



UNITED STATES  
 NUCLEAR REGULATORY COMMISSION  
 REGION II  
 101 MARIETTA STREET, N.W.  
 ATLANTA, GEORGIA 30323

Report Nos.: 50-390/90-26 and 50-391/90-26

Licensee: Tennessee Valley Authority  
 6N38 A Lookout Place  
 1101 Market Street  
 Chattanooga, TN 37402-2801

Docket Nos.: 50-390 and 50-391

License Nos.: CPPR-91 and CPPR-92

Facility Name: Watts Bar 1 and 2

Inspection Conducted: November 13-16 and 27-30, 1990

Inspector: J. J. Lenahan 12/21/90  
 Date Signed

Approved by: F. Jape 12/21/90  
 Date Signed  
 F. Jape, Chief  
 Test Programs Section  
 Engineering Branch  
 Division of Reactor Safety

SUMMARY

Scope:

This special, announced inspection was conducted in the areas of follow-up of the licensee's investigation of concrete quality, review of corrective action plans related to embedded plates, and IE Bulletin 80-11, Masonry Wall Design.

Results:

In the areas inspected, violations or deviations were not identified. The licensee's approach to identification and resolution of design and construction deficiencies has been very conservative, although not always timely. The licensee is in the process of evaluating other issues relating to the concrete quality program.

## REPORT DETAILS

### 1. Persons Contacted

#### Licensee Employees

R. Alexander, Supervisor Civil Engineer  
\*R. M. Bellamy, Project Manager  
C. Brillaste, Supervisory Civil Engineer  
\*J. H. Garrity, Site Vice-President  
F. R. Gass, Civil QC Inspector  
\*R. O. Hernandez, Project Engineer  
H. Hutchinson, Structural Engineer  
B. Majors, Quality Assurance Specialist, Site QA Group  
\*W. A. Massie, Licensing Engineer  
N. L. Perry, Civil-Structural Section Supervisor

Other licensee employees contacted during this inspection included craftsmen, engineers, operators, mechanics, security force members, technicians, and administrative personnel.

#### Other Organizations

T. Kipp, Project Manager, EQE Engineering

#### NRC Resident Inspectors

G. Walton  
M. Branch

\*Attended exit interview

### 2. Review of Concrete Quality Program (46055)

The inspector examined the results of the licensee's investigation of issues and concerns relating to concrete quality identified through the Employee Concerns program. The inspector also reviewed other concerns identified by the licensee during review of the Employee Concerns and design reevaluations conducted as part of the licensee's corrective action programs to prepare the plant for licensing. The inspection effort included review of reports and records documenting evaluation and resolution of the Employee Concerns, review of the licensee's corrective actions, where appropriate, and a walkdown of safety-related structures to evaluate the physical condition of the concrete. The inspector also reviewed the status of issues related to the concrete quality program.

a. Concrete Quality Evaluation

The licensee's Employee Concerns program identified 24 concerns related to concrete. The 24 concerns were grouped into fourteen issues covering processes such as concrete placement preparation, placement activities, structural adequacy, cracks, repair activities, curing, and commitments in regard to concrete testing. Four of the fourteen issues were determined to be factual. None of these represented conditions adverse to quality. Evaluation of employee concern number IN-85-995-002, which although in itself was not factual, resulted in identification of three significant conditions affecting concrete quality. These were as follows:

- (1) Some concrete mixes did not meet design compressive strength requirements for periods of time,
- (2) Concrete sampling frequencies did not comply with the specification requirement on some concrete placements, and
- (3) Use of bedding mortar was not properly controlled.

Nonconformance Condition Report (NCR) numbers 6719, 6720, and 6721 were issued to disposition these problems. The licensee performed a detailed study to assess these problems. The study included review of all concrete cylinder test data to identify low strength concrete placements, in place testing of potential low strength areas, and obtaining and testing cores in potential low strength areas. The results of these assessments are contained in TVA CEB Report 86-19C, Revision 1, Concrete Quality Evaluation, and TVA CEB Report 87-03C, Concrete Quality Evaluation - Testing of Inplace Concrete. The NRC Office of Nuclear Reactor Regulation (NRR) evaluated these problems and issued a Safety Evaluation Report dated January, 1990 for Watts Bar Unit 1. NRR concluded that the strength of the concrete and bedding mortar at Watts Bar is satisfactory and that these issues are resolved. The inspector reviewed TVA CEB Reports 86-19C and 87-03C. The test data indicates that the concrete at the outer surfaces of walls and at the top surface of slabs may be slightly below design strength values, although the overall section strength meets or exceeds design requirements. This can be most likely attributed to inadequate concrete curing. The NRC Construction Assessment Team inspection, conducted September - October, 1989 identified a concern regarding the concrete strength value used in design of embedded and surface mounted plates. This was identified as open item 50-390/89-200-26 pending further evaluation by TVA and NRC.

