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UNITED STATES NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

TVA PROJECTS DIVISION

Report No.: 50-390/90-04; 50-391/90-04

Licensee: Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

Docket No.: 50-390; 50-391

Construction Permit No.: CPPR-91; CPPR-92

Facility Name: Watts Bar Units 1 and 2

Inspection Conducted: March 5-10, April 2-6, and April 23-27, 1990

Inspectors: George Georgiev, Team Leader — 5-11-90 Date

Glenn Walton — 5-11-90 Date

David Smith — 5/11/90 Date

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1 INTRODUCTION

In response to employee concerns about the adequacy of the Tennessee Valley Authority (TVA) welding program, TVA established a Welding Project (WP) to review the welding program at each of its nuclear plants.

At the Watts Bar Nuclear Plant, TVA is reviewing the welding program in three phases. Phase I effort consisted of reviewing the written material (design documents, policies, and procedures) to ensure that the welding program correctly reflects TVA's licensing commitments and regulatory requirements. Phase II effort consisted of reinspecting selected welds and using the inspection results to evaluate how well TVA has implemented the written welding program. The sampled welds were also evaluated to determine whether the welds that TVA made in the field met the applicable code requirements and were adequate for service. In both Phases I and II of the welding program, TVA was to identify and categorize any deficiencies in the existing program, correct the problems, and implement changes to prevent recurrence of the problems. Phase III is an evaluation, integration, and strengthening of welding-related programs and procedures to ensure that future welding activities at TVA, including those at Watts Bar, are conducted in accordance with licensing requirements.

As part of both Phases I and II, the Department of Energy (DOE) reviewed welding activities within the framework of its own weld evaluation project (WEP). DOE selected EG&G to perform this independent evaluation. TVA is performing all work related to the Phase III effort.

The DOE/WEP group completed its independent evaluation of the welding activities at Watts Bar and TVA submitted the DOE/WEP report to the NRC by letter from S. A. White to S. D. Ebneter, dated February 17, 1988. The NRC staff completed its evaluation of the DOE/WEP report and transmitted that evaluation by letter from J. G. Partlow to S. A. White, dated August 12, 1988.

On January 13, 1989, TVA submitted to the NRC its Corrective Action Program (CAP) Plan for Welding at Watts Bar Unit 1. The objective of the CAP is to ensure that Watts Bar Unit 1 safety-related welds meet (or will meet upon completion of corrective action programs) TVA licensing commitments. The CAP includes a programmatic description of the Phase I, Phase II, and Phase III evaluation of the Watts Bar welding program and provides a plan for preventing recurrence.

On February 8, 1989, TVA representatives and the NRC staff met in Rockville, Maryland, to discuss the Watts Bar CAP. During the meeting, the NRC staff requested additional information regarding the CAP and posed 10 specific questions. TVA responded to those questions in its transmittal from R. Gridley to the NRC, dated March 29, 1989.

On February 21, 1989, TVA submitted its Watts Bar Phase I report to the NRC. The report included a recommendation for strengthening the existing TVA welding program at Watts Bar.

On April 10, 1989, TVA submitted its Watts Bar Phase II report to the NRC. The report described all welding-related corrective actions.

From April 24 through May 5, May 15 through May 19, and July 25 through July 27, 1989, an NRC welding team reviewed and assessed the adequacy of the welding evaluation program at Watts Bar. At the conclusion of the inspection, the NRC welding team noted no significant deviation from the results reported in the TVA's Phase I and II weld reports. Most of the weld deficiencies noted during the inspection were previously identified, evaluated, and corrected by TVA as a result of its reinspection effort. Therefore, the NRC's findings were in general agreement with the results of TVA's Phase I and II reports. The NRC welding team also found that the Watts Bar CAP Plan for Welding contained the essential elements needed to achieve its goals and objectives. Further, the NRC team found that the corrective action programs which resulted from the TVA's reinspection effort were adequate; this finding should provide reasonable assurance that the quality of the welds at Watts Bar Unit 1 would be adequate.

2 SCOPE

During the inspection on March 5 through March 10, April 2 through 6, and April 23 through 27, 1990, the NRC welding team reviewed (1) the status of items left open from previous NRC inspections, (2) commitments and TVA's Welding Project Final Report, and (3) the request for alternative acceptance in accordance with 10 CFR 50.55a(a)(3) concerning hydrotesting of containment penetrations, pneumatic test pressure for the control air system, and welds on the drain line vortex of the refueling water storage tank.

3 SUMMARY

The NRC welding team closed 10 of the 12 items left open from previous NRC inspections. The team reviewed and found acceptable TVA's Welding Project Final Report and the closure packages for 43 commitments associated with the Watts Bar CAP Plan for Welding. However, the remaining open items and outstanding commitments must be completely closed before the final closure of the welding CAP. TVA must also notify the NRC when all outstanding work on the CAP is completed. In addition, the NRC team reviewed and found acceptable the proposed alternative acceptance, concerning hydrotesting of containment penetrations, pneumatic test pressure for the control air system, and welds on the drain line vortex of the refueling water storage tank.

4 INSPECTION DETAILS

The inspection effort comprised the following inspection tasks:

(1) reviewed items left open from previous NRC inspections
(2) reviewed requests for alternative acceptance criteria in accordance with 10 CFR 50.55a(a)(3)
(3) reviewed commitments and TVA's Welding Project Final Report

These tasks are addressed in Sections 4.1, 4.2, and 4.3, respectively.

4.1 Review of Items Left Open From Previous NRC Inspections

The NRC team reviewed the status of 12 items left open from previous NRC inspections and closed 10 of them. The items reviewed and the associated NRC team action are detailed in the material that follows.

(1) URI 50-390/87-10-04 (Closed), Process Specification 2.M.1.1 to Comply With the ASME Code

This unresolved item (URI) identified the following issue. During a routine NRC inspection, the NRC inspector reviewed Process Specification 2.M.1.1, titled "Specification for Post Weld Heat Treatment" for compliance with the ASME Section III Code and the Final Safety Analysis Report (FSAR). The inspector noted 11 discrepancies (a-k) which are listed below. Items a-g are required by ASME Section III, 1971 Edition including Summer 1973 Addenda which is the Watts Bar Construction Code of Record. Items h-k need to be addressed to successfully perform post-weld heat treatment (PWHT) and return the system to its original state.

(a) The specification failed to require temperature monitoring during heatup and cooldown at temperatures between 600°F and 800°F.

(b) The specification failed to identify location of thermocouples.

(c) The specification failed to address procedure and personnel qualification requirements.

(d) The specification failed to address the allowable temperature spread (250°F maximum) between heating and cooling.

(e) The specification failed to adequately address requirements for the width of the heated band.

(f) The specification failed to address the allowable temperature spread (100°F maximum) during the holding period.

(g) The specification failed to address equipment calibration of PWHT equipment.

(h) The specification should address the use of temporary supports adjacent to welds undergoing PWHT to prevent the pipe from sagging when the metal is at high temperature.

(i) The specification should address removal of the welded thermocouple from the pipe and should require proper nondestructive examinations of the affected areas.

(j) The specification should address the use of spare thermocouples, such as the number, location, and criteria used when switching to the spares.

(k) The specification should address the amount and type of insulation to be placed over the heated and adjacent area affected by the PWHT.

The reply associated with each of these items follows:

(a) Temperature monitoring during heatup and cooldown between 600°F and 800°F was addressed in TVA's review of G-29 which was sent to NRC on August 21, 1987. The ASME Code was changed in 1974 to delete this requirement. TVA implemented this less-restrictive provision of the 1974 code as permitted by Paragraph NA-1140(f) of the Watts Bar Construction Code of Record. The use of this provision is recorded in the piping system applicable design specification. The 1974 code was accepted by NRC in the latest revision of 10 CFR 50.55(a).

(b) Thermocouple location is not a specific code requirement. Paragraph 5.0 of G-29 Process Specification (PS) 2.M.1.1 requires that temperature be measured by placing thermocouples at the anticipated hottest and coldest locations. A minimum of two thermocouples is required, but TVA usually installs several pairs of thermocouples on large-diameter welds. The exact location of the thermocouple is determined by the welding engineer. Attachment A of the CEP-4.09 or AI-9.4.3 will be used for each PWHT operation performed by the Nuclear Construction group. Attachment A includes a sketch to give elevation and end views showing weld centerline, width of PWHT zone, location of heaters, location of recording, controlling, and spare thermocouples, and zones of control (if used) (monitored area which would encompass the PWHT zone).

(c) Procedure and personnel qualification is required by ASME Section III, Paragraph NA-4451, and Appendix B to 10 CFR Part 50 Criterion IX. This requirement is met when the Nuclear Construction group (NC) trains the heat-treating crew to the requirements of the NC heat-treating procedure (CEP-4.09 or AI-9.4.3). CEP-4.09 or AI-9.4.3, Paragraph 5.1.3, specifically states that the Welding Engineering Unit of NC will ensure that qualified personnel perform the PWHT operations.

(d) CEP-4.09, Attachment D, Paragraph 2.1.1, and AI-9.4.3, Paragraph 6.4, addressed the requirement of Paragraph NB-4623 (the temperature spread shall be less than 250°F during heating and cooling above 800°F for ASME). PS 2.M.1.1 was revised by Addendum 2 to reflect these temperature requirements. PWHT charts for Watts Bar have been reviewed to determine if the temperature spread requirement was violated. The results will be documented as part of the corrective action results of Nonconformance Report (NCR) 6888. The NCR is currently being tracked by NRC Unresolved Items 50-390/86-14-03 and 50-391/86-14-02.

(e) The minimum band width requirements are given in by PS 2.M.1.1 and were addressed in a TVA submittal to NRC dated August 21, 1987. Provisions of a later Code edition (1974) were used as permitted by NA-1140(f). See item a for TVA's proposed action on use of later editions and addenda.

(f) The actual maximum temperature range permitted by PS 2.M.1.1, Paragraph 4.0; CEP-4.09, Attachment D, Paragraph 3.0; and AI-9.4.3, Attachment D, Paragraph 3D, is 75°F. This is determined by subtracting the lowest temperature from the highest temperature (given in Table 1) of each procedure. When longer holding times are used and the minimum temperature of 1050°F is used, then the permitted temperature range is 100°F. These requirements are more stringent than the code requirements. TVA procedures never allowed the temperature range to be greater than 100°F.

(g) TVA meets the requirements of Paragraph NA-4600 (Calibration of Equipment) by QMI-8.12-1, GCI-8.1.00-00, and the Nuclear Components Manual (NCM) section on PWHT (Section 8.1, Revision 19). This is also addressed in CEP-4.09, Paragraph 6.3.1 and Attachment A; QCP-4.09, Paragraphs 6.1.3.2, 6.1.3.4, 7.2.2, and 7.2.4; and AI-9.4.3, Paragraphs 5.3.2 and 6.0.

(h) The NC welding engineer in conjunction with an NC mechanical engineer determines when additional supports are needed. PS 2.M.1.1 does not address temporary supports. However, temporary supports are addressed in CEP-4.09, Paragraph 5.3.2; CEP-4.09, Paragraph 6.3.1; and AI-9.4.3, Paragraph 6.0; a check for adequate support is also included.

(i) Nondestructive examination (NDE) of areas from which thermocouples are removed is specified by CEP-4.09, Paragraphs 5.3.3 and 6.5.1, and CEP-4.03. NCR W-599 has been written to evaluate the NDE records for thermocouple removal areas for Unit 1. Thermocouple removal is also addressed in AI-9.4.3, Paragraph 6.5.1.

(j) TVA attaches spare thermocouples as determined by the NC welding engineer. CEP-4.09, Attachment D, Paragraph 5.0, discusses spare thermocouple installation (paired with a main thermocouple) and switching criteria to spare thermocouple. AI-9.4.3, Attachment 1, Paragraph 5.0, also discusses spare thermocouple installation.

(k) The NC welding engineer specifies the insulation required, as a minimum, according to CEP-4.09, Attachment D, Paragraph 6.0, and AI-9.4.3, Attachment 1, Paragraph 6.0. At least one layer of insulation will be used, and the insulation will be placed at least six inches beyond the edges of heater pads. The type of insulation will be at the NC welding engineer's discretion, but it shall be fire resistant.

The NRC team reviewed TVA's actions on this item and found them acceptable. In addition, the NRC staff has reviewed and approved the use of a later 1974 Code edition as applicable to PS 2.M.1.1(4), "Specification for Post Weld Heat Treatment for ASME and ANSI." This review and approval is documented in NRC Inspection Report 50-390, 391/89-04, dated August 8, 1989. This item is closed.

(2) URI 50-390/86-14-07 (Closed), ASME Section XI Was Used for Unit 1 Rework Activities

URI 50-390/86-14-07 documents that the NRC inspector has several concerns regarding the use of ASME Section XI rules for TVA rework activities at Watts Bar Unit 1. These are:

(a) Unit 1 is not an operating plant and TVA has not certified that it is ready for an operating license,

(b) Numerous employee concerns exist regarding the adequacy of construction. The N-5 data packages and program are also being questioned based on employee concerns. It is not clear that construction is complete until all construction issues are resolved,

(c) ASME Section XI exempts piping of less than 1-inch diameter from construction rules. ASME Section III does not exempt this size piping.

Therefore, hydrostatic testing is not exempt. Also, the authorized nuclear inspector is not exempt under Section III rules.

The TVA organization at Watts Bar has committed to the NRC as a result of the ASME III/XI meeting in Washington, DC, June 26, 1987, to return to a full ASME Code Section III program. All work should be performed to the Watts Bar Construction Code of Record, that is, Section III-1971 through Summer 1973 with application of later revisions of ASME Code Section III which are less restrictive than the code of record being presented to the NRC for review and approval.

TVA is currently reviewing its Watts Bar records for any repairs and modifications performed following the closure of the N-5 packages. TVA will evaluate such work performed in accordance with Section XI or by a nonstamp user. TVA shall identify exceptions to the code of record and shall request approval for the proposed alternatives as prescribed by 10 CFR 50.55(a)(3).

Because the NRC considers Watts Bar to be a "construction" plant, TVA has returned to a full ASME Code Section III program, including technical and administrative requirements for repairs and modifications, as well as instrumentation lines, until such time that all agree to proceed to the ASME Code Section XI program.

The NRC team reviewed TVA's actions on this item and found them acceptable. These issues were also addressed in the NRC Inspection Report 50-390, 391/89-04. This item is closed.

(3) IFI 50-390/85-50-01 (Open), Office of Engineering Evaluation of Hanger Welds

The NRC welding team inspector reviewed NCR 6179 and examined supports for the containment spray system spray rings located at the top of the Unit 2 containment. This NCR was initiated during the acceptance inspection of the Unit 2 hangers. It identified a nonconformance with weld joints on specific hangers supporting these spray rings. Apparently, this nonconformance resulted from poor quality control of contractor welds. The hangers for the spray rings were installed by the Chicago Bridge and Iron Company (CBI). The NRC originally identified welds on five specific hangers but later incorporated all of the hangers that attach the containment spray rings to the containment dome. The correction method identified in this NCR calls for a TVA Office of Engineering (OE) evaluation for the possible existence of different interpretations of specific acceptance criteria due to the fact that several years have elapsed since CBI installed the original hangers. Specific discrepancies identified were overlap, excessive undercut, insufficient throat, base-metal damage to the corners of the channels, and insufficient leg on hanger welds.

TVA has completed its work on NCR 6179. TVA performed an onsite evaluation of the welds using Nuclear Construction Issues Group document NCIG-01, Revision 2, "Visual Weld Acceptance Criteria [VWAC] for Structural Welding at Nuclear Power Plants," as acceptance criteria. TVA evaluated the engineering work to determine the effect of these deficient welds on the safety of the support. This analysis indicates that under design loading, the factors of safety against the allowable stress range between 3.38 and 6.77. Considering that the design loads are based on

envelopes of all support loads in the dome, there can be no doubt about the safety of these supports. In a letter from James P. Knight (NRC) to Douglas E. Dutton (Southern Company Services), the Office of Nuclear Reactor Regulation (NRR) stated that NCIG-01, Revision 2, represents a technically acceptable approach for visual inspection of structural welding. TVA's QA Topical Report TVA TR75-1A, "Quality Assurance Program Description for Design, Construction, and Operation of TVA Nuclear Power Plants," was revised to include the use of NCIG-01, Revision 2, as an alternative to Regulatory Guide 1.94 for visual welding acceptance criteria. NRC determined that utilization of this alternative should also be addressed in the appropriate technical section of the Final Safety Analysis Report (FSAR). TVA is in the process of amending the FSAR to include use of VWAC. This item is being tracked in the TVA/TROI (Tracking and Reporting of Open Items) system (IFI 50-390/85-50-01) and FSAR data bases.

The NRC team reviewed TVA's actions on this item. This IFI remains open until TVA completes the reinspection of welds on the containment spray system spray rings for Unit 1.

(4) URI 50-390/86-14-03 (Closed), Post-Weld Heat Treatment Deficiencies Identified on NCR 6888

The NRC inspector reviewed the records of post-weld heat treatment (PWHT) of weldments. Among the welds reviewed was field weld 1-001A-D001-01; furnace strip charts were reviewed to ascertain if work was performed in compliance with PS 2.M.1.1(b), "Specifications for PWHT" (dated April 6, 1987), and American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section III. This weld joins the main steam line (which is of base material SA234 WPB, ASME type P-1) to the steam generator (which is of base material SA508, ASME type P-3). This section of steam line has a 32-inch diameter and 1.175-inch wall thickness. The inspector found that the welding procedure WPS GT-SM13-0-2, "Welding Procedure Specification," was qualified with PWHT at a maximum temperature of 1100°F for 24 hours.

A review of the actual PWHT strip charts indicated that the temperature during PWHT never reached 1100°F. The maximum temperature for the control thermocouple (No. 5) was 1030°F. The Code specifies that PWHT will be performed at 1100°F and held at this temperature (soak time) for 1 hour per inch of wall thickness. This was not achieved; however, the ASME Section III Code allows a reduced temperature if the soak time is increased. An example: the maximum temperature can be 1050°F if the hold time is increased to 2 hours per inch, or 1000°F if the hold time is increased to 3 hours per inch. Extrapolation for temperatures between 1000°F and 1100°F is allowed by the ASME Section III Code. Therefore, for a temperature of 1030°F, the extrapolated hold time would be 2 hours and 24 minutes per inch of wall thickness. The wall thickness for this area was specified as being 1.175 inches thick, which would require a soak time of 2 hours and 49 minutes. The review of the strip charts indicated that the soak time at 1030°F commenced at 12:30 p.m. and left this temperature at 2:18 p.m. This indicates that a soak time of 1 hour and 48 minutes was used, which is below the minimum hold time specified in the ASME Section III Code.

When the NRC inspector advised TVA of this inadequacy, TVA indicated that a recent audit performed in this area uncovered similar problems. This audit was conducted by Stone and Webster Engineering Corporation in early June 1986. As a result of this audit deficiency, TVA subsequently reviewed all PWHT charts

and found discrepancies in the PWHT records for 157 welds. The item found by the inspector had been identified by TVA, but had not been documented in any nonconformance report. On June 18, 1986, all deficiencies were identified in NCR 6888. In addition to the item discussed above, which involved three welds, TVA noted that approximately 109 welds may have exceeded the total time (2 hours) at temperature as qualified on the welding procedure qualification report. Another deficiency identified in the NCR indicated that 45 welds which received heat treatment referenced a procedure qualification report that was qualified for use without PWHT. The inspector determined that TVA did have a procedure qualification report that was qualified for use with PWHT and TVA's solution to this issue may only entail changing the records to reference the proper procedure qualification report.

From this review, it appeared that TVA had identified this item before the inspector did and had requested engineering assistance to resolve it.

To resolve the deficiencies identified in NCR 6888, TVA has performed the following actions:

- issued Addendum 1 to PS 2.M.1.1
- issued WBN-CEB-4.09 (superseded by AI-9.4.3)
- requalified PQR GT-SM11-02A for 12 hours at 1150°F.
- requalified PQRs GT-SM11-02A and GT-SM13-02 for lower temperature and longer hold times
- reviewed Unit 1 welds that had received PWHT
- closed NCR 6888 for Unit 1

The NRC team reviewed TVA's actions on this item and found them acceptable. This item is closed.

(5) IFI 50-390/87-09 (Closed), Items Left Open From NRC Welding Team Inspection

This inspector followup item involved the following issues.

During an NRC welding team inspection at Watts Bar, the team reviewed the TVA's reinspection effort in order to determine its adequacy. At the conclusion of the inspection, the NRC team noted no significant deviations from the procedures established by TVA's welding reinspection program and found that the Watts Bar reinspection effort was conducted in accordance with the approach outlined in the Watts Bar welding program. However, the NRC welding team identified several areas of concern that TVA needed to address. These concerns included:

(a) TVA's review of the weld deficiencies identified in shear-lug-to-pipe welds did not include safety-related ANSI B31.1 welds. TVA must review an adequate number of safety-related ANSI B31.1 shear-lug-to-pipe welds to provide the required basis to assess this area.

(b) The current engineering reviews of deviation reports did not include the review of deficiencies identified in the "999" and WTG reports. These two

reports document additional welding deficiencies found by EG&G and TVA inspectors, respectively. These reviews also did not consider the cumulative effects of all identified deficiencies related to the affected weld connections. TVA must ensure that engineering reviews of weld deficiencies include the deficiencies identified in the "999" and WTG reports and the cumulative effects of all identified deficiencies related to the affected weld connections.

(c) The expanded sample of pipe welds, Group A, did not include a sufficient number of stainless-to-carbon-steel welds. The sample group had been expanded because a crack was found in a stainless-to-carbon-steel weld. TVA must review an adequate number of stainless-to-carbon-steel welds to provide the required basis to assess this problem.

(d) Group 254A was incorrectly classified as being related to electrical welding when, in fact, it should have been classified as ASME pressure-retaining containment welding. TVA must ensure that any identified weld deviations are considered and addressed in accordance with the requirements of Section III of the ASME Code.

(e) TVA's re-review of radiographs identified welds that had been radiographed twice using different weld identification numbers or two different sets of film that had been assigned to one weld. TVA must investigate these cases to determine whether they represent isolated incidents or whether the same condition also may apply to other welds.

The NRC team reviewed TVA's actions on those open items and found them acceptable. These issues were addressed in NRC Inspection Report 50-390, 391/89-04. These items were inadvertently left out when the listing of open items was reviewed during the NRC team inspections April 24-May 5, May 15-19, and July 25-27, 1989. These items are closed.

(6) IFI 50-390, 391/89-04 (Closed), Conduit Support Identified as Item 251-0055

The NRC welding team identified one area that will require additional attention. This area involves a conduit support that was originally included in Inspection Group 251, identified as Item 251-0055. This support was missing both of the specified welds, but contained unspecified welds of a configuration that made the effective amount of weld impossible to characterize. Therefore, suitability for service could not be evaluated, and this item was removed from the inspection group and replaced with another item. The removal and replacement of this item are documented on page 3 of 4 in the Group 251 Inspection Results and Data Analysis Report, dated August 27, 1987. The removal of Item 251-0055 from the inspection group was documented in Deviation Report 99-308 and Condition Adverse to Quality Report (CAQR) WBP 880025 for future resolution. By field observations and conversation with licensee personnel, the NRC team found that this is not an isolated case, but that it exists on a number of conduit supports. The primary concern regarding this configuration is not a welding issue, but a question of whether a support of this configuration can adequately transmit load to the supporting structure.

TVA documented this item as a condition adverse to quality in CAQR WBP 880025.

CAQR WBP 880025 contains a recommended corrective action which refers the resolution to Nonconforming Report (NCR) 64635. This NCR is part of the Electrical Conduit and Conduit Support Corrective Action Program (CAP) Plan. The basis of the CAP indicates that this NCR is also being reported under 10 CFR 50.55(e). Therefore, the issue is tracked and captured by the resolution of the CAP and the closure of NCR 64635.

The NRC team reviewed TVA's actions on this item and found them acceptable. This item is closed.

(7) URI 50-390/86-17-04 (Closed), Weld Identification vs. Hard Stamping the Weld

This unresolved item established that TVA relies on weld identifications found on site-isometric drawings rather than on weld hard stamping to locate and identify piping welds. The task of identifying welds is complicated by the insulation installed over the piping. Knowledgeable TVA construction personnel erroneously identified welds during the NRC nondestructive examination/van inspection. Although after subsequent investigation, TVA construction personnel correctly identified these welds and confirmed that the appropriate documentation was on file for each weld, the NRC inspectors were concerned that similar cases of erroneous identification may exist. The inspectors also noted that ANSI Standard N45.2 states that physical identification should be used to the maximum extent possible to identify items that affect quality. The present system of identifying welds at Watts Bar Unit 1 appears to require further evaluation by TVA.

NRC Inspection Report 50-390/87-19 expands the field weld identification issue to include erroneously identified welds. The inspector reviewed TVA's action on this issue relative to demonstrating that all ASME Code welds that require radiography were radiographed and that records properly reflected the correct weld. TVA is presently reviewing radiography and repeating radiography for approximately 400 welds. Identification is being verified. To date, TVA had identified seven welds which were either erroneously identified or not radiographed with the proper identification, or both. The problems regarding weld identification are documented in four condition adverse to quality reports (CAQRs): WBP 870469, WBP 870770, WBP 870554, and WBP 870467. These documents relate to field welds (FWs) 1-063B-D089-8A, 1-063B-D087-7A, 1-003B-D002-20, and 1-003B-D002-07, discovered by TVA's rereview, and 1-003B-D372-07B, 1-003B-D372-07A, and 1-003B-D372-37, disclosed during NRC Inspection 87-09. In response to the erroneous identification, one acceptable weld was repaired (1-003B-D002-20) and one rejectable weld was accepted (1-003B-D002-07). The rejectable weld is presently being repaired. TVA has committed to document erroneously identified welds in CAQRs. However, TVA was unable to demonstrate that all such weld problems were being documented in this manner. For example, TVA's current program requires the weld number on the part or documentation be corrected when errors are found. Provisions for writing CAQRs are not evident.

TVA reviewed the issue of hard stamping of welds and concluded that the Watts Bar plant is in full compliance with the weld identification requirements of ANSI Standard N45.2-1977, Section III of the ASME Code 1971 Edition with addenda through Summer 1973, and Section XI of the ASME Code 1977 Edition with addenda

through Summer 1978. A unique method (hard marking) of weld identification is not specified in the ASME Code Section III or ANSI N45.2. Isometric drawings, associated instructions, and records, as were used at Watts Bar before August 1987, are an acceptable method that meets Code requirements.

Before August 1987, the weld numbers were not permanently marked at the weld location. The weld maps were the only method used for locating welds. On August 17, 1987, Watts Bar revised Procedure WBN-QCI-4.03 to require that weld numbers be permanently marked at the weld location for ASME piping welds fabricated after that date.

When inservice inspection (ISI) personnel began inspecting the welds to the requirements of ASME Code Section XI, they permanently marked weld numbers on portions of systems within the ISI boundary per Procedure N-GP-1, "Marking and Identification Procedure for Critical Systems, Structures, and Components (CSSC)."

During the NRC van inspection, the staff identified two instances in which the physical stamping of weld numbers by ISI personnel did not match the ISI drawing numbers. Upon investigation, the NRC found that the ISI drawings had been revised to reflect changes in the construction weld maps, but ISI personnel failed to correct the physical weld identification stamping in the plant. To resolve this, Quality Assurance personnel (QA) reviewed the Unit 1 drawings and data sheets that had weld changes. From this review, the staff compiled a list of 136 weld numbers that had been changed. A physical verification determined that 3 of the 136 weld numbers did not match the drawings/data sheets. These 3 weld numbers were corrected to coincide with the drawings. Additionally, 10 welds were chosen for physical verification to ensure that weld numbers matched the drawings in those cases where changes had not been made. No additional matching problems were found.

The following is a restatement of a previous TVA response to NRC's question on the Corrective Action Program (CAP) Plan for Welding at Watts Bar Unit 1. It constitutes the basis for TVA's resolution of the issue of erroneously identified radiographs.

- During the nondestructive examination (NDE) Level II and III rereviews (two separate rereviews) of radiographs for ASME Code Section III piping welds, radiographs for 16 welds were determined to have 18 radiographic identification discrepancies. (Two welds had two different types of discrepancies.)

- During the repair program resulting from these rereviews, two additional welds were determined to have two radiographic identification discrepancies.

- The initial concern after identification of these discrepancies was whether TVA could demonstrate that all welds were radiographed in their final and acceptable condition. This issue is included in SCR WBN NEB 8651, initiated in October 1986, and addressed in a response to an NRC concern (refer to TVA's letter to NRC, dated October 16, 1987). All deficiencies relating to this issue will be addressed in the closure to the SCR.

- In order to evaluate the extent of the radiograph misidentification problem, TVA decided to first review the entire population of those radiographs which were for welds either repaired and/or reradiographed, either during

initial construction or during the rereview of radiographs. This decision was based on the judgment that the potential for erroneous identifications was much greater on welds that were reradiographed for any reason.

- Of the about 2650 Watts Bar Unit 1 and common to Unit 2 ASME Code Section III piping welds requiring radiographic testing by the Code, about 2080 welds were radiographed, interpreted as accepted during construction, and independently reviewed and accepted during the rereview. The remaining welds (about 570) required repair or reradiography, either during construction or as a result of the rereview program. This population of approximately 570 welds was selected as the basis for additional evaluation of radiographic identification discrepancies.

- Of these 570 welds, approximately 400 welds required repair during initial construction. Of these 400 welds, approximately 300 welds did not require repair or additional radiography as a result of the rereviews. The remaining welds (approximately 270) required repair, or additional radiography, or both, as a result of the rereviews.

- As part of the rereview, the Level III rereviews matched the repair radiographs (400 welds) to the original radiographs for repaired welds to ensure that the correct area was repaired and that the repair radiograph matched the original weld. No additional discrepancies were identified.

- During repair or reradiography, or both, of the 270 weld population, the new radiographs, verified as corresponding to the correct welds, were compared against the existing radiographs. Two additional discrepancies were identified.

- TVA concludes that the results of the two independent rereviews of the ASME Code Section III piping welds (2650 population) and the additional evaluations of the 270 and 300 weld populations (about 22 percent of the total population) demonstrate that upon completion of the repair program, ASME piping welds requiring radiography will comply with TVA licensing commitments and that further evaluation for erroneously identified radiographs is not necessary.

The NRC team reviewed TVA's actions on this item and found them acceptable. This item is closed.

(8) IFI 50-390/86-18-04 (Closed), Wall Mounted Instrument Panels Fabricated Onsite

The NRC welding team inspector held discussions with TVA's Modification Group regarding the disposition of NCR 6738, Revision 0. This NCR identified approximately 118 wall-mounted instrument panel supports, fabricated on site, that had not been documented in accordance with Procedure WBNP-QCI-1.08, "Quality Assurance Records." After the supports were fabricated, the documents were removed from the vault and destroyed. TVA had visually inspected 11 of the supports to determine if the fabrication met the drawing (47W600-23, Revision 0) requirements. TVA reported that visual inspections revealed unacceptable weld penetration on all panels inspected. Because no documentation existed and full weld penetration was lacking on all welds inspected, TVA required that all wall-mounted panels in the Category 1 structure be replaced. TVA plans to

perform this work using Work Plan N6738-1, which it is presently reviewing. This corrective action appears acceptable; however, this item was identified as Inspector Followup Item IFI 50-390/86-18-04.

TVA reported this deficiency to NRC Region II on February 19, 1987, in accordance with 10 CFR 50.55(e) as Significant Condition Reports (SCRs) WBN 6738-S and 6713-S for Units 1 and 2, respectively. Subsequent to the initial notification, SCR WBN 6738-S was replaced by SCR W-559-P-S. A revised 10 CFR 50.55(e) report was issued on September 21, 1988. An excerpt from the corrective action of that report is submitted here to document closure of this IFI.

> For the wall-mounted instrument panels, the following actions will prevent recurrence of this deficiency:
>
> - Engineering Requirement ER-WBN-EEB-001, Revision 2, was issued to clarify and consolidate in one document the engineering and design requirements necessary for installation, modification, maintenance, and inspection of instrument systems. Affected site procedures have been revised to incorporate these requirements and enhance the program for fabrication, inspection, and documentation of the panels.
>
> - Training has been provided to affected craft personnel in procedure changes and adherence to drawing requirements, and to quality control (QC) inspectors to encompass the procedure changes and weld symbol interpretation.
>
> - Management overview of QC inspectors has been included in site procedures to provide early detection of potential problems in the future.

Additional measures which will prevent recurrence of this problem were implemented independently of this deficiency subsequent to the fabrication of these panels. These include procedural requirements that foremen verify fitup for all welds before beginning welding and random surveillance inspections by welding QC inspectors for weld fitups.

TVA evaluated the safety significance of the deficiencies for the panels required for Unit 1 operation. The evaluation involved a visual, qualitative grading of the highest loaded welds on the wall-mounted panels identified by SCR W-559-P-S. This grading identified panels 0-L-310 and 2-L-290 as having the least amount of effective weld at the critical joints. These two panels were tested at TVA's Singleton Materials Engineering Laboratory with three loading cycles: a safety-significant load; a long-term qualification load; and, finally, an ultimate load for the panels was found by fragility (destructive) testing. Each panel satisfactorily passed the two qualification load levels and a factor of safety of approximately 10 was demonstrated for the ultimate structural capability of the panel above the long-term qualification load. Therefore, it was concluded that the Unit 1 panels are acceptable for use as is without rework. The two panels destructively tested have been replaced in accordance with applicable site procedures; refer to Work Plans N-W559P-1 and N-W559-2.

The NRC team reviewed TVA's actions on this item and found them acceptable. In addition, this issue was addressed in NRC Inspection Report 50-390, 391/89-04 during the review of the 10 CFR 50.55(e) closure report. This item is closed.

(9) 10 CFR 50.55(e) Report 50-390/86-66 (Closed), Questionable Weld Radiographs

The Department of Energy/EG&G weld inspection program, in response to employee concerns expressed about Watts Bar, included the review of radiographs of ASME Code Section III piping which was completed during the construction period of Unit 1. Approximately 400 previously accepted radiographs, representing 86 welds, were reevaluated. The review identified indications in two welds that did not meet ASME Code Section III requirements. Further investigation of these 400 radiographs by TVA identified 1 additional unacceptable indication. The radiograph review population was subsequently expanded to 100 percent. The expanded review involved approximately 2700 welds and associated radiographs. EG&G rejected an estimated 500 radiographs, representing approximately 350 welds.

This deficiency is attributed to lack of attention to detail by TVA inspectors when interpreting radiographs. Also, there was insufficient management oversight and Quality Assurance (QA) surveillance of the work of radiographic interpreters. TVA considers that the oversight and surveillance problems, in conjunction with the high deficiency rate in the interpretation of weld radiographs, represent a significant breakdown in a portion of the QA program.

The Unit 1 review of radiographs by Level II inspectors and the rereview of all Unit 1 radiographs by independent Level III inspectors are complete. Of the approximately 12,000 radiographs, which represented approximately 2700 welds, 297 radiographs representing 185 welds were rejected for weld imperfections, 192 radiographs representing 138 welds were rejected for film quality or technique discrepancies, and 27 radiographs representing 20 welds were rejected for base material imperfections.

All Unit 1 radiographs have been rereviewed. All indications which deviate from ASME Code Section III requirements have been identified. Corrective actions, including repair of unacceptable indications and radiography of unacceptable radiographic technique and film quality discrepancies, are approximately 85 percent complete for Unit 1. Two deviations (summarized below) are still being evaluated. All corrective actions, hydrostatic testing, and final documentation of the repairs on Unit 1 will be completed before fuel loading.

TVA has identified two welds in the containment sleeves at the residual heat removal (RHR) sump suction with radiographic indications which exceed the acceptance criteria of ASME Code Section III. These sleeves are a part of the containment pressure boundary and not the RHR system pressure boundary. As such, they will experience no more than peak containment pressure during a design-basis accident. Because the welds are embedded in concrete, it would be extremely difficult to repair them. Corrective action on these two welds will be pursued by a separate submittal if current evaluations result in a corrective action other than repair.

The NRC team reviewed TVA's actions on this item and found them acceptable. In addition, this issue was also reviewed and addressed by an NRC welding team in NRC Inspection Report 50-390, 391/89-04. This issue is closed. UNIT 1 60 TVPO – SEE CDR 86/66 & 86/60

(10) 10 CFR 50.55(e) Report 50-391/86-66 (Open), Questionable Weld Radiographs UNIT 2

The issue, described in item 9 (above), was also found to be applicable to Watts Bar Unit 2.

The independent review of Unit 2 radiographs by Level III inspectors is approximately 35 percent complete. A corrective action program identical to the CAP for Unit 1 will be observed for Unit 2 and will be completed before cold hydrostatic testing.

This item remains open pending completion of the Watts Bar Unit 2 review of radiographs by Level III inspectors.

(11) VIO 50-391/86-13-10 (Closed), Interpass Temperature Control

This violation identified the following issue. Between June 25, 1980, and November 13, 1985 (5 years, 4½ months), a weld procedure used on site had an incorrect interpass temperature specified that went undetected and uncorrected. After identifying the deficiency, TVA took inadequate corrective actions to resolve the violation regarding interpass temperature controls, and analyses were not done to determine the effects of higher interpass temperatures on stainless steel weldments. TVA provided the following response:

> The original nonconformance report (NCR) cited two welds which were found during a surveillance of in-process welding where the interpass temperatures were measured at 850°F and 861°F, respectively, much higher than the required maximum of 350°F. The minimization of weld interpass temperature is one of the procedural controls used to control weld heat affected zone sensitization, which is one of several conditions that can be conducive to stress corrosion cracking (SCC). In order to determine the sensitivity of the two welds to SCC, corrosion tests (ASTM* A262, Practice A) were performed. Weld 1-067J-T359-12, a 2-inch pipe-to-flange socket weld located in the safety injection pump room, was polished and etched to determine the amount of sensitization. Surface replicas were made and examined at TVA's Singleton Materials Engineering Laboratory, and no sensitization was seen. The same procedure was performed on weld 1-067C-N280-7, a pipe to a 4 x 3-inch reducer located in the reactor building. No sensitization was seen in this weldment. These welds passed the ASTM A262, Practice A test. This indicated a low susceptibility to intergranular attack and SCC.

The results of the investigations and test described justify the use-as-is disposition of welds made from June 25, 1980, to November 13, 1985.

Although a use-as-is disposition has been justified for all welds in the disposition to W-309-P, TVA has decided to adopt a conservative approach and replace the two welds in the safety injection system, welds 1-063-T197-25A and 29A, described above.

The NRC team reviewed TVA's actions on this item and found them acceptable. In addition, the same issue was reviewed and closed for Watts Bar Unit 1 and is documented in NRC Inspection Report 50-390, 391/89-04. This item is closed.

(12) 50-390, 391 (Closed), Confirmation of Action Letter, Welder Recertification Issue

On August 23, 1985, the NRC issued a confirmation of action (COA) letter concerning inadequate and potentially inaccurate records of welder recertifications at Watts Bar. On September 17, 1985, the COA letter was revised on the basis of current events. The COA letter was issued when members of the NRC staff conducted a special inspection between July 31 and August 22, 1985, to address employee charges of impropriety in TVA's welder recertification program. This inspection resulted in the issuance of a Notice of a Violation that identified that no validation by continuing performance or certification by test were performed. This violation finding resulted in the issuance of the COA letter. TVA responded on April 30, 1987, with its final report on the matter. NRC inspected TVA's actions on the COA letter and on Violation 50-390, 391/85-45-01, documented in Inspection Report 50-390, 391/90-04, and found remedial actions acceptable. The team reviewed all issues relative to this matter and determined that TVA has resolved the issues. The COA issue is closed.

85/56-01

4.2 Review of Requests for Alternative Acceptance Criteria in Accordance With 10 CFR 50.55a(a)(3)

The NRC welding team reviewed three requests for alternative acceptance criteria in accordance with 10 CFR 50.55a(a)(3): (1) an alternative acceptance criterion for containment penetrations, (2) an alternative acceptance criterion for pneumatic test for the control air system, and (3) welds on the drain line vortex for the refueling water storage tanks. These are addressed in Sections 4.2.1, 4.2.2, and 4.2.3, respectively.

4.2.1 Containment Penetrations.

In a letter to the NRC dated November 21, 1989, TVA requested, in accordance with 10 CFR 50.55a(a)(3), that the NRC staff approve an alternative acceptance criterion for a number of containment penetrations at Watts Bar.

During construction of Watts Bar Unit 1, TVA discovered that the manufacturer of certain containment penetrations had exercised specific provisions of Section III of the ASME Code that permitted the use of system hydrostatic tests instead of component hydrostatic tests. TVA did not discover this substitution until the hydrostatic tests of the systems in which the penetration assemblies had been installed were completed. Therefore, although the system pressure tests were performed and the penetration assemblies were exposed to the required (ASME Code Section III) hydrostatic test pressure, no provisions were made to examine the manufacturer's welds during this test. Nonconformance Report (NCR) 5609 was initiated to document this condition on April 27, 1984. On May 17, 1984, NCR 5609 was dispositioned "use as is." TVA subsequently decided that NCR 5609 was not dispositioned properly and Condition Adverse to Quality Report (CAQR) WBP 870310 was issued to change the disposition of NCR 5609 to require that the penetrations are hydrotested to the required examination pressure and visually examined for leakage in accordance with ASME Code Section III requirements. TVA subsequently determined that this disposition will, as stated in 10 CFR 50.55a(a)(3), "result in hardship and unusual difficulties without a compensating increase in the quality and safety" of Watts Bar.

TVA requests relief pursuant to 10 CFR 50.55a(a)(3) to apply an alternative to the ASME Code Section III requirements for visual examinations during hydrostatic testing for the vendor welds that are not accessible and were not examined during the original field hydrostatic test. TVA proposes to accept the original use-as-is disposition which provides an acceptable level of safety.

In order to make the manufacturer's welds in question accessible for examination, as proposed in the disposition to CAQR WBP 870310, several "windows" must be cut in the guard pipe protecting the process pipe. Experience gained during similar work on Unit 2 indicates that this effort will be very difficult, especially replacing the "windows." Even with the "windows" cut in the guard pipe, some of the unexamined welds will only be accessible for examination by using such remote viewing equipment as mirrors or fiberoptic devices. This type of examination is difficult to execute to ensure both completeness and accurate interpretation. TVA believes that a use-as-is disposition of these welds is technically acceptable for the following reasons:

(1) The circumferential welds in question were fabricated and inspected in accordance with Section III, Division 1 of the ASME Code with authorized nuclear inspector (ANI) involvement at the manufacturing plant.

(2) A hydrostatic or pneumatic test to Section III, NC-6000 of the ASME Code was performed on the field welds installing the penetration assemblies in the piping system. Each of these was visually examined in accordance with ASME Code Section III and accepted.

(3) Pressure boundary pipe containing longitudinal weld seams used by the manufacturer to fabricate the penetration assemblies was hydrostatically tested by the material manufacturer in accordance with the ASME material specification. Therefore, all longitudinal welds were pressure tested and inspected as required by the ASME Code.

(4) Many of the vendor welds not visually inspected during field hydrostatic testing are so close to TVA field welds which were inspected that it is reasonable to assume leakage from these welds would have been detected during the inspection of field welds. The distance from the field weld to the unexamined vendor weld is listed in Table 1.

(5) The circumferential welds in question were volumetrically examined (radiography) and accepted by the vendor in accordance with ASME Code Section III, Class 2, requirements. These radiographs were subsequently reviewed and accepted by TVA.

(6) The systems involved include the safety injection, residual heat removal, containment spray, and auxiliary feedwater systems. These systems are safety related and are necessary for achieving and maintaining cold shutdown. Also affected are the relief valve discharge line from the safety injection system (which carries relief valve discharge back to the reactor coolant drain tank and is classified as part of the reactor coolant system) and the reactor coolant pump seal water injection lines. The other systems involved (main steam, ventilation, control air, demineralized water, ice condensor, chemical and volume control, waste disposal, fuel handling, primary makeup water, and spare parts originally associated with the upper head injection system) either isolate or are already isolated during

accidents. The likelihood of compromising the safety function of any of the affected systems by accepting this condition is believed to be minimal for the following reasons:

(a) As stated previously, all penetrations involved were part of a system test and therefore have been taken to hydrostatic or pneumatic test pressure. If a discontinuity large enough to cause total loss of function existed and was of such a nature as to cause failure during operation, it would have failed during testing whether or not the visual examination was performed.

(b) As stated previously, all involved penetrations were radiographed. It is extremely unlikely that a defect which would have caused leakage during testing could exist and not be visible on the radiographic film. Therefore, since the film was acceptable, it is extremely unlikely that such a defect exists.

The NRC welding team reviewed the radiographic film and the supporting quality control documentation and found them acceptable.

Results of the NRC team examination generally agreed with the examination results reported on the manufacturer's radiographic reader sheets. However, the radiographic film for penetrations 1X-8A, 1X-8B, 1X-8C, 1X-8D, 2X-8A, 2X-8B, 2X-8C, and 2X-8D could not be retrieved from the radiographic storage area at the time of the inspection. As a result of this finding, TVA issued CAQR WBP 900156 to track and resolve this finding. See Table 1 for details. A linear indication was also found in one weld on penetration 1X-46. CAQR WBP 900148 was issued to track and resolve this finding.

The NRC team concluded that TVA has adequately reviewed the issues associated with this request for alternative acceptance and that proposed alternatives to the code of record will not impair the integrity of the affected containment penetrations.

4.2.2 Pneumatic Test for the Control Air System

In a letter to the NRC dated April 5, 1990, TVA requested, in accordance with 10 CFR 50.55a(a)(3), that the NRC staff approve an alternative acceptance pneumatic test pressure criterion for portions of the control air system.

During the construction of Watts Bar Unit 1, the ASME Code Class 3 portions of the control air system were installed in accordance with the requirements of ASME Code Section III. These portions were tested in accordance with the pneumatic pressure test requirements of Paragraph ND-6000 of Section III of the ASME Code. However, the test pressure was insufficient because the design pressure used to establish the test pressure was incorrectly recorded on the flow diagram for this system. The design pressure specified in the design criteria and documented in the Final Safety Analysis Report (FSAR) was 115 psig. The design pressure recorded on the flow diagram was 105 psig. The maximum system operating pressure as documented in the manual describing the system is also 105 psig.

Subsection ND-6000 of ASME Code Section III requires a test pressure 1.25 times the design pressure. In accordance with this requirement, the control air system was tested at a minimum test pressure of 131.25 psig (1.25 times 105 psig) and

not at the required 143.75 psig (1.25 times 115 psig) due to the error described above. As a result, the control air system was tested at a pressure 12.5 psig less than the required test pressure. TVA concludes that this test provides an acceptable level of quality and safety for the following reasons:

(1) The original pneumatic test was performed in accordance with the requirements of ND-6000, except for the required test pressure.

(2) The test pressure used was 1.25 times the maximum system operating pressure.

(3) Testing at the higher pressure would not result in a significant increase in the stress levels of system piping or components. Therefore, the results of testing at the lower pressure should be acceptable.

(4) The consequences of any minor leakage would not be significant since there exists sufficient capacity to compensate for small leakage without affecting normal or safety functions.

(5) Any increase in operating pressure over 115 psig will be controlled by the safety relief valves.

Performance of a second pneumatic pressure test will require the examination of each welded joint and each mechanical joint (i.e., bolted and screwed connections, compression fittings) in the portion of the control air system that was fabricated according to the ASME Code. To complete this inspection, TVA would have to inspect numerous welds and mechanical joints. This would also require installing scaffolding and disconnecting instrumentation. TVA finds that performing this additional pneumatic test in order to comply with the requirements of ASME Code Section III would "result in hardship or unusual difficulties without a compensating increase in the level of quality and safety" of Watts Bar.

The NRC team concluded that TVA has adequately reviewed the issues associated with this request for alternative acceptance and that proposed alternatives to the code of record will not impair the integrity of the control air system.

4.2.3 Welds on the Drain Line Vortex for the Refueling Water Storage Tanks

In a letter to the NRC dated September 21, 1989, TVA requested, in accordance with 10 CFR 50.55a(a)(3), that the NRC staff approve an alternative acceptance criterion for the welds on the drain line vortex for the refueling water storage tanks at Watts Bar.

In December 1986, TVA committed to reviewing the radiographs provided by certain vendors. Pittsburgh-Des Moines (PDM), the supplier of the refueling water storage tanks (RWSTs), was one of these vendors.

The RWSTs are ASME Code Section III Class 2 manufactured to the requirements of ASME Code Section III 1974 Edition up to and including the Winter 1975 Addenda. There were 635 weld sectors radiographed for each RWST. TVA has reviewed the radiographs for both units again. Radiograph technique deficiencies were identified in 61 sectors for Unit 1 and in 58 sectors for Unit 2. Weld defects were identified in 34 sectors for Unit 1 and in 38 sectors for Unit 2.

Most of the discrepant sectors which did not comply with the requirements of ASME Code Section III for radiographic or weld quality were radiographed again and, where necessary, were repaired. Only one ASME Code Section III requirement could not be performed: the RWST vortex nozzle assembly welds could not be radiographed. However, these vortex nozzle assemblies located in the bottom of each RWST are fabricated from SA240 Type 304 stainless steel. Each assembly consists of a cone subassembly formed from four segments of 5/16-inch-thick plate welded with vertical seam welds, and a pipe subassembly which consists of seam-welded 3/8-inch-thick rolled plate. The cone and pipe subassemblies are joined with a full-penetration groove weld.

Subarticle NC-5280 of ASME Code Section III requires Class 2 butt joints of nozzles to be fully radiographed. TVA's review identified the following discrepancies:

(1) The seam welds in the cone subassemblies (14A) for both units were not radiographed, nor was radiography specified on the PDM drawings. This discrepancy has been documented in Condition Adverse to Quality Reports (CAQRs) WBP 890317 and WBP 890318 for Units 1 and 2, respectively.

(2) The radiographic techniques for the Unit 1 circumferential weld (attaching the cone to the pipe) and the pipe seam weld do not fully comply with the requirements of ASME Code Section III for the film quality and coverage. The quality of the radiographs for Unit 2 was acceptable.

(3) Weld defects which do not meet the acceptance criteria of ASME Code Section III have been identified in both vortex nozzle assemblies.

   (a) In the Unit 1 assembly, a lack of fusion, approximately 3 inches long, exists in one of the cone subassembly's seam welds. This weld defect was identified in the radiograph of the circumferential weld attaching the cone subassembly to the pipe subassembly. Consequently, the entire length of the weld is not included on the radiograph (3 of 14 inches are shown). No other defects are apparent in the circumferential or seam welds.

   (b) In the Unit 2 assembly, unacceptable slag, approximately 3/8-inch long, and two linear indications which are transverse to the weld, each approximately 1/4-inch long, exist in the circumferential weld. Unacceptable slag, approximately 1/4-inch long, exists in one of the cone subassembly's seam welds, and six indications, each approximately 1/8-inch long, exist adjacent to the circumferential weld (3 of 14 inches are shown). The latter appear to be surface indications.

The operating pressure of the RWSTs is atmospheric pressure. Design temperature is 200°F, with a minimum operating temperature of 60°F. The RWSTs fulfill two basic requirements:

(1) Provide an adequate supply of borated water for use during refueling operations,

(2) Provide an adequate source of borated water to the chemical and volume control system (CVCS) pumps, the safety injection system (SIS) pumps, the residual heat removal system (RHRS) pumps, and the containment spray system (CSS) pumps in the event of a loss-of-coolant accident.

The cone subassembly, a portion of the pipe subassembly, and the attaching circumferential weld are embedded in concrete. Except for the portion of pipe extending beyond the concrete's surface into the pipe tunnel, it would be extremely difficult to uncover these welds for reradiography or repair. For this reason, TVA has performed fracture mechanics analyses of the subject welds. The calculation was identified by TVA as WBP-MTB-001. The calculations do not consider the structural support provided by the concrete backing. The calculations were performed using the method described in ASME Code Section XI, Paragraph IWB-3640 and Appendix C, and Code Case N-436.

The results of the calculations demonstrate that the cone subassembly can withstand a longitudinal through-wall flaw up to 48.9 inches and still maintain structural integrity. The cone subassembly-to-pipe weld can withstand a through-wall flaw up to 70 percent of circumference and still maintain structural integrity. Various fabrication checklists and nondestructive examination reports, including hydrostatic test reports, indicated that the welds are of acceptable quality. Fabrication and inspection activities, including inspection reports certifying surface examinations, were documented. The acceptable results of these examinations demonstrate that the welds do not contain throughwall flaws. On the basis of these examinations and the calculations, TVA concluded that the flaws will not result in failure of the nozzle assemblies.

Full compliance with ASME Code Section III requirements for radiographic acceptance of these welds would, as stated in 10 CFR 50.55a(a)(3), "result in hardship and unusual difficulties without a compensating increase in the level of quality and safety."

The NRC welding team reviewed a sample of quality control records and radiographs for the refueling water storage tanks. This review included 25 vertical, 20 horizontal, and 2 manway welds involving approximately 970 radiographs. The welds reviewed were:

- Vertical welds

1V1	1V2	1V3	1V4	1V5
2V1	2V2	2V3	2V4	2V5
3V1	3V2	2V3	3V4	3V5
4V1	4V2	4V3	4V4	4V5
5V1	5V2	5V3	5V4	5V5

- Horizontal welds

1H1	1H2	1H3	1H4	1H5
2H1	2H2	2H3	2H4	2H5
3H1	3H2	3H3	3H4	3H5
4H1	4H2	4H3	4H4	4H5

- Manway welds 1V6, 1V7, WB1, WB2, 9D1, 9D2, 9D3, 9D4, 1P5

The review of the radiographs for weld 1V7 revealed that the coverage for area 7-8 can not be determined. Areas 10-11 and 11-12 also showed linear indication. As a result of these findings, TVA reradiographed weld 1V7. The new radiographs showed that areas 10-11 and 11-12 had rejectable linear indication. As a result of this finding, TVA issued CAQR WBP900186 to track and resolve this finding.

The NRC welding team also reviewed the radiographs and related quality control documentation for the welds on the drain line vortex for the refueling water storage tanks. The NRC inspection results agreed with TVA's inspection results as described in discrepancies 1, 2, and 3 above.

With the exception of the welds on the tank's drain line vortex and two areas on weld 1V7, the reviewed radiographs were found to be acceptable. For the drain line vortex welds, TVA has performed fracture mechanics analysis which indicated that the welds will maintain their structural integrity during the design life of the tanks.

The NRC team concluded that TVA has adequately demonstrated through conservative analysis that the integrity of the drain line vortex welds will be maintained because the flaws will not propagate and cause failure during the design life of the tanks.

The NRC team also reviewed the spot radiographs, drawings, and associated nondestructive examination (NDE) reports for the Unit 1 primary makeup water storage tank. This tank was fabricated by PDM, which also supplied the refueling water storage tanks. This review involved 11 radiographs. The reports reviewed were; 1V1, 1V3, 1V5, 1V6, 2V2, 2H1, 3H3, 3V4, 4V2, 4V3, and 1R1. No problems were noted during this review.

4.3 Review of Commitments and TVA's Welding Project Final Report

4.3.1 Inspection Scope

The NRC welding team reviewed the status of commitments made by TVA to the NRC in the Corrective Action Program (CAP) Plan for Welding at Watts Bar Unit 1. The team also reviewed the Welding Project Final Report for adequacy.

4.3.2 Inspection Findings

TVA has made 58 commitments in its CAP Plan for Welding at Watts Bar Unit 1. These commitments are being tracked by TVA's corporate commitment tracking system. The review by the NRC team of the status of the licensing commitments revealed the following.

- TVA had closed the following 45 licensing commitments at the time of this inspection:

NCO890012001	NCO890012010	NCO890012027	NCO890012036	NCO890012047
NCO890012002	NCO890012011	NCO890012028	NCO890012039	NCO890012049
NCO890012003	NCO890012012	NCO890012029	NCO890012040	NCO890012050
NCO890012004	NCO890012013	NCO890012030	NCO890012041	NCO890012051
NCO890012005	NCO890012014	NCO890012031	NCO890012042	NCO890012053
NCO890012006	NCO890012019	NCO890012032	NCO890012043	NCO890012054
NCO890012007	NCO890012020	NCO890012033	NCO890012044	NCO890012055
NCO890012008	NCO890012022	NCO890012035	NCO890012045	NCO890012056
NCO890012009	NCO890012026	NCO890012037	NCO890012046	NCO890012057

The NRC team reviewed the closure reports and the associated documentation for those 45 licensing commitments and found them acceptable.

- The following 13 licensing commitments were still open at the time of this inspection:

NCO890012015	NCO890012018	NCO890012024	NCO890012038	NCO890012052
NCO890012016	NCO890012021	NCO890012025	NCO890012048	NCO890012058
NCO890012017	NCO890012023	NCO890012034		

The NRC team concluded that TVA must address those commitments before completing all work related to the CAP Plan for Welding at Watts Bar Unit 1.

The NRC welding team also reviewed the information contained in the TVA's Welding Project Final Report which summarized TVA's Welding Project corporate review effort. That corporate review effort included all TVA nuclear plants and comprised three phases. The Phases I and II reports for Watts Bar were reviewed by an NRC welding team in 1989; the results of that NRC inspection are documented in NRC Inspection Report 50-390, 391/89-04. The Welding Project Final Report covers, in part, the third and final phase of the program. It presents a summary of the root-cause analysis and recurrence control plan for welding at Watts Bar Unit 1 which has been completed. The NRC team found these efforts acceptable. The evaluation of the effectiveness of the modifications to the welding program as a result of commitments made was not completed at the time of this inspection and will be reviewed by the NRC staff.

4.3.3 Conclusions

The NRC welding inspection team found that TVA has adequately addressed 45 out of 58 commitments made in the CAP Plan for Welding at Watts Bar Unit 1. However, 13 commitments were still open at the time of this inspection and the evaluation of the effectiveness of the modifications to the Watts Bar welding program as a result of the commitments made in the welding CAP was incomplete at the time of this inspection. TVA must address and close these items before final closure of the CAP and must also notify the NRC when all outstanding work on the CAP is completed.

5 PERSONS CONTACTED

D. Adkins, Sr., Supervisor, NDE Certification and Monitoring, TVA
G. Ashley, Compliance Manager, NRLA
K. Boyd, Information Systems Supervisor, TVA
W. Brenzeale, Quality Improvement, QA, TVA
S. Crowe, Site Quality Manager, TVA
T. Dean, Nuclear Engineer, TVA
D. J. Etzler, Principal Materials Engineer, TVA
D. Garland, Maintenance Specialist, TVA
K. Hasting, Supervisor Welding Engineering, TVA
L. Hebert, QA Specialist, TVA
D. Miller, Supervisor, QA, CAQ, TVA
L. Peterson, Manager QC, TVA
J. Self, Program Supervisor, TVA
R. Stevens, Manager, Site Licensing, TVA
D. Ward, QA Auditor, TVA
J. Yarborough, Welding QC, Supervisor, TVA

NRC resident inspectors:

M. Branch, Sr. Resident Inspector
G. Humphrey, Resident Inspector

6 DOCUMENTS REVIEWED

(1) Unit 2 - 2-001A-D001-04 - 32" dia. x 1.175" thickness - SA-155 GR KCF70 CL.1, SA-234 WPB, PWHT Report #467 WPS GT-SM-11-0-2A Revision 0.

(2) Unit 1 - 1-001A-D003-01A - 32" dia. x 1.175" thickness - SA-155 GR KCF70 CL.1, PWHT Report #365/#354. This weld and weld 1-001A-D003-02 PWHT together, welds are approximately 6" apart. WPS GT-SM-11-02A.

(3) Unit 1 - 1-001A-D003-02 - 32" dia. x 1.175" thickness - SA-155 GR KCF70 CL.1, SA-234 WPB, PWHT Report #354. PWHT completed with item 2 above, WPS GT-SM-11-02-A.

(4) Unit 1 - 1-001A-D006-05 - 32" dia. x 1.175" thickness - SA-155-1 KCF70 SA-234 WPB, PWHT Report #305, WPS GT-SM-11-02-A.

(5) Unit 1 - 1-001A-D009-06 - 32" dia. x 1.175" thickness - SA-155 GR KCF70, CL.1, SA-350 GR LF2, PWHT Report #364 Weld 1-001A-D009-13 recorded on strip chart - TVA believes chart misidentified; should be for weld 06 WPS GT-SM-11-0-2A.

(6) Unit 1 - 1-001A-D009-01 - 32" dia. x 1.175" thickness - SA-508 CL.2, SA-234 WPB, PWHT Report #397A, TVA has repeated PWHT new PWHT Report #537, WPS GT-SM-11-0-2A NCR 68881.

(7) Unit 1 - 1-001A-D006-02 - 32" dia. x 1.175" thickness - SA-234 WPB, SA-155 GR KCF70 CL.1, PWHT Report #327 (need code justification), WPS GT-SM-11-0-2A.

(8) Unit 1 - 1-001A-D006-01 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-234 WPB, PWHT Report #356, WPS GT-SM13-0-2.

(9) Unit 1 - 1-001A-D003-01 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-234 WPB, PWHT Report #134, WPS GT-SM13-0-2.

(10) Unit 1 - 001A-D001-01 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-234 WPB, PWHT #415, WPS SM13-0-2 Revision 0.

(11) Unit 2 - 2-001A-D001-12 - 32" dia. x 1.175" thickness, SA-155 GR KCF70 CL.1, SA-234 WPB, PWHT Report #479, WPS GT-SM11-0-2A.

(12) Unit 2 - 2-003B-D002-10 - 16" dia. x 0.844" thickness, SA-420 WPL 6, SA-508 CL.2, PWHT Report #367, WPS GT-SM13-0-2.

(13) Unit 2 - 2-003B-D001-12 - 16" dia. x 0.844" thickness, SA-420 WPL 6, SA-508 CL.2, PWHT Report #361, GT-SM13-0-2.

(14) Unit 1 - 1-001A-D001-11 - 6" dia. x 0.864" thickness, SA-106 GR B, SA-216 GR WCB, PWHT Report #448, WPS GT-SM11-0-2A.

(15) Unit 1 - 1-001A-D009-13 - 32" dia. x 1.175" thickness, SA-234 WPB, SA-155 KCF CL.1, PWHT Report #363, WPS GT SM11-0-2A.

(16) Unit 1 - 1-001A-D003-06 - 32" dia. x 1.175" thickness, SA-155 GR KCF70 CL.1, SA-350 GR LF2, PWHT Record #321, WPS GT-SM11-0-2A.

(17) Unit 2 - 2-001A-D006-08 - 32" dia. x 1.175" thickness, SA-155 KCF70 CL.1, SA-155 KC-70 CL.1, PWHT Record #493, WPS GT-SM11-0-2A.

(18) Unit 2 - 2-001A-D003-01 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-234 WBP, PWHT Record #480, WPS GT-SM13-0-2.

(19) 1-067H-T127-15 thru 22 - 30" x 24" dia. x 0.375" thickness, TVA fabricated reducer, SA-155 KC-70 CL.2, SA-234 GR WPB, PWHT Record #180, WPS GT-SM11-0-3B Rev. 5, Welds repaired after PWHT. PWHT 8/5/77, weld completed 7/28/77, RT rejects 8/13/77, stress chart not dated, HT required due to bending not for welds.

(20) 2-067H-T125-14 thru 21 - 30" x 24" dia. x 0.375" thickness, TVA fabricated reducer, SA-155 KC-70 CL.2, SA-234 GR WPB, PWHT Record #183, WPS GT-SM11-0-3B Revision 5.

(21) Unit 1 - 1-001A-D001-01 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-516 GR 70, PWHT Record #534, PWHT required by NCR 6888.

(22) Unit 1 - 1-001A-D006-08 - 32" dia. x 1.175" thickness, SA-155 KCF70 CL.1, SA-234 WPB, PWHT Report #542A, film evaluation repair, 4/16/88.

(23) Unit 1 - 1-001A-D001-03 - 32" dia. x 1.175" thickness, SA-155 KCF70 CL.1, PWHT Report #535A, film evaluation repair, 2/17/88.

(24) Unit 1 - 1-001A-D009-03 - 32" dia. x 1.175" thickness, SA-155 KCF70 CL.1, PWHT Report #536A, film evaluation repair, 3/1/88.

(25) Unit 1 - 1-001A-D001-06 - 32" dia. x 1.175" thickness, SA-155 KCF70 CL.1, SA-350 LF2, PWHT Report #538, film evaluation repair, 2/22/88.

(26) Unit 1 - 1-001A-D006-1 - 32" dia. x 1.175" thickness, SA-508 CL.2, SA-516 GR 70, PWHT Report #540, film evaluation repair, 4/6/88.

(27) Unit 1 - 1-001A-D0006-05 - 32" dia. x 1.175" thickness, SA-516 GR 70, SA-155 KCF70 CL.1, PWHT Record #539, film evaluation repair, 3/15/88.

(28) Unit 1 - 1-001A-D006-06 - 32" dia. x 1.175" thickness, SA-350 LF2, SA-155 KCF70 CL.1, PWHT Record #541, film evaluation repair, 4/28/88.

(29) Unit 1 - 1-003B-D002-08 - 16" dia. x 0.843" thickness, SA-420 WPL6, SA-508 CL.2, PWHT Record #543A, film evaluation repair, 6/3/88, NCR-NEB-8651.

(30) Inspection Report 50-390, 391/87-10 dated September 9, 1987.

(31) Process Specification 2.M.1.1, "Specification For Post Weld Heat Treatment for ASME and ANSI."

(32) Letter from R. Gridley (TVA) to NRC dated August 21, 1987, (L44 870821 811).

(33) CEP-4.09, "Local Post Weld Heat Treatment of Piping Welds."

(34) QMI-812.1, "Control and Calibration of Construction Tools, Gauges, Instrument, and Measuring Devices."

(35) GCI-8.1.00-00, "Control of M&TE Equipment."

(36) Nuclear Components Manual, Section 8.1, Revision 19.

(37) QCP-4.09, "Post Weld Heat Treatment."

(38) CEP-4.03, "Process Control and Weld Procedure Assignment."

(39) AI-9.4.3, "Local Postweld Heat Treatment of Piping Welds."

(40) NCR 6888.

(41) Inspection Report 50-390, 391/89-04 dated August 8, 1989.

(42) Detailed Welding Procedure GT-SM13-0-2, Revision 0.

(43) Detailed Welding Procedure GT-SM11-0-2A, Revision 2A.

(44) WBNP-QCI 1.12, Revision 0.

(45) M&TE Specifications Manual.

(46) NCR 4719.

(47) Construction Lesson Plan CLP-056.

(48) AI-5.9, Rev. 39, Control of Measuring Equipment.

(49) Construction Specification N3M-868.

(50) WBN HCI-HM15, Hazard Control Instruction.

(51) TVA Communication L44880921806, WBRD-50-390, 391/87-08, Revised Final Report, dated 9/21/88.

(52) NCR W-559-P, Revision 2.

(53) TVA Communication B2688061503 SER and Revised Disposition to NCR W-559P and SCR W-559-PS, dated 6/15/88.

(54) Fabrication Documentation Package Panel 0-L-142A.

(55) Fabrication Documentation Package Panel 0-L-310.

(56) Singleton Materials Engineering Lab. Test Document Package Instrument Panels PNL-0-L-310 and PNL-2-L-290.

(57) WBRD-50-390/86-66, Final Report and WBRD-50-391/86-60, Fifth Interim Report - Questionable Weld Radiographs 50.55(e) TVA Response.

(58) Watts Bar Unit I - Electrical Conduit and Conduit Support Corrective Action Program (CAP) Plan - Revision 1.

(59) USNRC, NRR Safety Evaluation - Electrical Support Corrective Action Program Plan - Revision 1.

(60) WBN Unit-I Conduit and Conduit Support Engineering Walk Through - Package AB-C9-18.

(61) WBN Unit-I Conduit and Conduit Support Engineering Walk Through - Package AB-B25-051.

(62) WBN Unit-I Conduit and Conduit Support Engineering Walk Through - Package AB-B25-053.

(63) WBN Unit-I Conduit and Conduit Support Engineering Walk Through - Package AB-C9-064.

(64) CAQR WBP 880025.

(65) Conduit Sketch 47A056-60 Revision 2 - 2/10/77.

(66) NDE Procedure N-GP-1 (Marking & Identification)

(67) Process Control & Weld Procedure WBN-QCI-4.03 Revision to Paragraph 6.1.2.2.

(68) TVA Memorandum TD3 890519 801, dated 5/19/89.

(69) TVA Memorandum L 44 880707803, dated 7/7/88.

(70) Welding Project Final Report.

Table 1 Penetrations requiring alternative acceptance

Penetration number	System	Weld type	Weld number	Notes
1K-14	74	Butt	12	1,3
		Lug	8,9,10,11	
1K-15	74	Butt	12	1,3
		Lug	8,9,10,11	
1K-16	72	Butt	12	1,3
		Lug	8,9,10,11	
1K-17	72	Butt	12	1,3
		Lug	8,9,10,11	
1X-8A[1]	03A	Butt	15	2
1X-8B[1]	03A	Butt	15	2
1X-8C[1]	03A	Butt	15	2
1X-8D[1]	03A	Butt	15	2
1X-12A[1]	03A	Butt	15,16	1
1X-12B[1]	03A	Butt	15	1
1X-12C[1]	03A	Butt	15	1
1X-12D[1]	03A	Butt	16,17	1
1X-13A[1]	01A	Butt	15,16	1
1X-13B[1]	01A	Butt	15,16	1
1X-13C[1]	01A	Butt	15,16	1
1X-13D[1]	01A	Butt	15,16	1
1X-14A	15	Fillet	12	1,3
		Lug	8,9,10,11	
1X-14B	15	Fillet	12	1,3
		Lug	8,9,10,11	
1X-14C	15	Fillet	12	1,3
		Lug	8,9,10,11	
1X-14D	15	Fillet	12	1,3
		Lug	8,9,10,11	
1X-15	62	Fillet	12	1,3
		Lug	8,9,10,11	
1X-16	62	Butt	1	1,3
1X-17	63	Butt	30	1,3
		Lug	26,27,28,29	
1X-20A	63	Butt	12	1,3
		Lug	8,9,10,11	
1X-20B	63	Butt	12	1,3
		Lug	8,9,10,11	
1X-21	63	Butt	12	1,3
		Lug	8,9,10,11	
1X-22	63	Butt	12	1,3
		Lug	8,9,10,11	
1X-24	68	Butt	12	1,3
		Lug	8,9,10,11	
1X-30	63	Fillet	12	1,3
		Lug	8,9,10,11	
1X-32	63	Butt	12	1,3
		Lug	8,9,10,11	

Table 1 (Continued)

Penetration number	System	Weld type	Weld number	Notes
1X-33	63	Butt	12	1,3
		Lug	8,9,10,11	
1X-34[2]	32	Fillet	1	1,3
1X-40A	03B	Butt	1	1
1X-40B	03B	Butt	1	1
1X-41	77	Fillet	1	1,3
1X-42	81	Butt	1	1
1X-43A	62	Fillet	1	1,3
1X-43B	62	Fillet	1	1,3
1X-43C	62	Fillet	1	1,3
1X-43D	62	Fillet	1	1,3
1X-44	62	Butt	1	1
1X-45	77	Fillet	12	1,3
		Lug	8,9,10,11	
1X-46	77	Butt	12,14	1,3,4
		Lug	8,9,10,11	
1X-47A	61	Butt	12	1,3
		Lug	8,9,10,11	
1X-47B	61	Butt	12	1,3
		Lug	8,9,10,11	
1X-48A	72	Butt	1	1
1X-48B	72	Butt	1	1
1X-49A	72	Butt	1	1
1X-49B	72	Butt	1	1
1X-77	59	Fillet	1	1,3
1X-81	77	Fillet	12	1,3
		Lug	8,9,10,11	
1X-82	78	Butt	1	1
1X-83	78	Butt	1	1
1X-90[2]	32	Fillet	1	1,3
1X-91[2]	32	Fillet	1	1,3
1X-97[2]	30	Fillet	1	1,3
1X-107	74	Butt	30	1,3
		Lug	26,27,28,29	
1X-108[3]	87	Butt	8	1
1X-109[3]	87	Butt	8	1

[1]These penetration assemblies have a spool piece welded to the outboard side of the flued head which will be examined during hydrostatic testing.

[2]These penetration assemblies were pneumatically tested rather than hydrostatically tested. The requested relief is for examination during pneumatic testing rather than hydrostatic testing.

[3]These penetration assemblies have been converted to spares, however we are requesting relief in the event that we may use them in the future.

Notes:

(1) The NRC team inspection results agreed with the manufacturer's interpretation.

(2) The radiographic film could not be found at the time of the inspection. CAQR WBP900156 was issued to track and resolve this finding.

(3) Liquid penetrant or magnetic particle report for the fillet welds were also reviewed for adequacy.

(4) Linear indication found in weld 14. CAQR WBP900148 was issued to track and resolve this finding.