TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

5N 157B Lookout Place

MAR 01 1990

WBRD-50-390/87-09
WBRD-50-391/87-09

10 CFR 50.55(e)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Gentlemen:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2 - SAFETY-RELATED HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) DUCT WELDING - WBRD-50-390/87-09 AND WBRD-50-391/87-09 - FINAL REPORT

The subject deficiency was initially reported to NRC Inspector Gordon Hunegs on March 12, 1987, in accordance with 10 CFR 50.55(e) as Significant Condition Reports WBN MEB 8721 and MEB 8722. Our interim reports were submitted on April 16, 1987, April 21, 1988, and November 6, 1989. Enclosed is our final report on this subject.

The final report includes the results of reviewing additional data sheets and the results of the functional and material strength evaluations. This completes the commitments identified in our third interim report. This report contains no new commitments.

If there are any questions, please telephone G. R. Ashley at (615) 365-8527.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

E G Wallace

E. G. Wallace, Manager
Nuclear Licensing and
Regulatory Affairs

Enclosure
cc: See page 2

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U.S. Nuclear Regulatory Commission

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cc (Enclosure):

Ms. S. C. Black, Assistant Director
for Projects
TVA Projects Division
U.S. Nuclear Regulatory Commission
One White Flint, North
11555 Rockville Pike
Rockville, Maryland 20852

Mr. B. A. Wilson, Assistant Director
for Inspection Programs
TVA Projects Division
U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

INPO Record Center
Institute of Nuclear Power Operations
1100 Circle 75 Parkway, Suite 1500
Atlanta, Georgia 30339

NRC Resident Inspector
Watts Bar Nuclear Plant
P.O. Box 700
Spring City, Tennessee 37381

ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
SAFETY-RELATED HVAC DUCT WELDING
SCRs WBN MEB 8721, WBN MEB 8722
WBN 7077, AND WBN MEB 8714
WBRD 50-390/87-09, WBRD 50-391/87-09
10 CFR 50.55(e)
FINAL REPORT

DESCRIPTION OF DEFICIENCY

A deficiency has been identified at Watts Bar Nuclear Plant (WBN) affecting the safety-related heating, ventilation, and air-conditioning (HVAC) welded ductwork (including the hydrogen collection system) which could prevent the HVAC systems from performing their intended safety-related design function. The structural adequacy of the safety-related ductwork for all operating conditions (including a seismic event) is unknown because existing welds were not inspected to verify compliance with Nuclear Engineering (NE) requirements.

Safety-related ductwork (including the hydrogen collection system) was fabricated and installed (1978 timeframe) without a quality assurance (QA) program and without specific welding requirements from NE. A QA program was established for these systems in 1980. Subsequently, the engineering design drawings were revised (December 1980) to require full penetration welds. Welds completed before this full penetration requirement were not visually inspected for compliance with the criteria. As a result, in April 1981, a stop work order was issued against all safety-related HVAC systems, and a violation was issued (390, 391/81-05-02) to document the lack of a QA program and failure to report a significant deficiency. The stop work order was lifted in September 1981, based in part upon the development of an "alternate acceptance criteria" for inspection and testing. The alternate acceptance criteria established for the HVAC system included a leak test in lieu of visual weld inspection for inaccessible welds. Later, the alternate acceptance criteria was authorized to be applied to not only inaccessible welds but to all welds. This acceptance criteria was incorporated into WBN Construction Specification N3M-914, Revision 2 (Quality Assurance Requirements for Construction, Construction Testing, and Inspection of Safety-Related HVAC Systems), and was applied to all safety-related HVAC ductwork including the hydrogen collection system. Because the leak tests were performed to 25 percent over design pressure with less than one percent of total volume leakage, the systems were accepted as constructed.

