UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30303

Report Nos.: 50-390/84-05 and 50-391/84-05

Licensee: Tennessee Valley Authority
500A Chestnut Street
Chattanooga, TN 37401

Docket Nos.: 50-390 and 50-391

License Nos.: CPPR-91 and CPPR-92

Facility Name: Watts Bar 1 and 2

Inspection at Engineering Design Office, Knoxville, Tennessee

Inspector: J. J. Blake for W. C. Liu — 2/23/84 Date Signed

Approved by: J. J. Blake — 2/23/84 Date Signed
J. J. Blake, Section Chief
Engineering Program Branch
Division of Engineering and Operational Programs

SUMMARY

Inspection on January 17-20, 1984

Areas Inspected

This routine, unannounced inspection involved 24 inspector-hours at TVA Engineering Design Office, Knoxville, Tennessee, in the areas of pipe support base plate designs using concrete expansion anchor bolts (IE Bulletin 79-02).

Results

Of the areas inspected, two apparent violations were identified (Criterion V, Failure to Follow Procedure - Civil Design Standard (DS-C1.7.1) - paragraph 5.c, and Criterion V, Failure to Follow Procedures for Pipe Support and Base Plate Design Calculations - paragraph 5.d).

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*R. Hernandez, Head Civil Engineer, EN DES
*N. Liakonis, Principal Civil Engineer, EN DES
*N. Perry, Senior Civil Engineer, EN DES
*M. Cones, Civil Engineer, EN DES
*D. Williams, Nuclear Licensing Supervisor
*E. Beasley, Assistant to Manager, OEDC
*J. Ellis, Senior Civil Engineer, EN DES
*J. Ritts, Nuclear Licensing Engineer
*J. Worthy, Nuclear Licensing Engineer
R. Pratt, Senior Mechanical Engineer, EN DES
A. Manzano, Mechanical Engineer, EN DES
T. Demacopoulos, Civil Engineer, EN DES

*Attended exit interview

2. Exit Interview

The inspection scope and findings were summarized on January 20, 1984, with those persons indicated in paragraph 1 above. The licensee was informed of the inspection findings listed below. The licensee acknowledged the inspection findings with no dissenting comments.

(Open) Violation 390, 391/84-05-03, Failure to Follow Procedure - Civil Design Standard (DS-C1.7.1), paragraph 5.c.

(Open) Violation 390, 391/84-05-04, Failure to Follow Procedures for Pipe Support and Base Plate Design Calculations, paragraph 5.d.

(Open) Unresolved Item 390, 391/84-05-01, Factors of Safety for Concrete Expansion Anchor Bolts (IE Bulletin 79-02), paragraph 5.a.

(Open) Unresolved Item 390, 391/84-05-02, Pipe Support Base Plate Design Consideration (IE Bulletin 79-02), paragraph 5.b.

(Open) Unresolved Item 390, 391/84-05-05, Friction Force Consideration For Pipe-Support Design, paragraph 5.e.

3. Licensee Action on Previous Enforcement Matters

Not inspected.

4. Unresolved Items

Unresolved items are matters about which more information is required to determine whether they are acceptable or may involve violations or deviations. Three unresolved items identified during this inspection are discussed in paragraph 5.

5. IE Bulletin 79-02, Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts (25528) Units 1 and 2

The inspector held various discussions with the licensee's responsible personnel. It was noted that Watts Bar Pipe Support Groups perform not only pipe support/restraint analysis but also base plate designs including using concrete expansion anchor bolts. Some of the personnel who perform the aforementioned work activities have mechanical engineering background while others have civil engineering background.

