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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
TVA PROJECTS DIVISION

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ABBREVIATIONS

AI	Administrative instruction
AISC	American Institute of Steel Construction
ANI	authorized nuclear inspector
ANII	authorized nuclear in-service inspector
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BBC	Brown Boveri Corporation
CAP	corrective action program [TVA plan]
CAQ	condition adverse to quality
CAQR	condition adverse to quality report
CATD	corrective action track document
CBI	Chicago Bridge and Iron
CFR	Code of Federal Regulations
COA	confirmation of action
DCN	design change notice
DNE	Department of Nuclear Engineering
DNQA	Department of Nuclear Quality Assurance
DOE	Department of Energy
DR	deviation report
DRR	document revision request
DWP	detailed welding procedure
ECN	engineering change notice
ERCW	essential raw cooling water
ERT	employee response team
FSAR	Final Safety Analysis Report
FU	fitup
GTA	gas tungsten arc
HAAUP	hanger analysis and update program
HAZ	heat-affected zone
HVAC	heating, ventilation, and air conditioning
IFI	inspector followup item
LP	liquid pentrant
MC	metal containment
NCIG	nuclear construction issues group
NCR	nonconformance report, nonconforming condition report
NDE	nondestructive examination
NE	nuclear engineering group TVA's

NEP	nuclear engineering procedure
NQA	nuclear quality assurance (group) TVA's
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
OGC	Office of General Counsel
PDM	Pittsburgh-Des Moines Steel Corporation
PIR	problem identification report
PS	process specification
PWHT	postweld heat treatment
QA	quality assurance
QAP	quality assurance procedure
QC	quality control
QCI	quality control inspection
QCP	quality control procedure
RHR	residual heat removal
SCC	stress corrosion cracking
SFS	suitability for service
SCR	Significant Condition Report
TROI	Tracking and Reporting of Open Items
TVA	Tennessee Valley Authority
URI	unresolved item
VC	visual civil
VIO	violation
WBN-1	Watts Bar Nuclear Plant Unit 1
WDR	weld deviation report, 999's
WEP	weld evaluation project [DOE/WEP] EGPG's
WP	welding project (established by TVA) [Phases I, II, & III]
WTG	welding task group

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APPENDIX

1 BACKGROUND INFORMATION

Because employees of the Tennessee Valley Authority (TVA) expressed concerns about the adequacy of TVA's welding program, TVA established a welding project (WP) to review the welding program at each TVA nuclear plant.

At the Watts Bar Nuclear Plant, TVA is reviewing the welding program in three phases. Phase I effort consisted of reviewing the written TVA welding program (design documents, policies, and procedures) to ensure that the welding program correctly reflected TVA's licensing commitments and regulatory requirements. Phase II effort consisted of actual reinspection of selected welds, and using the inspection results to evaluate the implementation of the written welding program. The sampled welds were also evaluated to determine whether the welds made by TVA 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 upgrading 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 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 with the 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 with the 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 for Watts Bar Unit 1. The objective of the CAP is to provide assurance 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 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 identified 10 specific questions. TVA responded to those 10 specific 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 weld report to the NRC. The report included recommendation for strengthening the existing TVA welding program at Watts Bar.

On April 10, 1989, TVA submitted its Watts Bar Phase II weld report to the NRC. The report included a description of completed or ongoing welding-related corrective actions.

From April 24 through May 5, 1989, from May 15 through May 19, 1989, and from July 25 through July 27, 1989 an NRC welding team reviewed and assessed the adequacy of the welding evaluation program at Watts Bar.

2 SCOPE

During the inspection on April 24 through May 5, 1989, May 15 through May 19, 1989, and July 25 through 27, 1989 the NRC welding-inspection team (1) reviewed the status of open items from previous NRC inspections, (2) reviewed and evaluated the content of the Watts Bar CAP plan for welding, (3) verified the accuracy of data, analysis, and conclusions of the TVA's Phase I and II weld report, and (4) reviewed several other issues related to welding. The NRC team also interviewed knowledgeable TVA personnel about TVA's implementation effort of the Watts Bar weld evaluation program.

3 SUMMARY

The NRC team noted no significant deviations from the results reported in TVA's Phase I and Phase II reports. As a result of its reinspection effort, TVA had previously identified, evaluated, and corrected most of the weld deficiencies noted during this inspection. Therefore, the NRC's findings are in general agreement with the results of TVA Phase I and II reports. The NRC team also found that the Watts Bar Unit 1 CAP plan for welding contained the essential elements needed to achieve its goals and objectives. Further, the NRC team found the corrective actions programs that resulted from TVA's reinspection effort to be adequate, providing reasonable assurance that the quality of the welds at Watts Bar Unit 1 would be adequate. However, the NRC team did identify one area that will require additional attention. This area involves a conduit support identified as Item 251-0055. The details of this issue are discussed in Section 4.3.1.2.3 of this inspection report. This support was found to be missing both of the specified welds, but contained unspecified welds for which size could not be measured. Therefore, suitability for service could not be evaluated, and this item was removed from the inspection group and replaced with another item. Field observations by the NRC team and conversations with TVA personnel revealed that this is not an isolated case, but that this condition exists on a number of conduit supports. The primary concern regarding this weld condition is not the quality of the welds but a question of whether a support of this configuration can adequately transmit loads to the supporting structure. Therefore, this item is identified as an item to be followed up and will be addressed in conjunction with the NRC's review of the corrective action program for conduit supports.

4 INSPECTION DETAILS

To facilitate the evaluation, the NRC team sorted its review effort into five areas: (1) review of open items from previous NRC inspections, (2) review of TVA's Phase I weld report, (3) review of TVA's Phase II weld report, (4) review of miscellaneous welding-related issues, and (5) review of TVA's corrective action program plan. Each of these is addressed in the following sections.

4.1 Review of Open Items From Previous NRC Inspections

The NRC team reviewed the status of 21 items left open from previous NRC inspections. During this effort the NRC team closed 20 of the items. The open

items reviewed and the associated NRC team action are detailed in the material that follows.

a. (Closed) VIO 390/86-12-10, Interpass Temperature Control

This violation identified the following issue. During the period June 25, 1980 through November 13, 1985 (5 years, 4 months), a weld procedure was used on site with an incorrect interpass temperature specified that went undetected and uncorrected. After identifying the deficiency, TVA took inadequate corrective actions to resolve the Final Safety Analysis Report (FSAR) 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.
>
> In order to determine how many other welds were associated with the welding procedure that specified an incorrect (maximum) interpass temperature, a tabulation of all welds made with detailed welding procedure (DWP) GT88-0-3 was made by way of the Watts Bar Weld Monitoring Information System. This tabulation identified 15,018 welds made using DWP GT88-0-3. All but 22 welds were in system 67 (essential raw cooling water system). The 22 welds are in the following systems: main steam--7 welds; safety injection system--8 welds; component cooling system--5 welds; RHR (residual heat removal) system--1 weld; and primary water makeup system--1 weld. All welds identified are either in Class 2 systems (16 welds) or Class 3 systems (6 welds). All Class 2 welds made with DWP GT88-0-3, Revision 1, except welds 1-063B-T197-25A and 29A, are in systems or portions of systems with a design temperature of 200°F or less. All Class 3 welds are in systems or portions of systems in which the design temperature is 200°F or

*American Society for Testing and Materials.

less. Temperatures of 200°F or less are not regarded as conducive to intergranular stress corrosion in power plant service. All Class 2 pressure boundary welds are in small lines, 1-1/4-inch diameter or less. With regard to welds 1-063B-T197-25A and 29A, both are 3/4-inch-diameter pipe designed for a test temperature of 650°F. Therefore, TVA had two welds that could be conducive to sensitization and potential SSC.

In order to evaluate worst-case conditions for sensitization due to high interpass temperature, two 2-inch-diameter buttwelds and two 1/2-inch-diameter socket weld test assemblies were developed. The two butt welds were made on 2-inch, schedule 160 pipe composed of SA 376, type 316 material (heat 08285). The test setup provided up to two continuous weld passes to be made without stop and created interpass temperatures in the range of 650°F-1090°F. Cross-sections taken from test samples were sent to TVA's Singleton Materials Engineering Laboratory, where they were polished through 1 micron and etched, using ASTM A262, Practice A procedures.

Neither weldment shows complete sensitization as would be evidenced by grains completely surrounded by ditches. On the contrary, both specimens show partial ditching of the grain boundaries, which is an acceptable microstructure under the conditions of ASTM A262, Practice A. Micrographs of the specimens exhibit typical structures at the fusion line and the region of the heat-affected zone (HAZ), where maximum sensitization would be seen.

The two socket welds were made on 1/2-inch, schedule 40 pipe composed of SA 312, type 316 material (heat 474148), and 1/2-inch, 3000-lb fittings composed of A 182, F 316 material (heat BHH). The entire microstructure of each socket was evaluated from weld to weld. Micrographs give typical microstructures from the weld fusion line to the center of the socket. In no case was anything other than minor grain boundary pitting observed. Ditching did not occur.

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, including repair of the two affected welds. The welds were replaced on Work Plan M5590-1. The welds are 3/4 inch 218 wall stainless steel welds in the safety injection system. TVA has completed all work on the replacement, except for the hydrostatic examination which is scheduled to be completed later.

All areas reviewed by the NRC team were found acceptable and this item is closed.

b. (Closed) URI 390/86-17-08, Radiographic Procedure

This unresolved item identified that:

(1) The criteria in EG&G accept/reject procedure WEP 3.2.6, Appendix A did not appear to be consistent with ASME* Section III NB requirements.

(2) Weld 1-015A-T002-12 was originally rejectable. Subsequently, the weld was ground and only two views that were re-radiographed, were rejected and were repaired in one area. Subsequent to this repair, the weld was again radiographed. The radiograph did not appear to cover the full repair area.

TVA has taken the following actions on this issue:

(1) To align terminology, EG&G Standard Practice WEP 3.2.6, "Radiographic Examination Methods and Acceptance Criteria," Appendix A, paragraph 1.2, has been revised by EG&G Document Revision Request (DRR) 385 and TVA Specifications, Process Specification PS-3.M.3.1, paragraph 13.1.3, has been revised by Addendum No. 3, Revision 3, to read "elongated indications," formerly "elongated inclusions." This now accurately reflects the terminology of ASME Section III, "Radiographic Acceptance Standards."

(2) Weld 1-015A-T002-12 was re-radiographed on July 13 and 14, 1986, and re-evaluated on August 20, 1986 by the TVA Level II radiographer and on June 29, 1987 by a Level III contractor. The evaluation data sheets document that the weld, including any previously repaired areas, was completely re-radiographed and evaluated.

The NRC team reviewed TVA's actions on this issue and, on the basis of TVA's commitment to have a Level III examiner perform a radiographic review of all welds, the re-radiography of weld 1-015A-T002-12, and the revising of the RT procedures in question, concluded that adequate corrective actions were taken and this item is closed.

c. (Closed) 10 CFR 55.55(e) Report 50-390/86-65, 391/86-58, Inadequate Weld Connections for Control Building Structural Framing

TVA reported per 10 CFR 50.55(e) that during the review of weld deviation reports (WDRs) for the Watts Bar Nuclear Plant weld program, calculations were made to check the adequacy of the as-constructed welded connections on the main framing and bracing for a structural platform in the control building (elevation 741.0 feet). Several of these connections proved to be inadequate because the welds were too small or too short and some welds were missing.

