TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

March 14, 1983

WBRD-50-390/81-14
WBRD-50-391/81-13

U.S. Nuclear Regulatory Commission
Region II
Attn: Mr. James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - IMPROPERLY INSTALLED SUPPORT ANCHORS - WBRD-50-390/81-14, WBRD-50-391/81-13 - FINAL REPORT

The subject deficiency was reported to NRC-OIE Inspector H. Dance on June 8, 1981 in accordance with 10 CFR 50.55(e) as NCR 3311R. NCR 3311R concerns improperly installed support anchors for the Watts Bar unit 2 reactor building. This is the same type of deficiency and corrective action program as NCR 2789R, which was initially reported to NRC-OIE Inspector M. Thomas on January 7, 1981. NCR 2789R was written for units 1 and 2, and interim reports were submitted on February 6 and June 23, 1981. Since these deficiencies are closely related, TVA has combined both NCR's into one report. Combined interim reports were submitted on July 8, August 13, September 27, and November 24, 1981 and January 25, March 30, July 13, September 8, and November 12, 1982. Enclosed is our final report.

NRC-OIE Inspector P. Fredrickson was notified on March 1, 1983 that this submittal would be several days late.

If you have any questions, please get in touch with R. H. Shell at FTS 858-2688.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Licensing

Enclosure
cc: Mr. Richard C. DeYoung, Director (Enclosure)
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
IMPROPERLY INSTALLED SUPPORT ANCHORS
WBRD-50-390/81-14, WBRD-50-391/81-13
10 CFR 50.55(e)
FINAL REPORT

Description of Deficiency

In at least two previous nonconformance reports (NCR) (CAQRE5 and CAQRM31) on Watts Bar Nuclear Plant (WBN), TVA reported deficiencies associated with the installation of support anchors used on cable trays and seismically qualified piping. The final reports on these NCR's (CAQRE5 and CAQRM31) were transmitted from J. E. Gilleland to J. P. O'Reilly on July 10, 1979, and May 15, 1979, respectively. The problem with support anchors is not, however, limited to cable tray and pipe supports, but rather to any support installation that uses surface-mounted plates and self-drilling expansion shell anchors (SSD). Recent nonreportable NCR's have been written on conduit supports and HVAC duct supports. There have also been a large number of nonsignificant NCR's written on specific areas of the plant. However, after completing the inspection and evaluation of approximately 2000 anchors, the conclusion is that the extent of the problem has been properly defined.

The common installation deficiencies that have been identified include:

(1) Anchors that have been cut short. (NCR's 3311R, 2901R, 2789R).

(2) Cut off bolts or improper length bolts which may result in insufficient thread engagement. (NCR's 3624R, 3311R, 2789R)

(3) Anchors not set to the proper depth (a common but nonsignificant problem).

(4) Oversized base plate holes (NCR's 3311R, 2789R).

(5) Removal and relocation of conduit supports without Electrical Engineering Unit's (EEU'S) approval (NCR 3311R, unit 2 reactor building, conduit supports in annulus area only).

(6) Anchors installed without proper pull test documentation (NCR 3409R).

An inspection program was initiated in response to IE Bulletin 79-02 for testing anchors on safety-related pipe supports, but this program did not address other support installations that use surface-mounted plates and SSDs such as supports for cable trays, conduit, and HVAC ducting.

TVA General Construction Specification G-32 (G-32), "Bolt Anchors Set in Hardened Concrete," provides anchor installation requirements for setting threaded anchoring devices into hardened concrete. However, prior to the issuance of revision 6 of G-32 (February 17, 1981), specific anchor installation requirements were not adequately addressed by the pertinent procedures available to site personnel. During this time period (i.e., prior to the issuance of revision 6 of G-32), each engineering unit was responsible for formulating and updating their individual procedures for anchor acceptance. The root cause of the deficiencies identified by items 1-5 above was failure to review G-32 revisions and promptly incorporate them into site procedures. Consequently, although the craft personnel followed the site procedures governing their work, the work performed did not conform to upper tier requirements.

The deficiency related to anchors being installed without proper pull test documentation is attributed to a procedural change which allowed a written description of lot boundaries to be used by Quality Control (QC) inspectors rather than requiring marked drawings and a lack of emphasis placed on documentation requirements. Use of the ambiguously defined lot boundaries resulted in the exclusion of some supports during the inspection process.

Safety Implications

The cited deficiencies could degrade the ability of the affected seismic supports and anchors to perform their intended safety functions. Consequently, the safety-related systems on which the potentially degraded supports and anchors were used may not have been able to withstand the effects of a design basis seismic event. This could result in a reduced level of performance or a loss-of-function failure for the affected safety-related systems which could be adverse to the safety of operations of the plant.