The inspector reviewed portions of the following design standards, construction specification, and computing documents to determine whether they conform to the licensee commitments and NRC requirements:

- Civil Design Standard DS-C1.7.1, General Anchorage to Concrete, Rev. 1, December 19, 1983

- Civil Design Standard DS-C6.1, Concrete Anchorages - General, Rev. 1, August 26, 1976

- General Construction Specification G-32, Bolt Anchors Set in Hardened Concrete, Rev. 8, May 31, 1983

- Base Plate II (flexible base plate analysis) Computer Program User Manual, Rev. A, May 28, 1982

- User's Manual for CASDBAP (Computer Program For Rigid Base Plate Analysis), September 15, 1983

- Watts Bar Unit 1, IE Bulletin 79-02 Final Report, August 26, 1983

- EN DES-EP 3.03, Design Calculations, Rev. 6, January 31, 1983

a. Factors of Safety For Concrete Expansion Anchor Bolts (IE Bulletin 79-02)

Watts Bar Unit 1, IE Bulletin 79-02 Final Report, dated August 26, 1983, was reviewed and discussed with the licensee's responsible personnel. It was noted that the design allowables for self-drilling expansion shell anchor (SSD) and wedge bolt anchor (WB) were controlled by TVA's Civil Design Standard DS-C6.1. The factors of safety for SSD and WB anchors in DS-C6.1 are 2.8 and 2.6, respectively, for the abnormal loading conditions. The factors of safety for SSD and WB anchors under normal loading conditions are 4.5 and 4.0, respectively.

In accordance with IE Bulletin 79-02 requirements the minimum factors of safety for SSD anchors should be five and for WB anchors should be four. A review of the results from the sample of 41 safety-related base plate calculations indicates that factors of safety for SSD anchors are less than five in 15 base plates. These factors of safety are ranged from 4.0 to 4.90 as shown in Table 1 of the licensee's 79-02 Final Report.

The NRC inspector noted that the licensee had made a justification to raise the aforementioned factors of safety for SSD anchor calculations. An example of this justification was to use a 5,000 pounds per square inch concrete strength versus a 3,000 pounds per square inch originally utilized in the design. Furthermore, the inspector reviewed portions of the sample calculation (flexible base plate analysis) for Support No. 47A450-3-76. Results from the computer printout on January 22, 1983, indicated that a factor of safety for SSD anchor at node point 23 was 2.60 After a justification the factor of safety for the same anchor was 4.44 (should be 3.70) as shown in Table 1 from the licensee's 79-02 Final Report dated August 26, 1983. Sample calculation for Support No. 47A450-3-75 indicated that a factor of safety for SSD anchors at node point 9 and 13 was 2.80 based on computer run on December 5, 1983. This compared to a factor of safety 4.0 after a justification shown in the licensee's 79-02 Final Report.

Results from the sample of 41 base plate calculations indicate that factors of safety for SSD anchors in 15 base plate calculations do not meet NRC requirements even with a justification of using higher concrete strength. Pending further information to be furnished by the licensee, this matter is identified as Unresolved Item 390, 391/84-05-01, Factors Of Safety For Concrete Expansion Anchor Bolts (IE Bulletin 79-02).

b. Pipe Support Base Plate Design Consideration (IE Bulletin 79-02)

IE Bulletin 79-02 requires that the effect of base plate flexibility be considered in obtaining the anchor's maximum design load. A discussion held with the licensee indicates that Watts Bar base plates designs have not accounted for plate flexibility when determining the maximum anchor design loads and factors of safety as required by the bulletin. All Watts Bar base plate designs as of now have been based on rigid plate analysis. IE Bulletin 79-02 states that the base plates should be considered flexible if the unstiffened distance between the member welded to the plate and the edge of the base plate is greater than twice the thickness of the plate. The licensee has not implemented the aforementioned bulletin requirements nor added stiffeners to the base plates to reduce plate flexibility. Pending further evaluation by the licensee with regard to the above requirements, this matter is identified as Unresolved Item 390,391/84-05-02, Pipe Support Base Plate Design Consideration (IE Bulletin 79-02).

c. Civil Design Standard Implementation

During the discussions held with the licensee in the areas of IE Bulletin 79-02 requirements, it was noted that TVA Civil Design Standard DS-C1.7.1 has not been fully implemented by the licensee pipe support group in the area of base plate designs. Paragraph 5.0 of the standard states that the method of analysis may be based on the assumption that the contact surface between the plate and the concrete remains a plane provided the plate projects no more than four plate thickness (two plate thickness required by IE Bulletin 79-02) from the attached member or from stiffeners welded to the attached member and the base plate (i.e., rigid plate analysis). Otherwise the effect of base plate and anchor deformations shall be considered (i.e., flexible plate analysis). The failure of implementing the above documented criteria is a violation of 10 CFR 50, Appendix B, Criterion V. This item is identified as Violation 390, 391/84-05-03, Failure To Follow Procedure - Civil Design Standard (DS-C1.7.1).