These conditions were identified during inspections associated with the WBN weld sample program. Welds found to deviate from the inspection criteria were described on WDRs. The WDRs were submitted to the design organization for evaluation of the welded connections to determine if they were suitable for service. This condition involves 10 WDRs that, after evaluation based on the original design calculations, were deemed to be unsuitable for service (i.e., the stresses in the welded connections exceeded AISC** allowable stresses). Three of the ten

*American Society of Mechanical Engineers.
**American Institute of Steel Construction.

WDRs were issued for mainframing connections and seven were issued for bracing connections in mainframing due to cable tray support loadings. After evaluating approximately 800 structurally related WDRs, the 10 WDRs described for elevation 741.0 feet were the only ones deemed unsuitable for service.

TVA performed a walkdown to inspect, evaluate, and document all field-welded connections of structural platforms at elevation 741.0 feet. Configurations not meeting design criteria allowables were subsequently redesigned. All deviant welds were subsequently replaced or repaired to the applicable design criteria.

The boundary for this corrective action, although commonly specified as elevation 741.0 feet, included weld connections on elevations 729.0, 741.0, and 755.0 feet of the control building, and 776.0 feet of the auxiliary building. As part of the bounding process, structural and miscellaneous steel drawings were searched to determine if other welded connections having unclear weld specifications existed. These were included in the boundary evaluations.

A total of 1098 connections were evaluated. Most connections were reworked. Of the 1098 connections, TVA modified 1091 connections. The modifications included cleaning, redesigning, and repairing welds. TVA has completed the 100-percent reinspection and rework of all affected welds.

TVA reported that WDRs involving mainframing connections stem from a lack of through-weld inspection. The bracing connection WDRs stem from the designer's failure to recognize a conflict between two connection details, failure of construction personnel to notify design personnel of the modifications to the connections, and improper weld inspection. TVA has determined that in this specific area of structural steel weld inspection, the quality assurance (QA) program was not effective.

The following actions were initiated for the identified deficiency that will help prevent of recurrence of similar deficiencies. Quality Control Procedure QCP-2.04, "Fabrication, Erection, and Inspection of Structural and Miscellaneous Steel," was issued after the construction of the mainframing to control the installation of structural and supplemental steel. Also, the records accountability program has been initiated since the fabrication of the deficient welds. This program requires the responsible engineer to assign specific inspection test requirements for each structural feature. The current Nuclear Engineering Procedure NEP-5.2, "Review," provides methods to ensure that designs are reviewed for suitability and compatibility with other designs.

To provide additional assurance that welding activities are performed to specifications, measures have been taken in the welding inspection area to monitor the performance of welding inspectors. A system has been instituted under which peer inspectors reinspect randomly selected and previously accepted inspections for adequacy. In addition, TVA has implemented a Level III quality control (QC) welding inspection program for structural welding to monitor the performance of QC inspection activities on a sampling basis to ensure that structural welding inspections are being performed to established requirements and that acceptance criteria are met.

The NRC team has completed its review of this 10 CFR 50.55(e) report and this item is closed on the following basis:

(1) TVA has inspected and corrected all structural welding with this type of welded connections.

(2) TVA and EG&G have performed additional inspections which are documented in the DOE/WEP report and in TVA's Phase II report.

(3) NRC inspections were performed in selected areas of structural steel which are included in Section 4.3 of this report.

d. (Closed) URI 390/86-21-05, 390/87-03-13, Weld Fitup Gap

These unresolved items identified a concern regarding TVA programs for ensuring that weld gaps were being considered when welding inspections of American Welding Society (AWS) completed fillet welds were measured.

This item deals with American Welding Society, D1.1 Structural Welding Code (AWS D1.1) requirement to increase the fillet weld leg size with respect to fraying surface separations in excess of 1/16 inch. In NRC Inspection Report 390/86-21, Item 11, "EG&G Weld Inspection Activities--Unit 1 (55185B)," the inspection identified the following two concerns:

(1) On the basis of the inspector's review, the fitup separation was not inspected and documented in the QC procedures until June 11, 1986, when WBN-QCI-4.03, Revision 8, "Process Control and Weld Procedure Assignment," was issued and required that the weld foreman document the fitup separation.

(2) The NRC review of the EG&G procedure found that EG&G did not consider the requirement to increase the leg length by the amount of the gap (separation).

NRC Inspection Report 390/87-03, Item 13, "Structural Welding (55063C)," identified a third concern dealing with fitup gap requirements. The inspector included this item with the previous unresolved item (URI 86-21-05). A synopsis taken from this inspection report follows:

(3) The NRC inspector performed visual inspections, assisted with a weld fillet gauge, of several fillet welds on the 6.9-kV diesel generator switch cubicle 1A-A. The panel was not flush with the sill plate and a gap was evident, generally 3/16 inch. It appears the gap was not considered when the welding and QC acceptance was done.

TVA has completed the following inspections and evaluations on these issues.

AWS D1.1, Paragraph 3.3.1, requires that, "The parts to be joined by fillet welds shall be brought into as close contact as practicable. The gap between parts shall normally not exceed 3/16 inch.... If the separation is 1/16 inch or greater, the leg of the fillet weld shall be increased by the amount of the separation or the contractor shall demonstrate that the required effective throat has been obtained."

Clarification of AWS's intent regarding fitup inspection is given in the 1986 commentary of AWS D1.1. It states:

> "Except for final visual inspection, which is required for every weld, the inspector shall inspect the work at suitable intervals to make certain that the requirements of the applicable sections of the Code are met. Such inspection, on a sampling basis, shall be prior to assembly, during assembly, and during welding."

TVA general welding specifications and procedures listing requirements for welding (including fitup) are:

- G-29C, "General Construction Specification," for AWS welding (originally issued March 10, 1975)
- Process Specification PS-1.C.1.2(a), "General Welding Procedure Specification" (originally issued July 31, 1974)
- Process Specification PS-0.C.1.1(a), "Specification for Welding of Structures Fabricated in Accordance With AISC Requirements for Buildings" (originally issued September 1, 1981, and incorporated in G-29C in December 21, 1981).
- Process Specification PS-3.C.5.2(a), "Visual Examination of Welds" (originally issued September 23, 1974)

The requirements in TVA's procedures relative to increasing the fillet weld size for root openings that are 1/16 inch or greater are consistent with AWS D1.1. These requirements have been included in TVA procedures since the original issuance of PS-1.C.1.2 in July 1974 and were previously in General Welding Procedure Specification PS-1.C.1.1(a). This welding procedure specification is applicable to all welding performed in accordance with the AWS D1.1 revision of 1974, the revision of record for Watts Bar.

However, TVA did not include these requirements in its QC inspection procedures. These inspection requirements were included in an April 1986 revision to the QC inspection procedures.

At Watts Bar, the welding procedures for structural and miscellaneous steel features were assigned by the mechanical and welding engineering unit in accordance with Quality Control Procedure DEC-QCP-4.3, "Welding Surveillance and Weld Procedure Assignment." The engineering unit inspectors performed and documented the welding inspections to the quality level specified by the design drawings and the QC procedures in effect at the time of the inspections. In accordance with QCP-2.4, Revision 0, Quality Level I and II, primary and secondary safety-related items respectively, required erection inspection documentation; Quality Level III required no documentation.

Procedures DEC-QCP-4.3, WBNP-QCP-4.3, and WBNP-QCI-4.3 implemented a surveillance program requiring a daily surveillance of welding activities in all work areas in which fabrication or erection activities were in progress. These daily surveillances were initially performed by the mechanical engineering unit, welding engineering unit, or welding quality unit inspector depending on the timeframe. They were summarized on a weekly welding surveillance checklist in accordance with the applicable version of the procedure. This program continues today in the

provisions of procedures WBNP-QCP-4.03-1 and N-VT-2. Civil inspections in WBNP-QCP-2.4 and the surveillance provision of WBNP-QCI-4.3, WBNP-QCP-4.03-1, and N-VT-2 have provided an overlapping network of procedural requirements to implement TVA commitments from 1974 to the present time.

TVA sampled welding surveillance weekly checklists from 1974 to 1985 during the DOE/WEP review of welding at Watts Bar Unit 1 for inspection documentation content, as required by WBNP-QCP-4.3. As stated on the checklist, inspection areas requiring specific surveillance attention were: (1) welding procedure adherence, (2) welder qualification verification, (3) filler metal control verification, (4) fitup verification, and (5) good workmanship verification. The inspectors were required to ensure compliance with these five aspects of welding quality control in 16 specific designated areas of the plant site.

The comments section of the welding surveillance weekly checklist in the sample examined by DOE/WEP substantiated the fact that in-process workmanship and fitup inspection were being performed on a daily basis in conjunction with final inspection required by the process specifications. Therefore, the inspection requirements listed in WBNP-QCP-4.3 for fitup and workmanship inspection satisfy the intent of AWS D1.1.

TVA has implemented an additional requirement to record the actual fitup gap. On April 30, 1986, TVA revised procedure QCP-4.13, FU and VC, Revision 3, "Fitup and Visual Civil," to add a requirement for recording the root gap. This procedure applies to Unit 2 at Watts Bar. Similarly, N-VT-2, Revision 3, dated June 10, 1986, "Visual Examination of AWS Structural Welds," was revised to add these requirements for application at Watts Bar Unit 1.

In addition to the dimension being recorded per procedure CEP-4.03-4, "Welding Activity Verification," and Administrative Instruction AI-9.4.2, "Control of Weld Documentation," for weld fitups as part of in-process welding, sampling verification checks on weld fitups are currently made by the QC staff. Final inspection of the weld is done by QC, including verification of increased weld size, if required, based on the root opening records made during fitup.

Of the 310 weld fitup inspections completed by QC in the period from June 1986 through March 1988, there were no rejects for fitup dimensions. All fitups are reported to QC when ready for inspection. QC elects to do sampling verification on the basis of achieving a minimum of 10 percent to the fitups overall, but is also monitoring to ensure that sampling verification inspections are done on all construction crews and on mechanical, electrical, and civil structural components. This provides greater assurance that the total population of fitups is being checked and that the sampling is not biased by an overabundance of data from only a few crews.

The NRC resident inspector questioned the lack of a requirement in the EG&G reinspection to account for root gap on fitup. However, EG&G reviewed the TVA weld program and concluded that the AWS requirements relative to fillet weld size and weld joint fitup were properly included in the program. The EG&G weld program review stated that the requirements have been present from the date of the first safety-related weld.

Fitup gap is an in-process inspection; it is difficult, even nearly impossible, to accurately determine fitup gap in a reinspection program. The parts being mated do not usually have machined edges. Because methods used for field

preparation of welding ends do not produce totally uniform surfaces, gaps may be the greatest at the ends. The visible gap at the ends of the two edges are indicative or representative of the gap along the entire welded area. Even with this conservatism, when the gap was reported, it was subtracted from the reported weld size for the evaluations. The evaluations have been completed by TVA and concurred in by EG&G, and all components were within design code allowables with the exception of the control building platform (elevation 741 feet), which has been documented with NRC.

EG&G reported to TVA by letter dated May 22, 1987, that by this date approximately 12,000 fillet welds had been inspected. Approximately 3000 were configured so that the gap at the end of the mating surfaces could be determined. Of these 3000 welds, 49 (1.6 percent) were reported as undersized welds when based on reducing the as-built fillet welds size by the amount of the gap exceeding 1/16 inch. The numbers reported in the May 22, 1987 letter were totals that included original groups and expansion groups. Three of the reported 49 welds were on two components on the platform at elevation 741.0 feet. These three welds would have performed their intended function if the proper length and all specified welds had been completed. Therefore, these welds would be classified as a part of configuration control problems instead of as a fitup problem. Three other welds were reported on independent deviation reports (999s), and the remaining welds have been evaluated in weld deviation reports (WDRs). All of these welds were determined to be capable of performing their intended function.