The inspector also reviewed the remaining employee concerns. These concerns are documented in a report titled "Employee Concerns Special Program, Volume 1, Construction Category, Subcategory Report 10200, Concrete". Several of the employee concerns dealt with construction procedure violations and violation of TVA Specification G-2,

Concrete. Resolution of these concerns resulted in revising the procedures and specifications to clarify requirements. However, since the concrete placement is for all practical purposes completed at the site, these type of corrective actions will not affect the quality of the in-place concrete. There were several other concerns which questioned the structural integrity and quality of the in-place concrete.

These concerns involved the following issues:

- Cracks in concrete
- Foreign objects or debris were not removed prior to placement of concrete
- Improper surface preparation prior to placement of concrete
- Substandard concrete (referred to in employee concerns as rotten, soft, weak, brittle and/or easy to drill)
- Concrete surface defects or improper concrete repair.

Since these issues would affect the visual appearance of the concrete, the inspector, accompanied by a licensee civil QC inspector and a licensee structural engineer, performed a walkdown inspection and examined the concrete surfaces in Category 1 structures. The walkdown inspection was conducted in accordance with ACI 201.1, Guide for Making a Condition Survey of Concrete in Service. This method is appropriate since the average age of the concrete at the plant exceeds 15 years. The inspector walked down the following structures:

Intake Structure  
Auxiliary Building  
Unit 1 and 2 Reactor Containment Building  
Diesel Generator Building  
Unit 1 and 2 Reactor Containment Shield Structures  
Control Building

In some areas, concrete surfaces were covered with paint (protective coatings) which masked the appearance of the concrete and precluded performance of the condition survey. However, the majority of the Category I concrete was in its natural state and could be visually inspected. The overall visual appearance of the concrete is good to excellent. The inspector noted the presence of some fine (less than 1 millimeter wide) vertical cracks in some walls, but these are normal conditions. The inspector also noted some pattern cracking on some exposed exterior walls, mainly in building parapet walls. The existence of the fine cracks, is a normal service condition, and does not affect the structural integrity of the concrete. There was no evidence of foreign objects or debris embedded in the concrete, substandard concrete, concrete deterioration, excessive cracking, distortion of structures, or concrete surface defects. Some cosmetic defects were noted, but these are normal in industrial type structures.

b. Review of Licensee's Corrective Actions Related to Concrete Quality Issues

The licensee issued Corrective Action Tracking Documents (CATD) which document the corrective action steps taken to fix specific deficiencies or discrepancies revealed by the employee concerns program. The inspector reviewed the CATDs issued for Subcategory 10200, employee concerns dealing with concrete. Concerns reviewed were as follows:

- (1) CATD 10200-WBN-01 - Inplace concrete temperature thermocouple reading not maintained as life-of-plant documents. During review of an employee concern licensee engineers discovered that concrete temperature thermocouple readings which recorded the freshly placed concrete temperature during curing were improperly filed in the QC unit. These readings covered various concrete pours placed prior to 1975. The licensee's corrective action was to file this data in the concrete records vault. During review of the temperature data a few instances were identified wherein the concrete temperature was permitted to fall below the specification limit of 50°F. However none of the temperatures went below 32°F. NCR 6926 was issued to disposition and resolve this problem. Since the concrete temperature did not fall below freezing, the licensee dispositioned the NCR "Use-As-Is". The inspector concurred.
- (2) CATD 10200-WBN-02 - Unable to locate pour card for concrete repair at sleeve mark 1686. This work involved installation of 10 pipe sleeves under Field Change Request (FCR) M10701. The sleeve locations are shown on mechanical drawings 47W471-9R3 and -24R3, and 47W472-9R26. The licensee was able to locate the pour card for the concrete repairs associated with installation of the other nine sleeves. The licensee issued NCR 7183, R0, later amended as NCR 7183, R1, to disposition this problem. The licensee reviewed all associated documentation associated with installation of sleeve 1686, which was installed under work release 6696. NCR 7183, R1 was voided and replaced by Condition Adverse to Quality Report (CAQR) WBP 871220. Based on review of concrete placement records for a one year period enveloping the time period when this work was completed, the licensee concluded that the missing pour card was an isolated occurrence, and that the concrete repair work was properly controlled during this period. The CAQR was dispositioned "Use-As-Is." The inspector concurred.
- (3) CATD 10200-WBN-03 - Problem with retrieving concrete QA records. During review of employee concerns, the licensee experienced difficulty in locating documentation for repair of concrete. The licensee issued procedure number QCI 1.40-6, Civil Engineer Unit Tracking Program in 1987 to improve civil QC record/document control. The licensee conducted a review of concrete

pour cards for repair of concrete, i.e. pipe sleeve installation, grouting of baseplates, etc. The conclusion from this review was that for work completed prior to 1984, the records are difficult to retrieve, but they can be found with enough time used in performing the search. For work completed after 1984, records are easier to locate.

- (4) CATD 10200-WBN-04 - Formwork cleanliness. This problem involved the cleanliness and condition of concrete formwork. Licensee's corrective action was to revise and clarify procedure QCP-2.02 to include reference to TVA specification G-8, Formwork for Concrete.
- (5) CATD 10200-WBN-05 - Control of use of epoxy bonding agents. This problem involved coating embedded plates and other metal surfaces with an epoxy bonding agent in locations where the temperature could exceed 120°F. The unrestricted use of epoxy material had been permitted prior to issuance of FCR-T-59, which clarified the use of epoxy bonding agent. The licensee performed a 100 percent review of concrete pour cards for grout placement under baseplates and identified three hangers/baseplates where the epoxy bonding agent was used. CAQR WBP 880074 was issued to disposition this problem. Design Change Notice (DCN) P-00511A specified corrective actions to rework the affected baseplates. TVA specification G-34, Repair of Concrete was revised to clarify restrictions against use of epoxy. It now specifies that epoxy materials are not to be used in areas where the temperature could exceed 120°F.
- (6) CATD 10200-WBN-06 - Use of epoxy grout to set anchors. This problem involved using epoxy grout materials to install anchors in concrete surfaces. This problem was originally documented on NCR 3567 and NRC Region II was notified on August 27, 1981 that this problem was a construction deficiency reportable under 10 CFR 50.55(e). The licensee conducted a testing program to determine the effect of heat and radiation on capacity of anchors installed using epoxy grout. The radiation testing was conducted by Wyle Laboratories while the load capacity versus temperature testing was performed at TVA's (now privately owned) Singleton Laboratory. The radiation testing showed that for an exposure period of 120 years (three times the life of the plant) radiation does not affect anchor capacity. The results of the testing of anchor capacity versus high temperature are reported in memorandum, RIMS number CEB-82-0920-077, Qualification of Epoxy Grout for Safety-Related Anchors. This testing shows that anchor capacity is reduced at a temperature above 120°F. The licensee issued ECN 3487 to identify all anchors installed using epoxy grout which may be exposed to a temperature in excess of 120°F, and to replace the epoxy grout with Portland cement

grout. Sixty-nine supports were identified inside containment which required repair because of this problem. In response to a 1987 Employee Concern, the licensee performed additional testing at Singleton Laboratory. The inspector reviewed Singleton Report dated February 9, 1989, Consistency Test of Epoxy Mortar Exposed to High Temperature. This report has similar conclusions as an earlier TVA report. As stated above, Specification G-34 has been revised to prohibit use of epoxy materials in applications where the temperature may exceed 120°F.