The root cause of this deficiency is as follows: Engineering Design (EN DES) Engineering Procedure (EP)-3.10 required a design revision to evaluate the effects the design changes would have upon the overall design. A review by NE was not performed on the alternate acceptance criteria to determine its ability to verify the structural integrity of the ductwork. Therefore, the seismic adequacy of the safety-related ductwork was not addressed. The Nuclear Regulatory Commission (NRC) subsequently issued a violation (390, 391/86-24-02) in February 1987 for this failure to provide sufficient design control to assure seismic adequacy. Significant Condition Report (SCR) WBN 7077 was issued to document the lack of full penetration welds on Unit 2 hydrogen collection system ductwork transition sections. These connections are located up against the containment wall, which precluded the possibility of welding the wall side of the joint from the exterior. This condition is known to exist at each end of the transition sections.

SCRs WBN MEB 8714, WBN MEB 8721, and WBN MEB 8722 were issued to document the inadequately evaluated acceptance criteria for safety-related HVAC duct welding.

SAFETY IMPLICATIONS

The safety-related ductwork is associated with various ventilation and gas treatment systems. Should a weld fail, the ductwork could separate and, possibly, fail to perform its design function. This could lead to a buildup of airborne radiation, gases, or contaminants during and/or following a design basis seismic event.

The hydrogen collection system ductwork is part of the combustible gas control system and is designed to prevent hydrogen, which may be generated following a design basis accident, from reaching concentration levels sufficient for combustion. Failure of this ductwork during a seismic event could adversely affect safe operation of the plant, although the hydrogen igniters or hydrogen recombiners which are also used to control hydrogen concentration levels would not be affected. However, TVA has performed a safety significance calculation (WCG-1-324) which documented that the ductwork would not have failed under safe shutdown earthquake loadings.

CORRECTIVE ACTION

Two stop work orders (WBN-DNQA-87-02 and -03) on the circumferential welds in safety-related HVAC ducts (spiral-welded duct and hydrogen collection pipe) were issued January 12, 1987, and released on October 14, 1988. TVA has developed a program to establish the structural adequacy of welded safety-related ductwork (including the hydrogen collection piping) for all operating conditions, including a seismic event. The program is documented on SCRs WBN 7077, WBN MEB 8714, 8721, and 8722. This program included visual weld verification, eddy current testing, mechanical testing of weld samples, and seismic analyses of ductwork. Although the SCRs describe basically round duct (scheduled and spiral-welded pipe), TVA applied these corrective actions to welds on all types of safety-related TVA duct, including the transition pieces welded to round and rectangular ducts, and rectangular duct welded to other rectangular duct (TVA Classes Q&S, Seismic Category I).

Phase I (Walkdown Procedure WP-26) of the original corrective action plan included a 100 percent examination (through paint) for weld presence and visible weld discontinuities, and a 100 percent eddy-current examination to verify presence of weld. Phase II (Walkdown Procedure WP-29) was to compare the required strength of the welds, established by analysis, to the actual weld strength determined by destructive testing of weld samples taken from the existing welded joints. After the second interim report, these phases of the corrective action have been replaced with a worst-case evaluation of the welds. The worst-case evaluation is documented in calculation WCG-1-324, "Safety Significance Evaluation for Seismic Category I HVAC Duct Welding Concerns."

Since the third interim report on this subject, TVA has completed additional reviews that did not change the previous conclusion. The previous report indicated that only 20 percent of the total population of welds were tested with eddy-current and, after reviews of the additional data sheets, approximately 26 percent were actually completed. The functional and material strength evaluations have been completed and the results are documented below.

The following is a detailed description of the program which has resulted in the release of TVA's stop work orders and structural and functional qualification of safety-related HVAC ductwork.

A walkdown procedure (WP-26) was initiated as a verification (through paint) of all (approximately 10,000) TVA field welds on the safety-related HVAC ductwork. The walkdown was conducted to collect data, i.e., number, location, and classification of all welds. The walkdown of all accessible joints, some of which were composed of several welds, provided verification of weld presence. However, obstructions caused by companion angles, shear bars, and other support members at some welds prevented complete verification. These welds were classified as inaccessible.

In addition, visual surveys (through paint) were conducted by quality control (QC) personnel on approximately 1600 welds (16 percent of the weld population) to verify weld presence. Welds that appeared to be missing for exterior survey were examined from inside the duct through doors, grilles, or openings cut in the duct skin. The overall results of this visual survey verified the presence of weld filler material in the joints. As discussed above, obstructions caused by companion angles, shear bars, and other support members prevented complete verification of welds at some joints.