d. Design Calculations

The inspector reviewed portions of the following approved design calculations and computer applications in the areas of pipe support analysis and base plate designs:

Support No.	Piping System
47A450-3-75, Rev. 1	Essential Raw Cooling Water
47A450-3-76, Rev. 1	Essential Raw Cooling Water
1-038-39, Rev. 0	Auxiliary Feedwater
17A586-1-12, Rev. 2	Essential Raw Cooling Water

The above design calculations, with respect to pipe support analysis, base plate design, and anchor load determination were reviewed for conformance to analysis criteria, applicable code, NRC requirements and the licensee commitments. Furthermore, these design calculations were evaluated for thoroughness, clarity, consistency and accuracy. In general, the calculations were performed in accordance with design documents with the exception of the following discrepancies:

(1) Support No. 47A450-3-76, Rev. 1, in the Essential Raw Cooling Water (ERCW) system was examined. It was noted on Sheet No. 3 of the design calculations that an incorrect bearing pressure diagram was used for base plate thickness calculation. The incorrect pressure diagram was based on a triangular distribution in lieu of a uniformly rectangular distribution. In addition, Sheet No. 6 through Sheet No. 19 of the design documents did not have the identification of preparer's and checker's names and the date of the work performed. Furthermore, the design calculations were not in conformance with the licensee's engineering procedure EN DES-EP 3.03, Design Calculations, Rev. 6 in terms of implementing the

requirements identified in Figure 3 through Figure 10 contained in the procedure.

(2) Support No. 47A450-3-75, Rev. 1, in the ERCW system was reviewed. It was found that Sheet No. 3 through Sheet No. 18 of the design documents did not have the identification of preparer's and checker's names and the date of the work performed. In addition, Sheet No. 2 of the design calculations showed that no tension-shear interaction formula was used to check the adequacy of the bolt allowable loads. The NRC inspector performed a calculation based on the actual tension and shear loads shown on Sheet No. 2. It was found that the ratio of the combined loads exceeded the allowable (i.e., greater than unity). As a result, the calculation of this anchor bolt would be rejected due to stresses over the limit. Furthermore, the calculations performed for this support were not in accordance with the requirements identified in engineering procedure EN DES-EP 3.03, Design Calculations.

(3) Support No. 17A586-1-12, Rev. 2, was evaluated. It was noted on Sheet No. 3 of the design calculations that the tension-shear interaction formula was not used to verify the adequacy of the bolt interactions. The bolt shear forces due to Fx (1626 lb.), Fy (1238 lb.), and Mz (2122 in.-lb.) were not calculated. By using the interaction formula, bolt no. 4 of joint 1 base plate would be overstressed resulting from the calculated tension-shear interactions.

(4) Support No. 1-038-39, Rev. 0, in the auxiliary feedwater system was inspected. It was noted that the design calculations for this support appeared to be adequate except that Sheet No. 2 was not signed and dated by the checker.

Discrepancies identified from the above 4 supports indicate that portions of these design calculations were not performed in accordance with engineering procedure EN DES-EP 3.03, Design Calculations; Civil Design Standards; and sound engineering applications (e.g., base plate bearing pressure distribution). These are violations of 10 CFR 50, Appendix B, Criterion V, and are identified as Violation 390, 391/84-05-04, Failure To Follow Procedures For Pipe Support and Base Plate Design Calculations.

e. Friction Force Consideration

The inspector held discussions with the licensee's responsible engineering personnel and reviewed various pipe support design documents. It was noted that friction forces due to thermal movement between the supporting member and the pipe have not been considered in

the pipe support design. Pending more information to be furnished by the licensee for further review, this matter is identified as Unresolved Item, 390,391/84-05-05, Friction Force Consideration For Pipe Support Design.

Within the areas inspected, two violations were identified.