- (7) CATD 10200-WBN-07 - Low concrete strength. This problem, which was discussed in paragraph a, above, was documented on NCR 6719 and involved concrete which had in-place strength slightly below the specified design value. The licensee's corrective action was to revise notes on the concrete drawing and in design input documents to reflect that actual in-place concrete strengths may be below the design strength specified in the original design documents. The inspector examined drawing numbers 41N301 through 328, Auxiliary Building Concrete, drawing numbers 41N7109 through 718, Reactor Building, and drawing numbers 10N320 and 324, Diesel Generator Building, and verified they contained the appropriate note referencing the low concrete strength. The inspector also examined Watts Bar Design Criteria WB-DC-20-1, Concrete Structures-General, and Design Criteria WB-DC-20-1.1, Additional Diesel Generator Building and NCW Category I Structures. Appendix A to the design criteria reference the potential low concrete strengths.
- (8) CATD 10200-WBN-08 - Lack of procedural controls when using grout for bedding mortar. This problem was documented on NCR 6720-S. The licensee concluded, through in-place testing of concrete, that possible unrestricted use of bedding mortar did not adversely affect the in-place concrete strength. However, the licensee revised TVA Specification G-2, Concrete, to clarify procedural requirements when using grout for bedding mortar. The inspector reviewed specification G-2 and verified that paragraphs 3.12, 4.4.5, and 7.3.9 clarify the provisions for use of bedding mortar. The inspector also reviewed procedure QCP 2.02 and verified that requirements for inspection of bedding mortar placement were specified.
- (9) CATD 10200-WBN-09, Administrative Changes to FSAR. This CATD is still open and involves minor administrative, non-technical changes to the FSAR.
- (10) CATD 10200-WBN-10, Errors in concrete tracking program. This problem concerns errors found on computer printout data during review of employee concerns. The errors were primarily encoding errors which have been corrected.

- (11) CATD 10200-WBN-11 - Failure to follow G-2 requirements for slump and lift thickness. This problem concerned some impractical specification requirement for control of slump limits. The minimum requirements for slump and allowable slump limits were not shown on charts as required by Specification G-2. Procedure QCP 2.02 was revised to clarify the inspection requirements to preclude exceeding slump limits.
- (12) CATD 10200-WBN-12 - FSAR Revisions. This problem concerned the need to clarify the FSAR to state the problems with potential low concrete strength in various concrete placements. FSAR Revision Package 466 discusses problems with low concrete strength and includes a statement similar to that in Appendix A to the Design Criteria, discussed in paragraph 2.b.7, above.

c. Other Concrete Issues

The licensee has identified several other issues as a result of their evaluation of the employee concerns. These include the cumulative effects of attachment loads, cut reinforcing steel, and structure live and dead loads. The licensee has retained EBASCO to perform a detailed design review and evaluate the structural adequacy of concrete structures and the technical adequacy of the design calculations. The work is scheduled to be completed in June, 1991. Other issues involve equipment anchorage design and verification of the adequacy of embedded plate design. These issues will include consideration of lower than design concrete strengths at the outer surfaces of structures. This is similar to the open item identified by NRC, number 390/89-200-26. NRC will review these items in a future inspection.

d. Conclusions

Based on a review of various documents discussed above, and a physical walkdown of Category 1 structures to visually examine the concrete, the inspector concluded that the concerns related to concrete quality have been resolved. There are no unresolved issues related to concrete quality. However, the design review items discussed in paragraph 2.c, above need to be completed. The inspector also did not review quality records associated with concrete construction. The need to review these records will be determined by the licensee and NRC, and if deemed appropriate, concrete quality records will be reviewed in a future inspection.

3. (Open) IE Bulletin 80-11, Masonry Wall Design. The licensee has identified masonry walls which are affected by IEB 80-11. These walls are shown on drawing numbers 41N369, and 41N370, Unreinforced Block Walls - Potential Failure Zones, drawing numbers 16W419-1, and -2 Diesel Generator Building Reinforced Masonry Walls, and drawing numbers 46W405-1 through 46W405-5, Control and Auxiliary Building Reinforced Masonry Walls.



The inspector walked down these structures and examined the masonry walls. The inspector noted that several of the unreinforced walls had been removed to obtain access to equipment. EBASCO is in the process of performing a design re-evaluation of the walls to verify the adequacy of wall reinforcement and wall attachments. IEB 80-11 remains open pending completion of the design re-evaluation and further review by NRC.

#### 4. Exit Interview

The inspection scope and results were summarized on November 30, 1990, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee.