TVA

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John H. Garrity
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OCT 16 1991

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) - NRC INSPECTION REPORT NO. 390, 391/90-15
REVISED REPLY TO VIOLATION 390/90-15-02

This letter transmits TVA's revised final report on violation 390/90-15-02 addressing lack of penetration and lack of fusion identified by NRC in ASME Class 3 weldments at WBN. It supersedes the report submitted on March 5, 1991. This revision is necessary to reflect changes in the weld count and minor changes to the format and references noted. The revisions are identified by revision bars placed in the margin. The results and conclusions remain unchanged in this report.

Enclosure 1 provides TVA's revised final response on this violation. Enclosure 2 contains the commitments made in this response. These enclosures supersede those provided in the orginal response.

If there are any questions, please telephone P. L. Pace at (615) 365-1824.

Sincerely,

JHGarrity

John H. Garrity

Enclosures
cc: See page 2

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cc (Enclosures):

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ENCLOSURE 1

RESPONSE TO NRC NOTICE OF
VIOLATION 390/90-15-02
REVISED FINAL REPORT

Description of Violation

An NRC inspection conducted during the period July 16 through July 27, 1990, and August 27 through September 6, 1990, identified a violation of NRC requirements. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions," 10 CFR Part 2, Appendix C (1990); the violation is set forth below.

A. 10 CFR 50, Appendix B, Criteria IX requires that special processes, including welding, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements. TVA's piping design criteria specification WB-DC-40-36 and N3M-868 invokes the ASME Boiler and Pressure Vessel Code, Section III, Class 3, 1971 through the Summer 1973 Addenda. Paragraph ND-5212 of the ASME Code requires longitudinal weld joints in piping, pumps and valves greater than 4-inch nominal pipe size be examined by either magnetic particle, liquid penetrant, or radiography. Code Interpretation III-82-19 (File NI-81-168) extends the requirement to circumferential welds. The applicable acceptance standards are those of paragraph ND-5300 for the method chosen. Paragraph ND-5321 (a) disallows any type of crack or zone of incomplete fusion or penetration when revealed by radiography, while ND-5321 (b) limits any other elongated indication which has a length greater than 1/4" for thickness up to 3/4", inclusive.

Contrary to the above, the licensee failed to properly control the welding and rejectable indications in Watts Bar Class 3 piping. An NRC independent measurement's inspection revealed that 50 percent of a sample of Watts Bar Unit 1, ASME Class 3 piping weldments has code rejectable lack of fusion and lack of penetration indications that extended to 80 percent of the weld length. Numerous welds displayed unacceptable ASME Code indications as determined by radiography where magnetic particle (MT) and liquid penetrant (PT) had been used to accept the welds in production. This is a Severity Level IV Violation' (Supplement II).

1.0 Admission or Denial of Violation

TVA admits the violation occurred, but would like to provide the following clarification:

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TVA has committed to fabricate the Watts Bar Nuclear Plant Class 3 piping in accordance with the ASME Code, Section III, 1971 Edition through the Summer 1973 Addenda. Subsection ND-3000, subparagraph ND-3611 (Piping Design Acceptability), refers to NC-3600 which refers to NB-3661.2 for the design of butt welds. NB-3661.2 states "butt welds shall be made in accordance with the applicable provisions of NB-4000. Ends shall be prepared for butt-welding so that they will meet the requirements of Figure NB-4233-1 and the welds shall be full penetration welds." Figure NB-4233-1 provides the general configuration alignment tolerances in order to achieve a full penetration weld.

Subsection ND-5000, subparagraph ND-5220 states, ". . . all pressure retaining welds in piping, pumps, and valves greater than 4 inches nominal pipe size shall be examined by either the MT, liquid penetrant PT, or radiographic (RT) methods." TVA, in accordance with industry practice, chose to perform surface (MT or PT) or visual examinations based on the nominal diameter of Class 3 butt welds. These surface or visual examinations would not identify volumetric type imperfections, such as weld root conditions, which would be identified by radiographic methods.

The code requires full penetration welds for Class 1, 2, and 3 systems; however, the fabrication examination requirements are less severe for Class 3 systems as compared to Classes 1 and 2 due to the fact that the system designs are for plant support systems and not high energy systems.

The ASME Code, Section III Committee recognized the problem of performing volumetric examinations on systems where only a visual or surface examination has been performed (Code Interpretation III-1-83-103). In this interpretation, conditions found to be unacceptable in subsequent volumetric examinations, as occurred during the NRC inspection, do not need to be repaired, but engineering judgement should be used in dispositioning such conditions. TVA has fully addressed all aspects of this violation, including performing any necessary engineering analysis as well as a root cause analysis.