In May 1987, EG&G was asked to record any fitup gaps available for the remaining inspections. The remaining inspections included some of the original groups and some of the expansion components. The remaining inspections had a total of 1316 welds of which 402 welds had measurable end gaps. Of these, 48 end gaps measured 1/16 inch or more. The fillet welds were increased by the appropriate gap on 23 of these welds. The remaining 25 welds, documented on WDRs (see table that follows for summary), did not meet the size requirement when reduced by the reported gap. In all cases, these components were found to be capable of performing their intended function.

Root gap (inch)	No. of welds	Rejectable for size based on listed gap
1/16	354	0
1/16	16	3
3/32	4	3
1/8	12	10
5/32	1	1
3/16	8	3
1/4	3*	1*
3/8	4	4
Total	402	25

*Includes one that varies from 1/16 inch to 1/4 inch.

EG&G has reviewed approximately 6000 employee concerns and approximately 7000 quality indicators. No AWS welds were identified specifically involving improper

or uncorrected fitup problems. There were two employee concerns that dealt with who made the inspections and the frequency of inspections. This issue has been addressed in Welding Project Report WP016-WBN, which concluded that pre-weld inspections on a sampling basis by the QC inspector satisfy the requirement of AWS D1.1 unless a 100-percent inspection is specified by nuclear engineering (NE) design output documents.

EG&G recognized that fitup is an integral part of in-process inspections. This is evident in the program review and the conclusions drawn. The EG&G inspections did conservatively report the end gaps when gaps were visible. Engineering evaluations took this into account when assessing the as-built condition.

During one of the NRC resident inspector's hardware inspections (NRC Inspection Report 390/87-03), a concern was raised (Item 13) about the welding on the 6.9-kV diesel generator switch cubicle 1A-A that was supplied by Brown Boveri Corporation (BBC) and installed by TVA. The inspector perceived the problem to be one of weld fitup and requested that it be part of Unresolved Issue (URI) 390/86-21-05 response.

Before the NRC inspection, EG&G had inspected the same component in its reinspection program. EG&G reported an undersize weld because of an excessive gap between the mating surfaces. The undersize welds are located at the front and back panels to the channel sill foundation. These panels are bolted to the main support housing of the switch cubicle by vendor-supplied bolting. The bolting arrangement in the main support housing and panels is predrilled by the manufacturer and is a standard part of the switch cubicle. NE drawing 15N211-1, Section Y-Y, shows that the welds in question should have been between the structural angle of the main support housing and the sill. The BBC drawings of the switch cubicle delivered to Watts Bar showed an anchorage system of bolts and no welding. The seismic report supplied by BBC showed a welded anchorage system. There was correspondence between TVA and BBC to clarify the differences, that is, to confirm that the bolted arrangement was equivalent to the welded arrangement used during the seismic test. A BBC letter to TVA dated July 23, 1982, stated in part:

> Comment No. 4 is concerned with frame strength near the bolting locations. The mounting method of the single-frame test specimen of Test No. 44918-1 was fillet weld (1/4" x 2") at four locations--two front and two rear welds. The mounting method of the three-frame test specimen of Test No. 43972-1 was to bolt the Power Switching Center at six locations per frame--two front, two rear, and two 18" forward of rear bolts. In order to prevent any confusion regarding applicability of the Test No. 44918-1 data to this installation, it is recommended that the Power Switching Centers be mounted by TVA utilizing both bolting and fillet welds. The General Arrangement Drawings will be revised to reflect this conservative simulation of the test mounting method.

After the NRC inspection, TVA inspected all the switch cubicles at the request of the NRC resident inspector. This inspection resulted in the issuance of Nonconformance Report NCR-W-583-P. NCR-W-583-P reports the same condition that EG&G reported but in more detail and on all the switch cubicles. This NCR has been dispositioned "use as is" by the TVA Engineering Department (DNE). Justification for this disposition is documented by calculations, RIMS No. B41880419800, that

considered the switch cubicle to be held in place by only the bolted anchorage from the main housing angle frame to the foundation sill. The corrective action is to revise the applicable drawings per Design Change Notices (DCNs) P-00498A and P-00499A to reflect this action.

The conflict between the as-built condition and the DNE drawing is an example of inadequate configuration control. The issue of discrepancies between the as-built plant and approved drawings has been previously identified by NCR-6297. This should close the final part of URI 390/86-21-05 as far as weld fitup as an issue. This does not close out the configuration control issue that is reported by NCR-6297.

From the reviews made by TVA and EG&G as previously presented, the weld project concluded that the TVA written program for weld fitup is now in compliance with TVA's commitments. Training of personnel involved with fitups and additional documentation and reinspection requirements have improved the program. Additionally, from the data obtained from the EG&G reinspection program and the TVA DNQA surveillance program, TVA concluded that although not meeting the requirements for fitup in all cases, had the reported conditions not been found, the welds would not have failed. TVA has reported that any other fillet welds that are not in compliance with the fitup requirements must be reported and evaluated or fixed to meet these requirements.

The NRC team reviewed TVA's corrective actions discussed above and finds that although QC requirements for gap size increase were not incorporated until 1986, which is after the welding and inspections were finished, the procedure used in the field did provide instructions to the craft to increase the weld proportion to the fitup gap. The subsequent sample inspection found some welds that were less than specified. However, none were found unacceptable after engineering personnel evaluated the actual condition. The NRC team verified that the licensee's procedures are now properly revised to ensure that QC inspections compensate for fitup gap tolerances. The NRC team also verified that fitup gap is recorded when fitup inspections are performed. This item is closed.

e. (Closed) VIO 390/86-17-02, Compliance With ASME Section III Radiography

This violation identified that radiographic film of welds 1-063A-D07604-5, 1-062A-D030-10, and 1-015A-T002-12 revealed lack of fusion indication in excess of ASME Section III acceptance standards and were accepted by TVA without repair.

TVA has completed a re-review of all radiographic film for Unit 1 and common welds (2650 welds) with the following results: 2080 welds were found acceptable; 570 welds required repair or reradiography to comply with ASME Section III requirements, of these 215 require repair to comply with ASME Section III requirements. At present, 4 welds remain to be repaired, these are in process.

As stated in an NRC letter dated June 12, 1987 on this subject, TVA submitted a 10 CFR 50.55(e) report on these welds to the NRC on November 26, 1986, describing TVA's planned actions to ensure the integrity of previously accepted safety-related welds and the measures implemented to ensure the integrity of welds fabricated by TVA in the future. At this point, the NRC team regards these as corrective actions taken to preclude the recurrence of similar violations rather than as the basis for determining whether this violation was warranted. For these reasons, the NRC team concludes that the violation occurred as stated. This item is closed.

The NRC team inspection consisted of a re-review of 64 film packages to verify the adequacy of the reviews previously performed by TVA and the contractor. The reviews were found acceptable. This item is closed.

f. (Closed) IFI 390/86-26-03, Cold Shut Condition

This inspector followup item identified that the weld evaluation project (WEP) deviation report B-0021 does not address the cold shut condition illustrated on page 2 of the EG&G inspection report. A liquid penetrant (LP) examination was performed only to evaluate incomplete fusion. Cold shut in the toe area of the weld was not LP examined nor was an engineering evaluation provided in the deviation report.

In response to this item, TVA provided welding task group (WTG) Discrepancy Report 999-0016 to identify the cast stainless steel valve 2-ISV-62-952 having possible cold shut on the back side extending from the weld area approximately 2-1/2 inches to 3 inches into the valve base material.

By further evaluation of the valve body condition, including visual and LP examinations of the suspect areas, it was determined that the subject valve does not contain a cold shut. The disposition to the WTG Discrepancy Report 999-0016 indicates the valve is acceptable on the basis of the test performed.

The NRC team consurs that the satisfactory completion of an acceptable liquid penetrant examination of the suspect areas indicates that the valve is acceptable. This item is closed.

g. (Closed) VIO 390/87-19-01, Weld Procedure Qualification

This violation identified that weld procedure qualifications GT-SM-11-0-2A, GT-11-0-1, GT-SM-11-0-3, and GT-SM-11-0-3C, failed to qualify the weld procedure in accordance with the essential variables required for Charpy impact test materials on the main steam lines. These welding procedures were used to perform welds on installed piping in Units 1 and 2.

TVA responded to the violation that TVA Process Specification PS-1.M.1.2 permitted the substitution of E70S6 filler material when E70S3 is specified on a detail weld procedure from June 22, 1976, until Problem Identification Report (PIR) BLN-NEB-8607 was issued December 5, 1986. This PIR identified substitution where impact requirements exist to be in violation of ASME Section IX, QW404.12. Part of the corrective action outlined in PIR BLN-NEB-8607 was to revise PS-1.M.1.2 (Revision 5 was issued on May 22, 1987) to prohibit the substitution of E70S6 for E70S3 in applications having impact requirements. This PIR was circulated to TVA sites for generic evaluation. However, the Watts Bar generic evaluation was not coordinated with all affected organizations. TVA personnel failed to recognize the substitution restriction in Revision 5 of PS-1.M.1.2 and inappropriately allowed the substitution in repair welding activities on the Unit 1 main steam system. TVA issued Condition Adverse to Quality Report (CAQR) WBP-871081 to address this incorrect substitution.

TVA disagrees that Welding Procedure Qualification Records GT-SM-11-0-02A, GT-11-0-1, GT-SM-11-0-3, and GT-SM-11-0-3C do not qualify for welding base materials of P number 1, group 2 (ASME Section IX) to P number 1, group 2; or to P number 1, group 1 materials. The base materials utilized in the qualification

record meet P number 1, group 1 and P number 1, group 2 requirements, as outlined in ASME Section IX, QW422.

TVA agrees that E70S6 filler material was substituted for E70S3 filler material on piping systems requiring impact testing. PIR BLN-NEB-8607, issued December 5, 1986, documented the potential problem for all TVA nuclear plants. Part of the corrective action revised PS-1.M.1.2 to prohibit the substitution of E70S6 for E70S3 in applications requiring impact testing. Additional corrective action outlined in the PIR required requalification of welding procedures utilized on systems with impact requirements using E70S6 filler material.

The weld procedures have been requalified to support the use of existing detailed weld procedures utilizing E70S6 filler material. TVA issued CAQR WNP-871081 to address the incorrect substitution of E70S6 for E70S3 in repair welding activities on the Unit 1 main steam system at Watts Bar. CAQRs WBN-871273 for Unit 1 and WBN-871274 for Unit 2 were issued to identify the substitution of E70S6 before May 22, 1987, at Watts Bar. TVA has revised PS-1.M.1.2 to allow the substitution of E70S6 for E70S3 in applications requiring impact testing when specified on the detailed weld procedure.

