

Submitted with Amendment No. 25

December 30, 1970

4189

1. Purpose of Structural Instrumentation

Unit 1 Reactor Building was instrumented to verify the design by comparing the calculated behavior with measured strain data obtained during the structural test.

The following instruments were installed in Unit 1 Reactor Building as shown on Figure 5-21, Sheets 1, 2 and 3, Section 5 of FSAR:

| Quantity | Mark | Designation |
|---|---|---|
| 118 | SGA-1 | Two element strain rosette attached to rebar. |
| 9 | SGE-2 | Linear element attached to concrete surface. |
| 6 | SGC-3 | Crack propagation gages attached to concrete surface. |
| 18 | SGR-4 | Three element rosette attached to inside and outside face of liner and penetration nozzles. |
| 26 | SFT-5 | Two element rosette attached to inside and outside face of liner and penetration nozzles. |
| 7 | LC | Load cells attached to the tendons. |
| 26 | CB | Calibrated deflection bars attached to concrete surface. |
| 1 | - | Cement paint area on concrete surface. |

2. Purchase and Installation of Gages

The gages were purchased by Specification OS-267A, "Specification for Reactor Building Instrumentation," dated March 31, 1967. The specification listed the schedule requirements and stated that the proof test would be performed January 1, 1970. Due to unforseen circumstances, the proof test has been delayed by approximately one year.

The gages were installed in accordance with Specification OS-267B, "Specification for Reactor Building Instrumentation Installation," dated November 30, 1967, and revised April 8, 1968. A conference was held with the supplier's representative to review the installation specification and methods of gage installation.

Prior to installing the gages, the supplier held a training session with Field Personnel on the proper methods and procedures for gage installation.

Gages mark SGA-1 were fabricated and waterproofed in the supplier's shop. The test results were reviewed by Duke Engineering and found to be acceptable. In addition, the gages were waterproof and load tested by Duke prior to installation and found to be satisfactory. The SGA-1 gages were installed between January, 1968 and January, 1970.

3. Performance of Gages

The gages performed satisfactorily through April 1970, with only five percent losses. In May 1970, a significant number of gage failures began to occur.

The status of gages on November 28, 1970 was as follows:

| Gage Mark | Number Inoperative | Number Operative | Number Being Replaced |
|---|---|---|---|
| SGA-1 | 114 | 4 | (See 4b below) |
| SGE-2 | 7 | 2 | (See 4b below) |
| SGC-3 | 0 | 6 | - |
| SGR-4 | 7 | 11 | 6 |
| SFT-5 | 7 | 19 | 6 |
| LC (Load Cell) | 1 | 6 | (See 4d below) |
| CB (Calibrated Bar) | 0 | 26 | - |

The gage losses have been investigated by Duke, Bechtel and the Supplier. It was concluded that the gage losses (increase in gage resistance) was caused by chemical etching. The waterproofing material, Epoxylite 222, has broken down and moisture mixed with concrete chemicals has penetrated into the grid area and attacked the gages.

One of the load cells is inoperative due to moisture penetrating the waterproofing and grounding the gages.

4. Proposed Instrumentation Program

Since a significant number of embedded gages are inoperative, we believe it prudent to verify the design by (a) utilizing test results from Palisades and, (b) continuing with the Oconee Structural Test, as noted below:

a) The design and construction of Palisades and Oconee Reactor Buildings are very similar. The Palisades' structural instrumentation program was successful and permitted a detailed comparison between design calculations and observed response.

b) At Oconee, the calibrated bars (optical measurements) will permit verification that the structural response is consistent with the predicted behavior. In addition, twenty-six Carlson SAIOS strain gages will be surface mounted on the Reactor Building to obtain concrete strains for comparison with Palisades and those predicted for Oconee. (See attached Figure 5-21, Sheet 4).

c) Six inoperative gages mark SGR-4 and SFT-5 are accessible and will be replaced to obtain data for comparison with Palisades and predicted strains for Oconee.

d) Load cells that are inoperative will be repaired or supplemented with prestress rams that have been modified with 20 psi division gages to measure tendon forces. Prestress rams were used at Palisades and performed satisfactory. Results of measured forces can then be compared with those predicted.

5. Summary of Palisades Structural Integrity Test
(Submitted to AEC by Consumers Power Company, December 1970)

The containment test provided data on structural behavior for assessment of the design methods. Test measurements included concrete, reinforcing steel and liner strains; concrete temperatures; prestressing tendon forces; overall displacements; and concrete cracking patterns.

Test measurements were made at locations where analytical predictions of the measured parameters were expected to be accurate and at locations where supplemental information on structural behavior was deemed useful. Approximately 450 sensors were used to obtain the test data.

Measurement of concrete strain was the primary means of evaluating the response of the structure to dead load, prestressing and pressure loadings. Rebar-mounted strain gages and embedded Carlson meters were the principal sensors used to obtain strain information.

For the prestressing plus test pressure condition, the concrete was compressed showing that the pressure could have been higher without reducing the compression strain to zero. As expected, the pressurization resulted in only a 1 to 3 percent increase in the prestressing force, an amount that is considered negligible. This demonstrates that pressurization causes negligible cycling of loads in the prestressing tendons which are an important contributor to the containment strength.

The test data showed that the containment met design criteria and shows Agreement with predictions made with the design methods. There was no evidence of structural instability or loss of equilibrium. The strains resulting from prestressing were within the expected range and the residual strain resulting from pressurization was negligible. There was, therefore, direct evidence that the structure can safely sustain the two largest loads, pressure and prestressing.

6. Conclusion

Unit 1 Reactor Building design will be verified by: (1) comparing the calculated behavior with measured strain data obtained during the structural test from operative instruments supplemented with the replacement of accessible inoperative gages and the addition of 26 Carlson SAIOS strain gages and (2) utilizing the Palisades structural integrity test results since the design and construction of Oconee Reactor Buildings and Palisades are very similar.