2.0 Reason for Violation

The reason for the lack of fusion (LOF)/lack of penetration (LOP) in the Class 3 system welds is substandard craftsmanship. To evaluate this, TVA has performed several investigations and evaluations addressing the cause and potential effects of the LOF/LOP which serve as the basis of the violation. These evaluations included a Welder Attribute Analysis (Attachment 1), a Statistical Analysis (Appendix D of Attachment 2), and a Root Cause Analysis (on file). The results of these analyses confirmed the root cause of LOF/LOP was the lack of a proper feedback system pertaining to welder performance during welding fabrication. The nondestructive examination (NDE) in place was a surface examination, and the feedback to individual welders was that performance was acceptable if so indicated by an acceptable surface examination. A more appropriate feedback system would have routinely monitored weld-root conditions and notified the welding organization of such deficiencies in the fabrication process.

3.0 Corrective Steps Taken and Results Achieved

The NRC's inspection focused on 18 pipe welds that were partially radiographed to look for microbiologically induced corrosion (MIC). Eight of these welds were stainless steel weldments of the Essential Raw Cooling Water (ERCW) System in the Reactor Building annulus. Four of these welds were determined to contain incomplete penetration, which is ASME code rejectable. As a result of this finding, NRC radiographed an additional sample of ten welds in other Class 3 systems. Five of these welds exhibited similarly rejectable indications. In response to the NRC's independent measurement's inspection where LOF/LOP were identified, Condition Adverse to Quality Report (CAQR) WBP 900336 was initiated.

To more fully understand the extent of the LOF/LOP problem, the nine unacceptable NRC-identified Class 3 welds were completely (100 percent) radiographed by TVA. Two welds of these nine which appeared from radiography to contain the deepest LOP were ultrasonically (UT) examined so that the depth could be established. After these initial results were analyzed, a program to address the structural integrity and code acceptability from a stress allowable standpoint was developed. This program utilized methodologies from both ASME Code Sections III and XI.

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The analysis program to demonstrate structural integrity for Class 3 systems is based upon modeling the statistically bounded worst-case depth of LOP at the locations of highest calculated stress. The following steps outline the approach taken by WBN to establish a greater than 95 percent level of occurrence with a 95 percent confidence level that Class 3 welds meet ASME Code Section III stress allowables:

- Develop a random statistical sample from all Class 3 butt welds.
- Radiograph these sample welds and record any incomplete penetration, incomplete fusion, and/or MIC.
- Ultrasonically size flaws on selected worst-case welds (determined by RT) to determine the depth. Destructively size one of these worst-case welds at several locations.
- Determine the statistically bounded worst-size flaw to assure that at least the 95 percent occurrence level/95 percent confidence level is confirmed. Remove the results of any statistically identified "substandard" welder from the data base.
- Review TVA Class 3 calculation packages in at least two stainless steel piping systems and one carbon steel piping system projected to have the highest stresses. The purpose of this review is to identify calculation packages with the highest stresses and to tabulate the maximum stresses for each pipe size.
- Recalculate the maximum stresses for each pipe size using bounded reduced section thickness as if the statistically worst-modeled flaw was located at the point of maximum stress using ASME Section III analysis methods.
- Determine the acceptability of statistically bounded worst-case indications (flaw models) and maximum stresses using both ASME Sections III and XI allowables.
- Perform location-specific analysis of any weld flaws that exceed the statistically bounded worst-case flaw size to demonstrate that Sections III and XI stress allowables are met.

A statistical sample of 84, Class 3 welds was radiographed. This sample of 84, when combined with 32 other welds, including a reinspection of the 28 done as part of the NRC inspection, provided a comprehensive base of 116 welds. Of these welds, 48 had some degree of LOP, 19 of which exceeded 10 percent of the circumference. Of the 19 welds, 11 were evaluated as having the greatest depth of LOP. These 11 welds were ultrasonically examined to further define the maximum depth of the LOP in the weld sample.

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This depth information was supplemented by the destructive analysis of one weld, where physical measurements were taken and compared with UT and RT image enhanced measurements. This comparison revealed that the UT flaw sizing was accurate, although conservative. The image enhanced RT flaw sizing was nonconservative. Therefore, for statistical flaw sizing, the UT data was used directly and the RT data had an additional factor applied to correct measured values as compared to actual depth of LOF/LOP. This depth information along with circumferential extent data were used in the structural integrity analysis.

During the structural integrity analysis for Class 3 systems, 44 nodes (point of stress analysis) were identified as potentially exceeding stress allowables based on a statistical worst flaw that was used in the LOF/LOP evaluation. However, from those 44 nodes, only 16 welds were identified to be at or near a node. Review of the weld maps and data for these 16 welds revealed that 6 are ASME Class 2 welds which fell outside the Class 3 boundary and were radiographically examined during construction, 5 were vendor shop welds, and 2 were welded with a backing ring in place. Therefore, only 1 carbon steel weld and 2 stainless steel welds were determined to require radiographic examination to verify weld quality. Results of these examinations revealed that the carbon steel weld was free of any LOF/LOP welding defects, one of the stainless steel welds had a 0.375-inch long LOF indication and the other stainless steel weld had a 0.25-inch long LOP indication; both of these were well within an analytically acceptable flaw size.

Based upon the structural integrity analysis for Class 3 systems, which is detailed in Attachment 2 of this response, it is concluded that Class 3 welds meet ASME Section III stress allowables with a greater than 95 percent occurrence level/ 95 percent confidence level.

The above 95/95 statistical criterion was used in the statistical evaluation of inspection data to establish the bounding flaw size for input to the structural integrity analysis. Since the bounding flaw is statistically based, some observed inspection data could be larger than the bounding size. A review of the inspection data revealed 3 welds (2 welds were made by a "substandard" welder discussed later in this report) having inspection indications greater than the bounding flaw. In order to complete the disposition of CAQR WBP 900336 for each observed condition, a second evaluation was performed for the 3 subject welds since the bounding flaw assumption did not envelop the observed condition.

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The evaluation, which used the observed flaw dimensions and location-specific stresses, demonstrated that these welds also satisfy the allowable stress limits for ASME Section III and the flaw acceptance criteria of ASME Section XI. On this basis, it was concluded that all observed LOF/LOP indications are acceptable to the design allowables of Section III. Furthermore, a safe operating condition would still have existed even if any or all of the observed adverse conditions had gone undetected before plant operation.

Future analysis utilizing a multiple flaw evaluation will be performed when MIC is found in conjunction with a weldment that contains LOF/LOP. This will be accomplished by using a degraded cross section (area and section modulus), based on NDE, considering flaw distribution for LOF/LOP and assuming MIC indications are through wall for their entire length. The analysis of combined MIC and LOF/LOP can be performed by the technique described above utilizing the flaw proximity rules of ASME Section XI. This analysis approach has been incorporated into Civil Design Standard DS-C-1.2.8. Watts Bar Engineering Procedures (WBEPs)-5.38 and -5.39, which cover the analysis for Category I piping, have been revised to reflect the evaluation requirements for flaws associated with LOF/LOP and MIC. These WBEPs have been converted to Engineering Administrative Instructions (EAIs).

In order to identify any "substandard" welders, a welder attribute analysis (Attachment 1) and a statistical analysis (See Appendix D of Attachment 2) were performed. The statistical data base was comprised of 116 welds that were made by 90 welders. Evaluations of radiographic examinations of the 90 welders' 116 welds revealed 14 welders who had performed 19 substandard welds (LOP >10 percent). The statistical analysis focused on the performance of these 14 welders. A result of the analysis required radiographic examination of an additional 60 welds. This brought the total number of Class 3 welds that were inspected, including the 3 from the structural analysis verification, to 179 and increased the number of welds with LOP >10 percent to 26. The primary finding of this statistical analysis was the identification of one "substandard" welder who had performed 23 welds. Of the 23 welds made by this "substandard" welder, 2 welds exceeded the bounding flaw size; however, based upon location-specific analysis, both of these welds meet Section III and XI stress allowables. All the welds made by this "substandard" welder are included in the 179 welds that have been inspected.

Based upon (1) the radiography performed, (2) the ASME Sections III and XI structural analyses, and (3) establishing a higher level of performance, the following "Management Directive" rework criterion has been established: Any weld from the 179 welds inspected, that has greater than 10 percent circumferential involvement of LOP, around the internal circumference, shall be reworked. This will require 26 welds to be reworked.

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This rework criterion was established even though the structural integrity analysis did assure with a greater than 95 percent probability/95 percent confidence level that Class 3 welds meet ASME Section III stress allowables.

The Final Safety Analysis Report (FSAR) will be revised to reference this violation and structural integrity analysis for Class 3 piping.

The LOF/LOP concern for Unit 2 will be addressed before Unit 2 fuel load. This concern has been documented for tracking by CAQR WBP 910029 dated January 9, 1991.

4.0 Corrective Steps Which Will be Taken to Avoid Further Violation Action

TVA has developed a random radiography requirement to assure proper feedback into the welding system during the fabrication of Class 3 systems. This requirement is that random radiography of full penetration welds will be performed on a quarterly basis as follows:

- 10 welds or actual number of welds up to 10, as a minimum, or
- 10 percent of all welds made during the quarter; whichever is greater, and
- a minimum of 1 weld per welder making Class 3 welds during the quarter.

5.0 Date When Full Compliance Will Be Achieved

The random radiography requirement during fabrication of Class 3 systems is now in effect. Procedural changes to implement random radiography have been completed.

The revisions of WBEPs-5.38 and -5.39 have been completed and converted to EAI-8.05 and EAI-8.15, respectively.

The rework program for 26 welds with greater than 10 percent circumferential involvement of LOP, around the internal circumference, will be completed by the end of the third quarter of calendar year 1992.

ENCLOSURE 2

LIST OF COMMITMENTS

The rework program for 26 welds with greater than 10 percent circumferential involvement of LOP, around the internal circumference, will be completed by the end of the third quarter of calendar year 1992.

The Final Safety Analysis Report (FSAR) will be revised by October 21, 1991, to reference this violation and structural integrity analysis for Class 3 piping.

The LOF/LOP concern for Unit 2 will be addressed before Unit 2 fuel load.

WELDER ATTRIBUTE ANALYSIS

As part of TVA's investigation into the cause of, and/or reason for, lack of fusion (LOF)/lack of penetration (LOP) in the Class 3 systems piping welds, a welders attribute analysis was performed. Nineteen welds made by 14 welders that had greater than 10 percent LOP around the internal circumference from a sample of 116 welds examined were evaluated in the analysis. This analysis considered attributes or parameters that could affect the quality of a root pass as follows:

1. Welder - did same person perform several or the most of the questionable welds
2. Time of Performance - were all the questionable welds made at the same time period
3. Accessibility - were all the questionable welds in a difficult position or location
4. Time Since Qualification - did the welder just qualify and then make the questionable weld
5. Foreman/Supervisor - were all the questionable welds made under the direction of the same foreman
6. Weld Position - were all the questionable welds made in the same position
7. Material - were all the questionable welds made in the same material
8. Experience - were the welds made by an inexperienced welder
9. Welding Process - did the welder have a problem with a certain process
10. Location - were all the questionable welds located in the same area of the plant
11. Quality Assurance/Quality Control - were all the fitups inspected by the same inspector

The historical weld records were reviewed for each of the 19 welds to acquire the information required for the analysis. Additionally, a physical walkdown was performed on the welds to determine location, position, and accessibility.

Once the welder who made the root pass was determined for each of the 19 welds, the certification dates were identified from the historical welding records. This along with the other attribute information was compiled into a matrix. Unfortunately, a comparative common attribute was not identified from this analysis. However, 1 welder (6EL) did perform more substandard welds when compared to the other 13 welders.

Pages 2 and 3 of this attachment list the attributes and results considered. An adverse trend by correlating foreman and/or QA reviewers could not be made. The identification of these individuals is on file.

19 WELDS WITH GREAT N 10 PERCENT LOP/LOF

WELD NUM	MATERIAL	WELDER	TIME	ACCESS.	QUAL TIME	EMAN	WELDING POS.	EXPERIENCE	PROCESS	LOCATION	Q IEWER
0-067J-T145-09	SS/SS	6PPE	Final PT 06/22/82	Could not get to but from floor appears easy	GT-7-0-1-L 12/13/79	on file	5G	See Attached	GT88-0-3	AUX	on file 06/20/82
2-067J-T349-01B	SS/SS	6SDD	Final VT 09/17/82	Very Easy	GT-7-0-1-L(A) 09/10/82	on file	5G	"	GT88-0-3	AUX	on file 09/16/82
1-067B-T435-06	SS/SS	6YYX	Final PT 03//31/82	Very Easy	GT-7-0-1-L(A) 10/28/80	on file	5G	"	GT88-0-3	AUX	on file 03/20/82
1-067J-T526-01	SS/SS	6GK	Final PT 01/04/80	Easy	GT-7-0-1-L 11/25/77	on file	5G	"	GT88-0-3	AUX	on file 01/02/80
0-026H-T010-06A	CS/CS	6NM	Final MT 09/29/78	25% Diff. but can be done	GT-6-0-3-L SM-4-B-3-L 10/14/76	on file	5G	"	GT-SM11-0-3B	IPS	on file 05/17/78
1-067C-T613-07	SS/SS	6PFF	Final PT 08/18/82	30% Diff.	GT-7-0-1-1(A) 04/21/82	on file	5G	"	GT-88-0-3	RB Ann	on file 08/04/82
1-067C-T273-08A	SS/SS	6UUH	Final PT 12/18/82	Easy	GT-7-0-1-L(A) 05/19/80	on file	2G Vert. Fix	"	GT88-0-3	RB1	on file 12/17/82
2-067G-T046-07	SS/CS	6RS	Final PT 12/21/78	Very Easy	GT-7-0-1-L 08/02/78	on file	2G Vert. Fix	"	GT18-0-1	DGB	on file 12/20/78
2-067G-T047-15	CS/CS	6AAI	Final MT 02/07/77	30% Inaccess	GTSM-6-4-0-1-L 05/15/74	on file	5G	"	GT-SM11-0-3B	DGB	on file 02/07/77
0-078A-D196-05B	SS	6SV	Final PT 09/07/78	Easy	T-7-0-1-L 08/23/78	on file	5G Horiz Fix	"	GT88-0-1	AUX	on file 08/25/78
1-067C-T612-05	SS	6TTC	Final PT 09/02/82	Easy for Bad Sect.	GT-7-0-1-L(A) 06/16/82	on file	5G	"	GT88-0-3	RB Ann	on file 08/30/82
1-067C-T614-03	SS	6EL	Final PT 10/14/82	Diff. but can be done	GT-7-0-1-L(A) 06/14/82	on file	5G	"	GT88-0-3	RB Ann	on file 10/08/82
1-067J-T606-01	SS	6RSS	Final PT 08/04/82	Easy	GT-7-0-1-L(A) 07/02/82	on file	5G Horiz Fix	"	GT88-0-3	RB Ann	on file 08/03/82
1-067J-T606-04	SS	6RSS	Final PT 08/04/82	Easy Bad Sector	GT-7-0-1-L(A) 07/02/82	on file	5G	"	GT88-0-3	RB Ann	on file 08/03/82
1-067J-T608-02	SS	6EL	Final PT 07/22/82	Easy	GT-7-0-1-L(A) 06/14/82	on file	5G	"	GT88-0-3	RB Ann	on file 07/17/82
1-067J-T608-03	SS	6EL	Final PT 07/22/82	40% Diff.	GT-7-0-1-L(A) 06/14/82	on file	5G	"	GT88-0-3	RB Ann	on file 07/21/82
1-067J-T608-07	SS	6TTC	Final PT 07/22/82	50% Inaccess	GT-7-0-1-L(A) 06/16/82	on file	5G	"	GT88-0-3	RB Ann	on file 07/21/82
1-067J-T635-06	SS	6NU	Final PT 12/11/89	14" Inaccess 25%	GT-7-0-1-L(A) 01/12/89	on file	5G	"	GT88-0-3	AUX	on file 12/02/89
1-067C-T612-03	SS	6EL	Final PT 10/28/82	40% Diff.	GT-7-0-1-L(A) 06/14/82	on file	5G	"	GT88-0-3	RB Ann	on file 10/27/82

Welding Position 2G - Vertical Fixed - 5G - Horizontal Fixed

HISTORY OF WELDERS WITH GREATER THAN 10 PERCENT LOP/LOF

WELDER	CLASS A	CLASS B	CLASS C	CLASS D	OPEN BUTT QUALIFICATION	EMPLOYED WBN	LEFT WBN
6PPE		4	8		110279	072479	012290
6SDD			98		091082	070882	061785
6YYX			40		102880	102880	060183
6GK	27	65	21		022576	022576	012585
6NM			124		101476	101476	081280
6PFF			11		042182	042182	082782
6UUH			28		051980	051980	092387
6RS			12		051377	051377	111485
6AAI	54	123	40	20	051574	032274	040485
6SV			54		062177	062077	Note 1
6TTC			52		041680	041680	092486
6EL			35		121775	121775	111982
6RSS			10		100881	100881	090182
6NU		2	33		020478	101476	Note 1
TOTAL PER CLASS	81	194	566	20			
TOTAL WELDS	861						

Note 1: Still employed at WBN.