The NRC team reviewed TVA's corrective actions which included the following records:

- CAQR WBP-871081: Action complete and CAQR was closed October 31, 1988
- CAQR WBN-871273: Action complete and CAQR was closed November 10, 1988
- Detailed Weld Procedure GT-SM11-0-2A, Revision 2, dated October 28, 1987
- Detailed Weld Procedure GM-11-B-12, Revision 0, dated December 30, 1987
- Detailed Weld Procedure GT-11-0-6, Revision 0, dated December 30, 1987
- Detailed Weld Procedure GT-11-0-5, Revision 0, dated December 10, 1987
- Detailed Weld Procedure GT-13-0-1, Revision 0, dated December 10, 1987
- Detailed Weld Procedure GM-11-B-11, Revision 0, dated December 30, 1987

The NRC team found TVA's corrective actions taken to resolve the CAQRs and qualification and requalification of the weld procedures acceptable. The team performed further reviews in the area in which TVA disagreed with the violation. The Welding Procedure Qualification Records GT-SM11-0-2A, GT-11-0-1, GT-SM11-0-3, and GT-SM11-0-3C do not qualify for welding base materials of P number 1, group 2 to P number 1, group 2, or P number 1, group 1 materials. The licensee states that the actual chemistry of the material used meets the requirements of both P number 1, group 1 and P number 1, group 2 and therefore does meet all requirements. The team reviewed the chemical analysis of the referenced qualification material and agrees with TVA. This portion of the violation is rescinded. All areas reviewed by the team were found acceptable and this item is closed.

h. (Closed) Violation 390/85-56-01, 391/85-45-01, Failure to Follow Procedures for Renewing Welder Performance Qualification

This violation was identified when members of the NRC staff conducted a special inspection between July 31 and August 22, 1985 to address employee concerns of impropriety in the licensee's welder recertification program. The inspector found that welder craft foremen possessed welder certifications when, in fact, no validation by continuing performance or certification by test were performed for those individuals as is required by the licensee's quality assurance program.

On August 23, 1989, the NRC issued a confirmation of action (COA) letter expressing the understanding that all welding activity in safety-related areas would stop until the licensee:

(1) conducted a thorough review of the program for recertification of welders who perform American Society of Mechanical Engineers (ASME) Code or American Welding Society (AWS) welding activities;

(2) determined if ASME and AWS welding activities have been conducted by properly certified welders; and

(3) determined the safety significance of any welding activities conducted by uncertified welders, including appropriate technical justifications.

On September 17, 1985 the NRC issued Revision 1 to this COA letter to amend the one issued on August 23, 1989, and responded positively to the licensee's corrective action for recertification of welders. Also the NRC agreed to permit the licensee to resume welding on safety-related structures and equipment.

In addition, the revised COA delineated NRC's understanding that any individual identified as having been directly involved with falsified welder recertification records would not be allowed to conduct, supervise, or inspect safety-related welding activities until TVA management had reviewed the actions and determined their significance in this issue. Also, all safety-related welds performed by any individual who failed the recertification program would be reinspected. In addition, any inspector who had been identified as directly involved with the falsified welder recertification issue would have his/her work re-examined. With this understanding, welding activities at Watts Bar were allowed to resume when TVA management was confident these activities could be properly controlled and conducted.

To address these areas of concern, TVA implemented the following corrective action which included: (1) a programmatic review of the welder recertification program, (2) a formal investigation by the TVA Office of General Counsel (OGC) to validate the occurrence of the problem and to ascertain any employee wrongdoing, (3) qualification renewal testing for all welders employed at Watts Bar, and (4) a weld reevaluation program for those welders who had difficulty passing the qualification renewal testing. The weld reevaluation included a 100-percent review of weld inspection records and inspection of field welds on a sample basis. The NRC has monitored implementation of corrective actions in the welder performance recertification program during this and previous inspections documented in NRC Inspection Reports 50-390/85-52 and 50-391/85-42; 50-390/85-62 and 50-391/85-51. To prevent recurrence of programmatic weaknesses in the welder performance recertification area, the licensee has improved its procedures. These improvements clarify and strengthen the control and documentation of

welder recertification, requiring objective evidence before recertification, providing for the welding foremen to be present during welding, and requiring the foreman and welder to sign the recertifying document.

On May 2, 1989, TVA was repairing a weld on a 24-inch-diameter pipe in the safety injection system. Because this work involved welding on a safety-related component, the NRC inspector elected to observe the activity as a spot check on the overall corrective actions relative to this area as committed by the licensee. The repair involved removing a defective weld along with a short length of pipe material on either side of the pipe and welding a short spool piece in its place.

Work Plan NR063LB was used to direct and document field activities. Welding was being performed under welding Procedure Specification PS-1.M.1.2, Revision 5 and detail Weld Procedure GT-88-0-1, Revision 6, qualified with the gas tungsten arc (GTA) welding process to weld stainless steel material in thicknesses ranging from 1/16 to 1/2 inch. Welders fabricating the two new field welds had been qualified through welder performance qualification test GT-7-0-1-L(a) which qualified them for this process within the replacement material thickness of 0.0375 inch. Both welders, identified by Serial Nos. GJJH and 6QQQ, had taken and passed the recertification test on their first attempt on September 4, 1985 and August 29, 1985, respectively. This recertification was one of the requirements imposed on TVA by the NRC's COA, on August 23, 1985.

The NRC welding team examined both field welds, Nos. 1-063A-D078-08F and 1-063A-D078-08C, which were still in process to verify workmanship and quality attributes per applicable Code requirements. The welds were identified as ASME Code Section III Class 2 welds.

The replacement pipe material was identified as SA-358, Class 1, stainless steel, type 304, 24-inch-diameter pipe with a 0.0375-inch wall thickness. The spool piece was identified by S/N 10944 and Piece No. 63-SI-49.

The bare metal wire (filler material) used to make the welds was identified by Control No. A4823-308. For both items, the team reviewed TVA's quality records, including certified material test reports, code data report(s), receipts reports, inspection reports, and issue slips which were found in order. Because of actions taken to correct previously identified weaknesses and to prevent their reoccurrence, this item is closed.

i. (Closed) URI 390/85-62-01, 391/85-51-01; Retests Allowed on Welder Performance Qualification Renewal

This unresolved item identified that during the welder recertification activity which took place in August 1985, TVA informed Region II management that out of 528 welders who took the welder qualification renewal test, 123 had failed the first test and, of these, 33 had failed on the second attempt. Allowing those welders who failed the initial test to be retested has caused Region II to question whether the ASME Section IX Code permitted retesting.

Thus, in order to help resolve the issue, Region II requested by memorandum from A. F. Gibson to H. L. Thompson, dated November 1, 1985, that the Office of Nuclear Reactor Regulation (NRR) provide an NRC position on the interpretation of Paragraph QW-320 in Section IX of the ASME Boiler and Pressure Vessel Code. The request stated, in part, that Region II had a differing interpretation on the application of subparagraph QW-321 to the renewal testing.

Hence the request states that TVA interpreted that because subparagraphs QW-321 and QW-322 are grouped together under the heading of QW-320, "Retests and Renewal of Qualification," the retest provisions of QW-321 apply to the renewal test allowed by QW-322.

Region II's interpretation was that the lead subparagraph of QW-321 did not state that the retest provisions apply to the tests allowed by QW-322 and therefore did not apply. The region's position was that a welder who failed in his initial attempt to renew his qualification should have to start over with an initial qualification test as if he were a newly hired employee.

In an effort to resolve this issue, on November 8, 1985, TVA asked for an interpretation from the appropriate ASME Section IX Code Committee on the subject. Specifically, TVA's inquiry was as follows:

> A welder or welding operator's qualification for a process has expired because he has not welded within the time periods required by QW-322(a) and (b). There is no specific reason to question his ability to make welds that meet the specification.
>
> Does QW-322 prohibit the use of QW-321 for retest of qualification where a welder has failed the single renewal test joint as provided by the last sentence of QW-322?

By memorandum dated December 2, 1985, ASME responded that QW-322 did not prohibit the use of QW-321 for the retest of qualification where a welder has failed the single renewal test joint as provided by the last sentence of QW-322. This item is closed.

j. (Closed) URI 390,391/87-05-03, ASME Code Compliance

This unresolved item identified that the licensee used a later ASME Code addendum to disposition a nonconformance report (NRC). The addendum was different from the commitments made in the final safety analysis report (FSAR). The inspector discussed the matter with TVA's engineer and reviewed the information provided. NCR-6910 stated that the butt welds on piping for Drawing No. 47W406-321 were not located and ground as required by Drawing Notes 21 and 22. The stress analysis for this piping assumed the butt welds to be ground and flush on both surfaces, as is required by the drawing notes. Therefore, the stress analysis was not adequate since the butt welds were not ground. TVA's nuclear engineering (NE) group did a preliminary analysis by using the as-is condition and found the stress level to be acceptable based on Paragraph NB-3653 (Equation 10) of the ASME Winter 1982 Code Addendum which was not the code of record in the FSAR for Watts Bar. The disposition of NCR-6910, Revision 1, was based on the later code; the licensee will reanalyze the piping stress by using the later code, revise the drawing to remove grinding requirement, and revise the FSAR to include the use of the ASME Winter 1982 Code Addendum. Section 3.7.3.8.1.6 of the FSAR, Revision 55, dated "early 1985," stated that other uses of later versions of the code are to accord with the piping analysis design specification. Neither the FSAR nor Design Specification WBNP-6S-1935-2473 for nuclear class 1 piping systems, did specify that the ASME Winter 1982 Code Addendum can be used during the disposition of NCR-6910, Revision 1. The provisions for use of specific provisions of later editions and addenda are included in ASME NA-1140 and are permitted by the applicable design specification for class 1 piping systems, WBN-DS-1935-2618-02.

The use of codes up to the Winter 1982 Addenda for qualification of class 1 piping stress problems was approved by the nuclear engineering group (DNE) by Memorandum B45-860516-258, dated May 16, 1986. This approval was not incorporated into the FSAR, design specifications, or design criteria. For consistency with the FSAR about the use of later code editions, TVA added Appendix A, Section A-1.4 to Design Criterion WB-DC-40-31.7, "Analysis of Category I and I(L) Piping Systems," Revision 8, dated December 21, 1987, to include Winter 1982 Addenda for stress qualification. Section 2.1 of Design Specification WBNP-6S-1935-2473, Revision 3, dated April 29, 1988, was also added to include that, in part, the specific provisions used for analysis are listed in Appendix A of WB-DC-40-31.7. The licensee is also preparing to add Winter 1982 Addendum to the FSAR directly and will submit this change to NRC for approval. The corrective actions for stress reanalysis and drawing revision will not be completed until March 1990, because of a shortage of manpower and money. The above corrective actions were entered into the licensee system, Tracking and Reporting of Open Items (TROI), and were verified by the NRC team. On the basis of TVA's actions, detailed above, this item is closed.

k. (Closed) WBNP-390/87-04, Improper Fabrication and Documentation of Wall-Mounted Instrument Panels

In 1987, in accordance with 10 CFR 50.55(e), TVA reported that the seismic adequacy of approximately 175 site-fabricated local instrument panels was in doubt because the panels were assembled using partial-penetration welds instead of the specified full-penetration welds.

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 most highly loaded welds. 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 subjected to destructive testing, which demonstrated a safety factor of approximately 10, thereby ensuring that the Unit 1 panels are acceptable for "use as is" without rework. The two panels that were destroyed by the test have been replaced.

In reviewing TVA's actions involving this issue, the NRC team visually examined a sample of the originally identified deficient welds and the two panels that were replaced, and determined that the corrective measures taken are appropriate to ensure that these panels will be able to perform their intended function. This item is closed.

l. (Closed) URI 50-390/86-17-07, Rejectable Weld Conditions in Miscellaneous Structural Steel Welds

This unresolved item was established to ensure that TVA either evaluated or repaired components found to have rejectable attributes during the reinspection of welding activities in the general groups from piping and structural components conducted by EG&G for TVA.

During the reinspection of the sampled 123 components, EG&G identified 50 components that had some rejectable element. The major portion of these rejectable elements were minor in nature, and less than 5 percent of the total components had possible significant structural deficiencies such as incomplete fusion,

cracks, or linear indications. The NRC team reviewed 14 of the 50 component packages, which contained a variety of rejectable elements, and has determined that TVA has adequately addressed these rejectable conditions either through weld stress evaluations or by repairing the component. This item is closed.

m. (Closed) URI 50-390, 391/86-09-01, Misexamination of Welds

The corrective actions taken by TVA on this unresolved item was to reinspect ASME containment field welds to determine if welds that had been accepted previously were indeed acceptable.

Two populations of welds were determined to be relevant: (1) the population of ASME welds performed by the 124 welders who did not pass the qualification renewal testing on the first attempt and (2) any ASME weld for which the records indicated that more than 90 days had elapsed since the particular welder had performed an ASME weld. The sample selection process for the two populations was the binomial statistical method described in Nuclear Construction Issues Group document NCIG-02, "Sampling Plan for Visual Reinspection of Welds." This procedure specified that the first sample size from an infinite population needed to be no greater than 64 samples. As a practical matter, a slightly larger sample size was used because the scheduling had to allow for welds that were no longer accessible. As a result of this scheduling consideration, a sample size of 72 welds from the first population and a sample size of 69 welds from the second population were selected (a total of 141 welds were actually reinspected).

Reinspection of these welds found that 12 welds did not meet the original ASME Section III acceptance criteria. These welds were evaluated by TVA's Office of Engineering in accordance with applicable ASME Section III requirements. Nonconformance Report RNC-6562 was issued to identify the welds in question and their evaluation.

The engineering evaluation showed that the 12 discrepant welds met the requirements of ASME Section III with no rework (10 welds), or met the requirements of ASME Section III after conditioning to determine the relevance of liquid penetrant indications (2 welds). All 12 welds met the requirements of ASME Section XI with no rework. Although the 12 welds were identified as unacceptable in the reexamination process, TVA concluded that no adverse condition with the weld quality or the original inspection existed. The discovery of the discrepancies in the reinspection was attributed to increased inspection sensitivity during TVA's highly visible reinspection effort. This item is closed.

n. (Closed) IFI 390/86-17-13, Corrective Action for Partially Welded 3/4" Shim, Weld Deviation Report (WDR) 12-0008

This inspector followup item refers to a specific employee concern, which had been reported to QTC. The completed structural steel weld did not comply with referenced Drawing Nos. 48W1707-04, Revision 8 and 48W1707-16, Revision 10 in that it did not meet joint design, weld penetration, and size requirements. In addition, the inspectors observed that a 3/4-inch piece of shim stock had been used to compensate for a gap caused when one of the two flanges to be welded was cut too short.

This weldment was one of the joints discussed in Weld Deviation Report 12-0008. The NRC inspector reviewed TVA's corrective action on this item and ascertained

that this matter had been identified on Discrepancy Report DR-999-0059 and had been tracked by Employee Concerns Task Group, Corrective Action Track Document CATD-50400-WBN-11. The deviation was identified as a condition adverse to quality (CAQ) and was resolved as part of CAQ Report WBP-871294.

Sargent and Lundy performed design evaluation and associated calculations, documented in report WB-999-0059, Revision 0, which was approved on November 17, 1987. This document concluded the weld joints were acceptable with no modifications to the existing welds. TVA completed its corrective action with Revision 11 to Structural Steel Details Drawing No. 48W1707-16, for the south main steam valve rooms. This item is closed.

o. (Closed) VIO 390/86-17-03, Welds in Supports and Structures Inconsistent With Engineering Drawing Requirements

This violation was identified when the NRC inspector questioned the suitability of weld joint design shown on certain drawings used to depict joint details for (1) a structural support assembly to No. 3 reactor coolant pump upper bearing spray shield and (2) joints in a miscellaneous steel safety-related structural assembly (ladders), in the auxiliary building.

The NRC inspector found that 11 weldments shown on Drawing No. 48N914-4, Revision 6, and four other weldments shown in Drawing Nos. 48E956-2, Revision 0, and 48W1263 differed from joint designs stipulated on the engineering drawings. Also, quality control inspections performed on these weldments failed to identify these discrepancies.

The team members discussed the findings and the corrective actions committed to in TVA's response dated March 11, 1987 with responsible personnel. Corrective actions reviewed included engineering calculations/evaluations of welds in question documented in Weld Deviation Report Package WDR-D0096, Revision 2. The weld deviation report summarized that all the analyzed welds were within code-allowable stresses, and therefore were acceptable in the as-found condition. In addition, the NRC team verified EG&G's concurrence in the evaluations, reviewed corrected miscellaneous steel drawings (48W1263, Revision 12 and 48N914-4, Revision 7), as well as TVA's Problem Identification Report WBN-CEB-8658, Revision 1, and the licensee's program for conducting root-cause analysis and generic problem evaluation. This item is closed.

p. (Closed) IFI 390/86-17-14, Adequacy of Weld Analysis Related to Loads, and Load Combination Considerations in Engineering Analyses

This inspection followup item was identified by, and was the result of, an NRC inspector's review of EG&G's weld evaluation project (WEP). From this review, the NRC inspector made several observations, one of which was that loads and load combinations considered in the analyses for a particular connection on a feature, were not clearly indicated, and should therefore be verified by EG&G. In response to this observation TVA indicated that load combinations were furnished to EG&G through TVA original design documentation. The design calculations referenced the design criteria and applicable code requirements. Design calculations for a particular feature (such as hanger, platform, or pipe weld) were obtained through the documentation trail (RIMS number, key nouns, unique ID number) from the feature design drawing.

Enveloping of reaction loads for a particular connection on a feature taken from the original design calculation package is an acceptable method of determining loadings (forces and moments) for evaluating that connection.

TVA stated that the weld evaluation project verified that the loads were those designated for the WEP scope features and that the associated loads were reasonable. However, TVA assured the NRC team that the WEP was never intended for reviewing TVA design input. Therefore, load accuracy verification was not placed within the scope of WEP activities. This item is closed.

q. (Closed) IFI 390/86-17-15, Visual Inspection of Weld Without Necessary Weld Detail Information, Component No. 48W1707-14

This inspector followup item pertained to the same weld discussed in IFI 390/87-17-13 above (section n), and to the inspection package issued by EG&G to the QC inspector. In its review of this inspection package, the NRC inspector noted that the package did not contain weld detail information needed for determining such attributes as weld size, length, and joint type. This observation was brought to the attention of the appropriate EG&G representative for corrective action. Because the WEP inspection was in progress at the close of the IFI 390/87-17 inspection, the NRC inspector could not review the licensee's final action on this matter. The condition described here appeared to be an isolated case. Through discussions with responsible TVA personnel, the NRC team ascertained that TVA provided EG&G with all the necessary drawings for subject inspections. In reference to this item, the responsible engineer stated that TVA Drawing No. 48W1707-16, detail D16-D16 required a double-bevel groove on both flanges. As an alternative, Drawing No. 48W1707-1, note 8 allows substitution of any full-penetration weld process described in TVA General Construction Specification G-29C such as a single-bevel-groove configuration. This combined with lack of a weld on one flange may have led to the confusion regarding the required weld detail. This item is closed.

r. (Closed) IFI 390/86-17-19, Selection of Electrical Installations for WEP Reinspection

This inspector followup item was identified when a field inspection of all selected electrical installations for WEP reinspections, disclosed that the electrical installation population selection, which was based on a 100/100 accessibility criterion, failed to include "large" supports, and as such it was believed that this omission biased the inspection sample. At the time, the inspectors asserted that although there may be no significance to this omission, in terms of statistics, large cable trays should be included in this inspection/engineering evaluation since those data could be used at another time in support of a safety evaluation of all electrical supports.

The NRC team members discussed the issue with responsible TVA personnel and reviewed related documents/memoranda that addressed the issue in order to ascertain the licensee's position on this matter. Basically, the review disclosed that WEP conducted a review on the introduction of a bias based on the 100/100 criteria and concluded that no bias was introduced. Moreover, in a memorandum dated September 24, 1987, EG&G stated the following:

> Groups I and J which pertain to X electrical support populations consisted of cable tray and conduit supports as a homogeneous population

based on the involved organizations, common code requirements (AWS), inspection criteria, and installation requirements. The combined entire population consisted of 22,891 individual electrical supports (the majority of this population is conduit supports and this is reflected in the majority of the samples being conduit supports). The original samples for Groups I and J (the first 64 drawn) were represented as follows:

- Group I: Four cable trays and 60 conduit supports. After the accessibility walkdowns, WEP inspected 1 cable tray and 63 conduit supports.

- Group J: Eight cable trays and 56 conduit supports. After the accessibility walkdowns, WEP inspected 12 cable trays and 52 conduit supports.

The codes that cover welder qualification are standardized in that the size of the item (large vs. small) that will be welded in production is not a consideration for qualification. The ability to weld in certain positions, on certain material thickness, and at various joint configurations is established without respect to "cable trays" or any other specific type of support.

Because all items in the population have an equal chance of being selected and because cable trays, regardless of size, are accurately represented, the fact that "large" cable trays were not selected or inspected is of no consequence to the scope of this inspection.

In conclusion, TVA's position was that the populations inspected represented a broad spectrum of electrical installations at Watts Bar Unit 1. Additional inspections, as suggested in the inspection report, would have no significant bearing on establishing the weld quality level or engineering evaluation beyond the data currently represented. This item is closed.

s. (Closed) 10 CFR 50.55(e), 390/84-17; IFI 390/86-25-08, Deficient Welds for Hanger Lugs

During rework activities on Unit 1 pipe supports, it was discovered that welds joining the piping shear lugs to the pipe did not achieve the complete penetration required by the design drawings. In addition, the welds on some of the shear lugs did not extend the entire length of the lug. This nonconformance was identified also by DOE/WEP during its evaluation and was reported under Significant Condition Report (SCR) W-518-P for Unit 1. TVA reported this condition to NRC in accordance with 10 CFR 50.55(e), 390,391/87-17.

TVA has taken the following corrective actions on this item.

All shear lugs on safety-related systems will be addressed. At present, all ASME Section III, Class 1 lugs have been determined to be acceptable by ultrasonic examinations. Lugs on ASME Section III, Class 2 and Class 3 Code piping, where full-penetration welds were specified on the design drawings, will be reanalyzed using ASME Code Case N-318 to determine the required size for fillet welds or partial-penetration welds. For lugs not qualified using an existing reinforcing fillet weld, the required minimum penetration will be established.

For welds not meeting minimum requirements, fillet welds meeting the requirements of Code Case N-318 will be added. Additionally, although the ASME code case is not applicable to B31.1 code piping, its logic will be used in the same manner on Category 1 and Category 1(L) pressure boundary lugs attached with full-penetration welds to this class of piping located in seismic Category I structures. The welds will require reinspection to determine if the existing fillet welds are of suffient size to meet design requirements. The Watts Bar FSAR will be revised to allow the use of ASME Code Case N-318 as endorsed by NRC Regulatory Guide 1.84.

In order to prevent recurrence of inadequate weld penetration of the subject shear lug installations, Quality Control Instruction QCI-4.03 was revised to require a quality control (QC) hold-point on the welding operation sheets to document back gouging. In order to provide assurance that welding activities are performed to specification, measures in the welding inspection area have been taken to monitor the performance of welding inspectors. A system was instituted under which randomly selected, previously accepted inspections are reinspected by peer inspectors for adequacy.

The team reviewed TVA's corrective actions and determined the corrective actions are acceptable with appropriate application of the requirements of Code Case N-318-3. Previous NRC staff inspection concerns have been adequately addressed in TVA's Phase II response.

The team reviewed the following documents associated with this issue:

- Phase II TVA Response 7.4 WBNOES 88002, WBN Class I, Unit I and II UT Evaluation Report 50-390/89-09, Special Projects Report
- Personnel training records for AI9.4.2 (Background and Inspection Requirement)
- Personnel training records for CTM-039 (Background and Inspection Requirement)
- Training Module CLP-046
- Training Module CTM-039
- Draft Revision to 10 CFR 50.55(e), "Deficient Welds for Hanger Lugs on ASME Piping"
- WBN AI-9.4.2, page 11 of 30
- Draft Revision to HAAUP CAP Plan
- Hanger Analysis and Update Program (HAAUP) CAP Plan, Revision 0
- Code Case N-318, N-318-3

This item is closed.

t. (Open) IFI 50-390/88/04-03, Torsional Shear Stress Effects on Weld Design

NRC team inspection 50-327, 328/86-27, related to the Sequoyah Nuclear Plant, identified a deficiency in cable tray support design which reflected the torsional shear due to the eccentricity of tray on weld design.

TVA agreed that this effect might apply to Watts Bar Units 1 and 2 since Sequoyah and Watts Bar have similar configuration and design for cable tray supports. TVA was asked to evaluate this generic problem on Watts Bar Units 1 and 2. The NRC team discussed this matter with a TVA engineer and reviewed the information provided.

In response letter L44-861103-808 (to NRC, dated November 3, 1986), TVA stated in part (on page 45 of referenced enclosure) that the result of the worst-case calculations was to show that the torsional shear stresses were negligible in Sequoyah. TVA concluded that the Sequoyah resolution of this deficiency could be cited as sufficient justification for the resolutions of the corresponding Watts Bar deficiency. However, the NRC team asked to review the justification of seismic factors and support member sizes used for Watts Bar in comparison to Sequoyah, since those two factors are different in the two nuclear plants. TVA could not provide the information immediately.

At the same time, TVA's engineers found that the justification and resolution for this torsional shear problem would be included in the licensee corrective action program (CAP) for the cable tray system. This item is carried on page 1 of 1 of Attachment 1, "Basis" of CAP as follows:

- Report Number: SCR SQN CEB 8622
- Problem Description: Cable tray support design issues identified at SQN [sequoyah] verify the potential generic condition evaluation performed for WBN [Watts Bar].

TVA decided to evaluate this problem thoroughly to determine its impact in Watts Bar.

Pending TVA's resolution of this problem within the framwork of the cable tray support CAP, this item remains open.

u. (Closed) URI 390/87-19-02, Interpretation of Radiographic Film

This unresolved item identified a concern regarding an apparent indication of the radiographic film for weld FW-1-072A-D059-01CA which TVA had reviewed and accepted. The inspector questioned the licensee's evaluation of this film.

TVA's corrective actions were to remove the insulation from the weld in question and to re-radiograph and reevaluate the radiographic film. The licensee's review found the weld acceptable.

The NRC team reviewed the re-radiography data package for weld referenced above. The inspector concurs with the licensee's interpretation of the reevaluation. It was determined that the questionable area was a surface indication that meets the requirements of the ASME Section III Code. This item is closed.

4.2 Review of TVA's Phase I Weld Report

4.2.1 Structural Welding

4.2.1.1 Inspection Scope

The NRC team selected 42 FSAR commitment review packages for review. The packages were selected to include the following areas: (1) pipe supports, (2) instrument supports, (3) electrical supports, (4) heating, ventilation, and air conditioning (HVAC) supports, (5) equipment supports, (6) structural and miscellaneous steel fabrication, and (7) analysis of employee concerns at Watts Bar.

The NRC team also reviewed five implementing procedures and four detailed welding procedures used at the site to verify that the FSAR commitments were translated in these specifications and procedures. In addition, the team also reviewed the Phase I weld report results, conclusions, recommendations, and commitments to confirm the validity of the information.

4.2.1.2 Inspection Findings

Listed below are the seven areas that the NRC team inspected; findings associated with the FSAR commitment packages and procedures that were reviewed also appear below.

(1) Pipe Supports

TVA reviewed a total 20 pipe supports as a part of its Phase I review. Six of those supports were unit 1 supports and 14 supports were unit 2 and common area supports. The NRC team reviewed the six unit 1 pipe support packages. In all cases the team found a traceable path between the design output documents and the FSAR documents. The team found no problems when it reviewed Process Specification PS-G29C to ascertain that the process specification incorporates the applicable design requirements. The six pipe support packages and the drawing numbers are identified in the table that follows:

TVA Item No.	TVA Dwg. No.	Piping System	General Location
WBEPC56	1-03A-284	Feedwater	Reactor building
WBEPC58*	47A435-6-46	Upper head injection	Reactor building
WBEPC60	1-68-065	Reactor coolant	Reactor building
WBEPC61	62-1CVC-R50	Chemical & volume control	Auxiliary building
WBEPC84	47A450-21-227	Emergency reactor cooling water	Reactor building
WBEPC89	07A400-6-243	Blowdown	Reactor building

*During its review, TVA noted that this drawing referenced G-29M instead of G-29C.

(2) Instrument Supports

TVA reviewed one instrument support as a part of its reinspection effort. The NRC team reviewed the same item and found a traceable path between the design output documents and the FSAR documents.

(3) Electrical Supports

TVA reviewed nine cable tray supports as a part of its Phase I review. The NRC team reviewed the same nine packages and found a traceable path between the design output documents and the FSAR documents.

(4) HVAC Supports

TVA reviewed one HVAC support as a part of its Phase I review. The NRC team reviewed the same package and found a traceable path between the design output documents and the FSAR documents. The NRC team also reviewed design specification WB-DC-20-1.1, Process Specifications 1.C.1.2 and QC1.1, and Construction Specification N3G-881, and noted no problems.

(5) Equipment Supports

TVA reviewed two equipment supports as a part of its Phase I review. The NRC team reviewed the same two packages and found a traceable path between the design output documents and the FSAR documents.

(6) Structural Steel and Miscellaneous Steel Fabrication

TVA reviewed 24 structural steel and 39 miscellaneous steel items as a part of its Phase I effort. The NRC team reviewed 11 structural steel and 11 miscellaneous steel packages. In all cases, the team found a traceable path between the design output documents and the FSAR documents. The team also reviewed four detailed welding procedures for adequacy and identified no problems. The NRC team reviewed the following 11 structural and 11 miscellaneous steel packages and 4 welding procedures:

- Structural steel packages: WBEPC01, WBEPC12, WBEPC15, WBEPC20, WBEPC27, WBEPC28, WBEPC29, WBEPC32, WBEPC70, WBEPC80, WBEPC91
- Miscellaneous steel packages: WBEPC06, WBEPC08, WBEPC09, WBECPC19, WBEPC24, WBEPC37, WPEPC44, WBEPC73, WBEPC82, WBEPC91, WBEPC92
- Detailed welding procedures: SM-P-1, R9; SM-U-1, R6; SM-U-1B R6; and SM-U-4, R2

(7) Analysis of Employee Concerns at Watts Bar

TVA reviewed and analysed 446 employee concerns that related to construction related welding in Section 4.7 of the TVA's Phase I weld report. Five major issues were identified as a result of those analyses. The NRC team reviewed the issue that related to inspection of welded structural connections coated with primer. This issue evolved from a large reinspection effort which principally addressed the geometric attributes of small fillet welds on structural items. In late 1981, TVA's engineering design organization (now NE) granted

limited approval for reinspection of fillet welds which had been coated with carbo-zinc prime. This was perceived by some individuals to be a violation of the AWS Structural Welding Code, which requires that welds be inspected before painting.

This limited reinspection of primed welds was first approved by internal TVA memoranda. In January 1982, Process Specification 3.C.5.4., "Watts Bar Final Visual Weld Examination," was issued. The specification included provisions for reinspection of primed welds.

The practice in question did not allow initial acceptance inspection of coated welds, nor did it allow reinspection for attributes which might have been masked by the prime coat. In that the intent of inspection through primer was to allow reinspection of previously inspected welds and was within the authority of the engineer.

The provision which allowed the reinspection of primed welds was made as part of an action to resolve a number of NCRs. As such, the reinspection methodology and criteria should have been included as part of the NCR dispositions, rather than in the process specification. By allowing reinspection of primed welds through the process specification, some confusion was created regarding the intent and limitations of the practice. This confusion was compounded by poor wording and organization of the specification. Thus, it appeared to some that the process specification allowed initial acceptance inspection of coated structural welds, which would be in violation of the AWS Structural Welding Code.

The TVA Nuclear Safety Review Staff performed a thorough investigation of this issue. The results showed that three individuals had actually performed acceptance inspections of primed electrical support welds. These supports were identified, the primer was removed from the welds, and the supports were properly inspected.

In early 1984, TVA revised the design specification and implementing procedure to remove the provision for reinspection of primed welds since the TVA sampling programs were completed. This removed the confusion of inspection of welds through paint. Complete details of the programmatic evaluation of this issue may be found in the Welding Project Evaluation Report WP-02-WBN, "Inspection of Welds Through Carbo-Zinc Primer at Watts Bar Nuclear Plant".

The DOE/WEP reinspections also addressed this issue by visual inspection of a random sample of over 1,540 welds fabricated and inspected by TVA from December 1, 1981, through January 23, 1984. This is the period during which the TVA program at WBN allowed reinspection of primed structural welds. Before inspection, all paint and primer was removed from this sample of welds, including their heat-affected zones. One of these welds was found deviant because of a crack, and one was found deviant because of porosity.

The DOE/WEP analysis of the reinspection data compared deviation rates for the welds inspected by TVA during, before, and following the subject time period. No significant differences existed between the deviation rates for the three time periods relating to the issue of reinspection through primer. All of the welds associated with this sample were determined to be suitable for service.

The DOE/WEP determined that quality documentation did not provide evidence of initial inspections being performed using the "reinspection through primer" provisions; and that if any welds were initially inspected through paint, it did not adversely affect the acceptability of the welds. Details of the DOE/WEP reinspections related to this issue may be found in the DOE/WEP weld reinspection report, and in the Evaluatin Report and Closure Statement for WEP Group 205, Inspection of Welds Through Carbo-Zinc Primer. The NRC team reviewed a sample of the referenced TVA documentation and found it acceptable. The NRC team concluded that TVA has adequately addressed this issue.

4.2.1.3 Conclusions

The NRC team review of the information contained in the TVA's Phase I weld report confirmed the validity of results and conclusions of the Phase I report in the structural welding area. The NRC team found that TVA's Phase I report contained the essential elements needed to determine whether the licensing commitments have been properly translated into the governing specifications and drawings.

4.2.2 Pipe, Instrument, and Spiral Duct Welding

4.2.2.1 Inspection Scope

The NRC welding-inspection team selected 30 FSAR commitment review packages for review. The packages were selected to include pipe, instrument, and spiral duct welds. The NRC team also reviewed 3 process specifications and 10 detailed welding procedures to verify that the FSAR commitments were translated in these documents. In addition, the NRC team also reviewed TVA's Phase I weld report results, conclusions, recommendations, and commitments to confirm the validity of the information.

4.2.2.2 Inspection Findings

(1) Pipe Welding

TVA reviewed 57 pipe welds as a part of its Phase I review. The NRC team reviewed 19 FSAR commitment review packages in the pipe weld area. These packages were selected to include all safety-related systems reviewed by TVA in its Phase I report. The NRC team also reviewed 3 process specifications and 10 detailed welding procedures to verify that the FSAR commitments were translated in these documents and found no problems. The NRC found a traceable path between the design output documents and the FSAR documents. The NRC team reviewed FSAR commitment packages, process specifications, and detailed welding procedures as follows:

- Pipe Weld Packages: WBM02, WBM13, WBM14, WBM19, WBM26, WBM28, WBM29, WBM38, WBM42, WBM44, WBM54, WBM62, WBM63, WBM65, WBM66, WBM67, WBM68, WBM71, and WBM72

- Process Specifications: 1.M.1.2(R4), 3.M.1.1(R4), and 3.0.5.4(R2)

- Detail Welding Procedures: SM11-B-3(R7), SM88-B-1(R2), GT-SM11-0-3B(R8), GT-SM13-0-1(R0), GT-SM18-0-1(R4), GT-SM88-0-1A(R5), GT11-0-1A(R7), GT18-0-1(R5), GT88-0-1A(R1) and GT43.43-0-1(R1)

(2) Instrument Welding

TVA reviewed 10 instrumentation welds as a part of its Phase I review. The NRC team reviewed the same 10 FSAR commitment review packages in the instrumentation weld area. The packages encompassed different safety-related systems and included 1/2-inch-diameter socket welds, pipe schedule 80 and 160, and ASME Section III, Classes 1, 2, and 3 welds. The NRC team identified no problems during its review of these items. The NRC team found a traceable path between the design output documents and the FSAR documents.

(3) Spiral Duct Welding

TVA reviewed five spiral duct welds as a part of its Phase I review. The NRC team reviewed FSAR commitment review package WBN70 as a part of its review of the sprial duct welding area and identified no problems. The NRC team found a traceable path between the design output documents and the FSAR commitments.

4.2.2.3 Conclusions

The NRC team review of the information contained in TVA's Phase I weld report confirmed the validity of the results and conclusions of the Phase I report in the pipe, instrument, and spiral duct welding area. The NRC team found that TVA's Phase I report contained the essential elements needed to determine whether the licensing commitments have been properly translated into the governing specifications and drawings.

4.2.3 Nondestructive Examination

4.2.3.1 Inspection Scope

The NRC team reviewed the content of the TVA's Phase I report as related to the nondestructive examination (NDE) area. In addition, the team reviewed seven NDE procedures and specifications for adequacy.

4.2.3.2 Inspection Findings

The team reviewed the following four procedures:

- 3.M.1.1 (R4), Liquid Penetrant
- 3.M.5.1(R6), Examination of Weld Ends, Fit-Up Visual and Dimensional Examination of Weld Joints
- 3.M.2.1(R3), Magnetic Particle Examination of Welds and Weld Edge Preps
- WBNP-QCP-4.13-RTM(R7), Radiographic Examination

and found no problems.

However, during the review of Procedure 3.C.5.4(R2), Final Visual Weld Examination, the NRC team identified one irregularity: Figure 2 of the procedure, January 28, 1985, identified overlap as being excessive reinforcement and the excessive reinforcement was identified as being overlap. The same Figure 2 of the procedure, dated January 22, 1986 has corrected this irregularity. No other problems were identified during the NRC team review of this procedure.

During the review of Radiographic Procedure 3.M.3.1(R3), the NRC team initially identified three areas of concern: (1) The procedure did not require that unique weld identification appear as a radiographic image, (2) Hard stamping of welds was not required by the procedure, and (3) Level III review was not required by the procedure. These three concerns also were identified during previous NRC inspections and TVA has committed to correct inadequacies. At the time of this inspection, the NRC team found that Radiographic Procedure 3.M.3.1 was revised and corrected in May 18, 1988. In addition, all recent radiographic examinations of pipe welds have been performed under TVA's Procedures WBN-QCP-4.13.RTM (R13) and N-RT-1(R8) which require unique identification, hard stamping, and Level III review of radiographs. The NRC team concluded that TVA has adequately addressed these concerns.

4.2.3.3 Conclusions

The NRC team review of the information contained in TVA's Phase 1 report confirmed the validity of the results and conclusions of the Phase I report in the NDE area. The NRC team found that the reviewed NDE procedures incorporated the governing codes and specification requirements.

4.3 Review of TVA's Phase II Weld Report

The NRC team obtained a summary of all welds that were inspected under the scope of TVA's Phase II inspection effort. The summary contained the number of homogeneous groups and weld attributes inspected and identified the weld deviations that were noted by the DOE/WEP inspectors. See Table 1 and Table 2 for details concerning structural and pipe welds inspected by the DOE/WEP inspectors.

The NRC team divided the information contained in TVA's Phase II report into four review areas: (1) structural welding, (2) pipe welding, (3) nondestructive examination (NDE), and (4) review of engineering calculations. Each of these review areas is discussed below.

4.3.1 Structural Welding

4.3.1.1 Inspection Scope

The NRC team reviewed the Phase II information relevant to the structural welding area. The selected items for review included: (1) pipe supports/restraints, (2) instrumentation installations and supports, (3) electrical installations and supports, (4) heating, ventilation, and air conditioning (HVAC) installations and supports, (5) mechanical equipment installations and supports, and (6) civil structures. Each of these items is addressed in Section 4.3.1.2. In addition, the NRC team reviewed six welding issues related to structural welding that were reported in TVA's Phase II report.

4.3.1.2 Inspection Findings

Areas that the NRC team inspected and findings associated with the reviewed items are discussed in the sections that follow.

4.3.1.2.1 Pipe Supports/Restraints

Through DOE/WEP (its contractor), TVA reinspected a total of 266 components involving 1230 welds in the area of pipe supports/restraints. In its reinspection of this area, DOE/WEP divided the plant population into eight homogeneous groups that included a sample of welds and components from the pipe supports/restraints area. The NRC team reviewed the records for 31 of these supports/restraints and inspected the same support/restraint to determine the adequacy of TVA's reinspection effort. See Table 3 for details. The NRC results generally agreed with the results reported in the DOE/WEP report, except for the results for items F-0006 and 015-0012. For item F-0006 the DOE/WEP inspectors did not note the existence of a 3/8-inch-long weep hole at the 6:00 o'clock position and did not accurately record the existing length of the weld. For item 015-0012, EG&G documents the examination and acceptance of two welds that did not exist on the inspected pipe restraint. As a result of this finding, quality information requests (QIR) Nos. CEBWBP89341 and CEBWBP89342 were issued to track and resolve these items.

4.3.1.2.2 Instrument Installations and Supports

Through DOE/WEP (its contractor), TVA reinspected a total of 153 components involving 696 welds in the area instrument installations and supports. In its reinspection of this area, DOE/WEP divided the plant population into three homogeneous groups. The NRC team reviewed the records for 14 of these items and inspected the same items in order to determine the adequacy of TVA's reinspection effort. See Table 4 for details. The NRC results agreed with the results reported in the DOE/WEP report.

4.3.1.2.3 Electrical Installations and Supports

Through DOE/WEP (its contractor), TVA reinspected a total of 457 components involving 2200 welds in the area of electrical installations and supports. In its reinspection of this area, DOE/WEP divided the plant population into eight homogeneous groups that included a sample of welds and components from the electrical area. The NRC team reviewed the records and reinspected 28 items to determine the adequacy of TVA's reinspection effort. See Table 5 for details. The NRC results generally agreed with the results reported in the DOE/WEP report. However, the NRC 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. The team found that 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 is documented on page 3 of 4 in the Group 251 Inspection Results and Data Analysis Report, dated August 27, 1987. When item 251-0055 was removed from the inspection group, its removal was documented in Deviation Report 999-308 and Condition Adverse to Quality Report (CAQR) WBP880025 for future disposition and resolution. By field observations and conversations 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 struc-

ture. Therefore, this item will be included as an inspector followup item to be addressed in conjunction with the NRC's review of the conduit support corrective action program.

4.3.1.2.4 HVAC Installations and Supports

Through DOE/WEP (its contractor), TVA reinspected a total of 192 components involving 3046 welds in the area of HVAC installations and supports. In its reinspection of this area, DOE/WEP divided the plant population into five homogeneous groups that included a sample of welds and components from the HVAC area. The NRC team reviewed the records and reinspected 29 items to determine the adequacy of TVA's reinspection effort. See Table 6 for details. The NRC inspection results generally agreed with the results reported in DOE/WEP report. However, on support No. K-0070 one weld had a 3/32-inch-long undercut that was not recorded by EG&G inspectors; support Nos. L-0011 and L-0015 had several washer plate welds that were not inspected by the EG&G inspectors (as is required by the general notes on the drawings); and on support No. 219-0010, one weld was 3/4 inch short and the EG&G inspectors did not report this. As a result of this finding condition adverse to Quality (CAQR) No. WBP890255 was issued to track the resolution of this finding

4.3.1.2.5 Mechanical Equipment Installations and Support

Through DOE/WEP (its contractor), TVA reinspected a total of 25 components involving 324 welds in the mechanical equipment area. In its reinspection of this area, DOE/WEP formed group No. 252 which included a sample of welds and components from the mechanical equipment area. The NRC team reviewed the records and reinspected 10 items to determine the adequacy of TVA's reinspection effort. See Table 7 for details. The NRC results generally agreed with the results reported in the DOE/WEP report. However, on support No. 252-0185, welds 1, 3, 4, 5, and 8 were 1 inch too short and the EG&G inspectors did not report this. In addition, on support No. 252-0347, weld 8 was also 1 inch short, and the EG&G inspectors did not report this. As a result of this finding CAQR No. WBP890255 was issued to track the resolution of this finding.

4.3.1.2.6 Civil Structures

Through DOE/WEP (its contractor), TVA reinspected a total of 312 components involving 7436 welds in the civil structures area. In its reinspection of this area, DOE/WEP divided the plant population into ten homogeneous groups that included a sample of welds and components from the civil structures area. The NRC team reviewed the records for 36 civil structures items and reinspected the welds on the structural steel partition wall at elevation 755 feet. See Table 8 for details. The NRC review and reinspection in this area identified no problems. NRC reinspection results agreed with the results recorded in the DOE/WEP report.

4.3.1.2.7 Six Miscellaneous Corrective Actions Related to Structural Welding Activities

In addition to reviewing the record and reinspecting selected structural welding items, the NRC welding team reviewed the status of corrective actions that related to structural welding. These corrective actions were included in Section 7 of the TVA's Phase II weld report. The results of the NRC review of each item follow.

(1) Structural Platform Welds--Elevation 741 Feet

Weld deviation reports (WDRs) were written for the Watts Bar weld program. As a result, calculations were made to check the adequacy of the as-constructed welded connections for mainframing and bracing cable tray support loads in the control building (elevation 741.0 feet). Ten WDRs were determined to report connections exceeding design allowables as a result of these evaluations for Unit 1. This problem was identified by DOE/WEP during its evaluation and is included under TVA's Corrective Action Report SCR WBN CEB 8689 which was reported under 10 CFR 50.55(e). See Section 4.1 item c of this report for additional discussion of this item.

(2) Structural Steel Partition Wall--Elevation 755 Feet

NCR 3454 required TVA to visually inspect a sample of the structural steel partition wall welds (drawing 48N1322-1) at elevation 755 feet of the control building at Watts Bar Unit 1. No documentation could be found to prove that the visual inspections required by this NCR had been performed.

The DOE/WEP review of TVA Drawing No. 48N1322-1 identified that 279 welds were required to fabricate the structural steel partition wall. Visual inspection performed by DOE/WEP indicated 118 deviant welds requiring engineering analysis to determine structural acceptability and two structural steel beams which were found removed to accommodate HVAC equipment. Also, one bolt anchor connection had only one bolt anchor instead of two, and the splice details were shown incorrectly. The corrective action specified for CAQR WBP880218 was to document reanalysis of the structure, perform safety significance review and revise calculations and drawings as required. Engineering calculations have determined that the wall would not have failed even if the deviant conditions had been undetected.