Corrective Action

TVA has completed an NRC-OIE Bulletin 79-02 type inspection at WBN for unit 1 and common anchors for cable tray supports, conduit supports, and duct supports. The inspection resulted in the evaluation of 1926 SSDs.

A minimum sample of 100 anchors was inspected for cable tray supports, conduit supports, and duct supports in the auxiliary building, control building, reactor buildings 1 and 2, and diesel generator building. The only place a sample was not taken is where SSDs were not used. An example would be in the reactor building where cable tray supports utilized embedded plates or in the diesel generator building where wedge bolts or embedded plates were used. The samples

were chosen primarily with the intention of identifying if anchor cutting to avoid reinforcing steel was a critical problem at WBN. Although all size anchors from 3/8-inch to 7/8-inch were inspected, a larger portion of the anchors were 5/8-inch or larger. The 5/8-inch anchor is usually the smallest size anchor that penetrates to the second layer of reinforcing steel and the probability of interferences with reinforcing steel would increase with the larger size anchors. The sample also required all accessible anchors on each support base plate to be inspected. This increases the chances of spotting cut anchors in a sample.

The inspection of cable tray supports and conduit supports was limited to inspection and evaluation. Those anchors that were outside criteria and were judged unacceptable were proof tested. The evaluation criteria used to evaluate the cable tray supports and conduit supports was the criteria developed by TVA for the Browns Ferry Nuclear Plant (BFN) NRC-OIE Bulletin 79-02 inspection. This criteria was developed to provide a 95 percent confidence level on plug depth measurements and a 99 percent confidence level on thread engagement measurements. The inspection data for conduit supports and cable tray supports is shown in Table 1. The results of the inspection of the cable tray support and conduit support anchors indicate that less than 3.57 percent of the anchors would not be expected to develop their maximum design loads with a 95 percent confidence level. The NRC-OIE Bulletin 79-02 requires a 95 percent confidence level that less than 5 percent of the anchors are defective. Since the failure rates of the samples were less than required by the NRC bulletin, no further inspection work will be required. TVA considers the inspection data and results to be acceptable. The anchors that were determined to be unacceptable by the 79-02 inspection criteria were proof tested and replaced where failure occurred.

The duct support samples were taken in the auxiliary building, control building, and reactor buildings 1 and 2. TVA proof tested all duct support anchors that were outside inspection criteria specified by G-32, revision 6, and replaced the anchors that failed the proof test. The inspection data for the duct supports is shown in Table 2. The inspection results for the duct support anchors were that less than 4.51 percent of the anchors would not be expected to develop their maximum design load with a 95 percent confidence level. Since the NRC-OIE Bulletin 79-02 requires a 95 percent confidence level that less than 5 percent of the anchors are defective, TVA considers the inspection data and results to be acceptable.

The inspection data was also reviewed for oversized bolt holes. There were only 17 baseplates in a total of 433 baseplates inspected (3.93 percent) that had oversized bolt holes; however, only 10 baseplates (2.31 percent) would be expected to slip before developing its shear loads. In all but three instances, the amount of oversizing was restricted to no more than 3/16 inch larger than the bolt diameter.

All samples except the control building cable tray support sample, had no more than 3.51 percent of the baseplates with oversized holes that would be expected to slip prior to developing their shear loads. The control building cable tray support sample had 3 baseplates out of the 24 baseplates inspected (12.5 percent) that would be expected to slip prior to developing their shear loads. The evaluation for all samples except the control building cable tray sample was determined to be acceptable with respect to oversize bolt holes based on the following reasons: (1) The percentage of baseplates with oversized bolt holes is small; (2) In all but a few instances, the oversized bolt holes are no more than 3/16 inch larger than the bolt size; (3) If slippage occurs, the frictional forces generated would contribute to higher effective damping and this will tend to "break up" any resonant responses.

The control building cable tray support sample was determined to be unacceptable with respect to oversized bolt holes (12.5 percent would be expected to slip prior to developing shear loads). The recommended corrective action for the sample is to require further inspection of baseplates for oversized bolt holes that could have potential shear transfer problems. The additional inspection would be restricted to expansion anchored baseplates (SSDs or wedge bolt) with two types of attachments: cantilever type with the distance from the back of the baseplate to the center of applied load being less than twice the bolt spacing and baseplates with sloping members attached. These two types of supports would not have the ability to transfer shear prior to slipping if the bolt holes are oversized. TVA will repair all oversized bolt holes in the original inspection samples that are oversized beyond the allowables and would result in the baseplate slipping prior to developing shear loads. If any oversized bolt holes are identified in the additional inspection, they will be repaired. The inspection and any required repair of cable tray supports is being performed in accordance with work package E293A02 which is scheduled for completion by May 1, 1983.

NCR 3311R identified a deficiency that is not common to the other NCR's in this report. The additional deficiency is, "Supports were removed and/or relocated without EEU approval." This NCR addresses deficiencies in the reactor building 2 annulus area. The NCR recommends a 100 percent reinspection for unit 2 conduit supports inside the annulus area. This reinspection will not be required on bolt anchors, but will be required to verify that the actual support location agrees with the drawings. The reinspection is included in work package F293A01 and is scheduled for completion by May 1, 1983.

One common deficiency identified with NCRs 3624R, 3311R, and 2789R is bolt thread engagement less than the one nominal bolt diameter required by G-32. TVA has evaluated approximately 2000 SSDs at WBN and has found only three bolts with a thread engagement that would not be expected to

develop the maximum designed load (factored load) with a 99 percent confidence level. The inspection data indicated that approximately 40 to 50 percent of the measured thread engagements were less than required by the WBN anchor bolt installation procedures. Although this is a violation of procedures, TVA does not consider thread engagement a structural problem at WBN because of the low probability of failure to meet the minimum design load.

NCR 2901R was to conduct a proof load test of both of the affected anchors. Proof load tests were documented on March 3, 1981, and both anchors were determined to be acceptable. All corrective action has been completed for this item.

The deficiencies identified in the description of condition have been corrected. To prevent recurrence, the following actions have been taken.

G-32, revision 6 requires plug depth and shell recess measurements as additional requirements during anchor proof testing. The plug depth measurement will identify cut anchors and the recess shell measurement will require more control over anchor depth below the concrete surface. The WBN Quality Control Procedures (QCP) 1.14 and 1.42-2 have been revised to incorporate G-32, revision 6. In order to minimize the possibility of future similar deficiencies, the Procedures and Training Unit now reviews and promptly implements all revisions to upper-tier requirements into site procedures.

The craft and inspection personnel have received additional training in WBN QCP 1.42-2 to prevent base plate installation with oversized bolt holes (beyond the allowable), removal and relocation of supports without EEU's approval, and installation of SSDs without meeting G-32 proof testing requirements. This training has been documented by the training officer.

In addition, seismic support inspections are now conducted utilizing drawings on which lot boundaries are drawn in to eliminate ambiguity with respect to the lot in which a specific anchor is included.

The inspection results of the cable tray supports/conduit supports and duct supports on a per-building basis are documented in Tables 1 and 2, respectively.

TABLE NO. 1

INSPECTION RESULTS FOR CONDUIT AND CABLE TRAY SUPPORTS

Bldg.	Type Support	Total Anchors Inspected	Anchors Outside Criteria				No. of Anchors Bad	Failure Rate
			Deep Plug	Short Plug (Cut Anchors)	Deep Shell	Short Ter		
Control Bldg. Unit 1 & Common	Conduit	267	13	10	12	170	5	1.87%
Reactor Bldg. 1	Conduit	104	5	2	2	60	3	2.88%
Auxiliary Bldg. Unit 1 & Common	Conduit	241	27	1	29	123	3	1.24%
Diesel Gen. Bldg.	Conduit	108	1	4	0	3	1	0.93%
Control Bldg. Unit 1 & Common	Cable Tray	129	1	17	13	60	2	1.55%
Auxiliary Bldg. Unit 1 & Common	Cable Tray	301	11	13	75	98	1	0.33%
Reactor Bldg. 2	Conduit	112	14	0	8	66	4	3.57%
Total Anchors		1262	72	47	139	380	19	1.50%

TABLE NO. 2
INSPECTION RESULTS FOR DUCT SUPPORTS

Bldg.	Total Anchors Inspected	No. of Outside Criteria Deep Plug	Deep Shell	Short Ter	No. of Anchors Proof Tested	No. Of Anchors Failed Proof Test	Failure Rate
Reactor Bldg. 1	102	39	4	25	45	1	0.98%
Control Bldg. Unit 1 & Common	224	37	6	63	51	11	4.91%
Auxiliary Bldg. Unit 1 & Common	229	15	19	118	54	7	3.08%
Reactor Bldg. 2	109	27	4	27	41	3	2.75%
Totals	664	118	33	233	191	22	3.32%