Eddy-current testing was performed on approximately 2600 welds (26 percent of the total weld population) to confirm that weld metal was present at each joint instead of nonmetallic fillers such as sealant and paint. Of the welds tested, a positive conclusion of complete weld could be made on approximately 2500 welds. The test results for the remaining welds in this population showed evidence of a combination of weld metal and nonmetallic filler material. All the joints tested were verified to contain weld filler material. Based on these findings and data from visual examinations, eddy-current testing to verify weld metal presence on additional weld joints was discontinued.

Stress analysis for the highest stress areas which gave consideration to concentrated weights, bends, discontinuities resulting from cutouts, overhangs, and branch connections, showed a worst-case requirement for 77 percent weld penetration. However, analysis shows most duct to have low stress as designed and, consequently, minimal weld penetration is required to meet allowable stress levels. Calculations for the low stressed areas showed approximately 22 percent weld penetration is required for the complete weld length or 45 percent is required for 75 percent weld length. These calculations for highly stressed areas and low stress areas are based upon material strengths from industry standards and ductwork basemetal tests which have been validated by the results obtained in calculation WCG-1-332.

In order to assess as-constructed conditions, weld thickness was measured from sample coupons cut through 17 of the highest stressed welds. Measurements were taken of weld cross sections which had been ground and etched to reveal the weld. The lowest effective average weld thickness measured was 10 percent more than the highest weld thickness required by analysis. The weld quality was evaluated by visual inspection of 81 welds after paint removal. The majority of welds examined exhibited no defects; however, those containing defects were bounded by the worst-case analysis (WCG-1-324).

Additional actions were performed to confirm that a joint, which was identified by the NRC inspector as not being completely welded, was completely welded. It was determined that the weld joint in question (Unit 2 hydrogen collection transition piece), through interior inspection of the duct surface at that location, was in fact welded.

Based upon the safety significance evaluation and the positive results from eddy-current testing/QC visual surveys, and visual inspections, further testing and visual survey inspections for the remaining welds to determine structural adequacy are not warranted.

A functional evaluation was performed and documented in calculation EPM-CJW-011990 to evaluate the effect of incomplete welds and nonmetallic substances that were discovered during the implementation of the walkdown procedure WP-26 on the functional design basis of the HVAC systems. Taking no credit for leakage reductions due to sealants, TVA concludes based on this calculation that the weld imperfections and incomplete welds will not prevent the systems from performing their required safety function.

Based on the safety significance and functional evaluation, TVA concludes the welded ductwork will perform its intended design functions.

The present commitment for TVA Classes Q and S ductwork in the Final Safety Analysis Report (FSAR) is Sheet Metal and Air-Conditioning Contractors National Association (SMACNA), High Velocity Duct Construction Standards, second edition, 1969 as modified by Oak Ridge National Laboratory-National Safety Information Center (ORNL-NSIC)-65, paragraph 2.8. SMACNA does not require welding for strength but only for sealing where minimum leakage is required. Weld requirements for Q and S ductwork fabricated or repaired after January 12, 1987, are based upon American National Standards Institute (ANSI)-N509 requirements. TVA will revise the FSAR (Tables 6.5-1, 6.5-2, 6.5-3, and 6.5-4) to reflect this design requirement. TVA has issued a design change notice (DCN-P-00798-A) against Construction Specification N3M-914 to document these welding and inspection criteria.

TVA performed calculations as part of the safety significance evaluation and determined that complete penetration welds are not required for welded ductwork installed. However, TVA has revised the design drawings and other applicable documents to require full penetration welds for all future ductwork installations.

WBN Construction Specification N3M-914 was revised (R3) December 29, 1986, to require visual inspection of welds completed after December 29, 1986. In addition, TVA has upgraded the weld and inspection criteria as part of the stop work order releases. These actions should prevent recurrence of the weld inspection deficiency. In addition, Nuclear Engineering Procedure (NEP)-3.3, "Internal Interface Control," which was issued subsequent to occurrence of this deficiency, should provide improved interface control among design organizations.