The NRC team selected ten welds for comparison of the actual weld condition against the EG&G reported condition. All discrepancies noted were previously identified and reported and evaluated by TVA. The NRC team agrees with the TVA's disposition of this item.

(3) Monorail Support Assembly--Missing Structural Brace

During the DOE/WEP reinspection of Group 263, "Safety-Related Civil Welds Fabricated and Installed Prior to February 13, 1981;" the component selected at random for reinspection was found to vary from the as-constructed drawing. A support brace noted as having been installed was missing. The engineering evaluation of the component, a monorail support assembly, showed the component to be unacceptable for "use as is." The missing brace had never been installed. TVA's corrective action on this item was to install the required angle. The NRC team verified that the angle was installed in compliance with specified drawing requirements. The NRC team agrees with the TVA's disposition of this item.

(4) Slugged Weld on Main Steam Line Jet Impingement Sleeves

Two employee concerns relate to slugs placed in the groove of a weld on a pipe rupture restraint. (The structure in question is a main steam jet impingement sleeve.) One of the concerns states that a large fitup gap was slugged with

steel rod to compensate for a large fitup gap. The DOE/WEP received additional information from the employee response team (ERT) which showed that the second concern deals with the same incident.

The concerns were found to be based on fact. ERT investigation of this issue resulted in the initiation of a nonconforming condition report. The TVA welding project (WP) evaluation led to the issue of a corrective action tracking document.

The ERT investigation identified a number of discrepancies in the restraint. ERT verified by visual examination that one of the girth welds in the restraint had a cold rolled steel slug embedded in the weld. ERT also reported a lack of penetration into the girth and longitudinal welds, slag residue from flame cutting and arc welding, and root opening (distance between the abutting members) that exceeded the drawing requirement. ERT performed a document review and determined that one of the welders was not qualified for the work performed. The ERT report states that the welder was qualified only for welding with a backing ring, and the work in question was an open root butt joint.

TVA initiated Nonconforming Condition Report (NCR) W-325-P to address the slugged weld. TVA examined the weld ultrasonically to determine the exact extent of the deficiency. Engineering calculations showed that the slugged weld was suitable for service.

NCR W-325-P and the engineering calculations did not, however, address the lack of penetration of the girth and longitudinal welds, the slag entrapped in the root of the welds, the increased root opening, or the welder's qualification for the work performed. However, as a part of its evaluation of welding at the Watts Bar plant, the TVA WP reviewed the welder qualification issue. The welders were identified, and a summary of their qualifications was obtained. The open root detail welding procedure assigned by the welding engineering unit met the requirements of the design drawing. The performance qualification tests taken by the welders allowed them to make open root butt joints in accordance with the assigned detail weld procedure.

Therefore, TVA WP concluded that the ERT finding that one of the welders was not qualified for the work performed was incorrect.

Details relating to qualification of welders are presented in WP-44-WBN, Paragraph III.A.a.

In addition, TVA WP visually examined the accessible areas of the longitudinal welds. TVA removed the insulation from the impingement sleeve. Accessibility was, however, limited by insulation on the pipe that passes through the sleeve. One of the longitudinal welds could not be examined because the pipe on which the weld existed was too close the inside of the sleeve. Thus, 6 to 10 inches of weld area was examined on each of three welds.

Of the areas examined, the welds displayed no visible weld penetration into the roots of the joints. Where the drawing and the detail weld procedure specified a root opening, the sections were abutted with no visible opening in the areas examined.

The excessive root opening noted in the ERT concerns did not appear in the longitudinal welds. DOE/WEP concludes that the wide root gap is associated with the slugged girth weld, as described in the test of the concern. This weld has been addressed by NCR W-325-P.

The design drawing shows the longitudinal welds on the straight sections of the sleeve rotated 90 degrees from those on the elbow section. All of the longitudinal welds are aligned.

In the areas examined, no slag was found.

Corrective Action Tracking Document 50444-WBN-01 has been issued to ensure that the lack of penetration, absence of a root opening, and misalignment of the longitudinal welds are evaluated and, if necessary, corrected. To date these issues have not been completed. Additionally the NRC team identified a concern regarding the sleeve material, certificate of compliance requirement, and visual inspection of the weld which is specified as a requirement on the applicable drawing.

(5) Wall-Mounted Instrument Panels

The seismic adequacy of approximately 122 Unit 1, site-fabricated local instrument panels in several safety-related systems at Watts Bar was questioned because of discrepancies identified in the fabricated configuration. Weld joints were shown on the design drawings to require full-penetration, single-bevel welds. However, these welds were found to generically lack the required complete penetration and joint configuration. In addition, TVA did not perform adequate structural (configuration and material verification) inspections of the instrument panels which, in conjunction with the identified weld deficiency, made questionable the overall adequacy of the panels. This problem was identified by TVA in Unit 2 and reviewed for applicability in Unit 1 and was included under TVA's Corrective Action Report SCR-W-559-PS. TVA reported this condition to NRC in accordance with 10 CFR 50.55(e). This item is discussed in detail in Section 4.1 item k of this report.

(6) Evaluation of Structural Welds in the Unit 1 Valve Room

During the reinspection/reexamination of Group 214, "North and South Valve Room Structural Welds," DOE/WEP performed an ultrasonic test on a representative sample of welds to address an employee concern dealing with the issue of welding over cracks. Ultrasonic examinations on these welds were not part of the original acceptance criteria.

Upon inspection of 236 structural welds, TVA documented 190 welds as acceptable and visually and ultrasonically examined 46 welds and documented them as needing further characterization for engineering evaluation. All 46 welds were determined to be acceptable for their intended function. However, TVA will perform additional reviews of the valve room welds in order to ensure that during the loss-of-coolant accident all welds do not exceed the allowable design stresses.

TVA is planning to examine all accessible seam weld surfaces of the four fabricated beams in each valve room using magnetic particle testing. This examination will use AWS D1.1, as contained in Construction Specification G-29C, "Process

Specification for Welding, Heat Treatment, Nondestructive Examination, and Allied Field Fabrication Operations." This effort has not yet been completed and TVA is transferring this effort from the TVA welding project to the applicable line organization for completion.

4.3.1.3 Conclusions

The NRC team concluded that TVA's Phase II reinspection effort was an effective sampling effort and thus the inspection results can be used to assess the welding quality at the Watts Bar Unit 1. In addition, the identified welding issues in the structural welding area have been adequately addressed and the current corrective actions plans are being properly implemented.

4.3.2 Pipe Welding

4.3.2.1 Inspection Scope

Through DOE/WEP (its contractor), TVA reviewed a total of 721 pipe welds as a part of its Phase II reinspection effort. In its reinspection of this area, DOE/WEP divided the plant population into 21 homogeneous groups and reinspected a sample of welds that were fabricated under the requirements of the ASME Section III, B31.1 and B31.5 codes. See Table 2 for details. The NRC team selected for inspection a total of 21 welds from the TVA's Phase II reinspection sample in order to verify the adequacy of the DOE/WEP reinspection effort. In addition, the team reviewed four welding issues related to pipe welding that were reported in TVA's Phase II weld report.

4.3.2.2 Inspection Findings

The NRC review of the sampled 21 welds revealed no significant deviations from the results reported in the DOE/WEP report. Therefore, the NRC findings are in general agreement with the results reported in the Phase II weld report. See Table 9 for details. However, during the review of the base material documentation the NRC team identified examples when ASTM materials were installed instead of the required ASME materials. In addition, in one instance, type 316 stainless steel material was used instead of the specified type 304 stainless steel material. As a result of this finding Condition Adverse to Quality Report (CAQR) No. WBP8905257 was issued to track the resolution of this finding.

Other Piping and Pipe-Related Welding Issues Reported in TVA's Phase II Report

(1) Piping Shear Lugs

During rework activities on Unit 1 pipe supports, TVA discovered that welds joining the piping shear lugs to the pipe did not achieve complete penetration required by the design drawings. In addition, the welds on some of the shear lugs did not extend the entire length of the lug. This nonconformance was identified also by DOE/WEP during its evaluation and was reported under SCR W-518-P for Unit 1. TVA reported this condition to NRC in accordance with 10 CFR 50.55(e).

The NRC team reviewed this issue. See Section 4.1 of this report for details.

(2) HVAC Ductwork Welding

Safety-related ductwork (including the hydrogen collection system) was fabricated and installed in 1978 without a quality assurance procedure (QAP) and without specific welding requirements from the engineering group. Quality Control Procedure QCP-4.27, "Inspection and Documentation of Ductwork," was established for these systems in 1980. Subsequently, the engineering design drawings were revised (December 1980) to require full-penetration welds. Welds completed before this full-penetration requirement were not visually inspected for compliance with this criteria. Also, during review of the welded HVAC ductwork, TVA recognized that some partial-penetration welds existed where full-penetration welds were specified. This condition had escaped recognition because the alternate acceptance criteria specified in Revision 2 of Construction Specification N3M-914 permitted leak tests in lieu of weld inspection. SCRs WBN-MEB-8714 and WBN-MEB-8721 were issued to document the inadequately evaluated acceptance criteria for safety-related HVAC duct welding. TVA reported this condition to NRC in accordance with 10 CFR 50.55(e).

Two stopwork orders on the circumferential welds in all safety-related HVAC ducts (spiral-welded duct and hydrogen collection pipe) were issued on January 12, 1987. At this time, none of the welds had been visually inspected to QCP-4.27. Subsequently, TVA developed a program to establish the structural adequacy of welded safety-related ductwork (including the hydrogen collection piping) for all operating conditions, including a seismic event. This program includes weld survey, seismic analysis, and weld repairs, as required.

TVA has completed the safety significance evaluation for this issue and the evaluation results are documented in the Nuclear Engineering (NE) calculation entitled "Safety Significance Evaluation for Seismic Category I HVAC Duct Welding Concern."

To prevent recurrence of the weld inspection deficiency, Watts Bar Construction Specification N3M-914 was revised to require visual inspection of welds or brazes of sheet metal for all ductwork constructed after December 29, 1986 (Revision 3). Leak testing is specifically not acceptable as verification of the welded or brazed connection.

Design drawings have been revised to reflect the acceptance criteria.

Nuclear Engineering Procedure (NEP) 3.3, "Internal Interface Control" was issued after this deficiency was found. This NEP establishes or references procedures covering the requirements and methods to control internal design interfaces and for requesting or conveying design information across NE internal interfaces. This should improve the quality of design output documents in establishing how interfaces will be satisfied.

The NRC team found TVA's review and disposition of this issue acceptable.

(3) Temporary Attachments--Piping

Employee Concern WI-85-053-003 indicated that the documentation for required NDE of postweld heat treatment (PWHT) thermocouple (minor temporary attachments)

removal areas could not be located. This condition was documented utilizing NCR-W-599-P. Areas were identified, the required magnetic particle examination was performed, and no rejectable areas were identified. However, as a result of grinding operations, minimum wall thickness requirements were not met on two components and on four welds. The licensee is correcting these violations. This item was identified by DOE/WEP and is included in the DOE/WEP report.

The NRC team found TVA's review and ongoing corrective actions acceptable.

(4) Classification of Containment Liner Welds

During the review of welding at Watts Bar Unit 1, several discrepancies were identified by TVA and DOE/WEP personnel on drawings for ASME Section III Class MC (metal containment) welds. Some attachments were classified as TVA Piping Class I which had never been defined. This issue was resolved under TVA's Corrective Action Reports WBP-870561, WBP-870562, and WPB-870563. All affected drawings have been revised to reflect the correct class by DCN-P-00385-A for Unit 1. DOE/WEP reported that some attachments that were classified as MC welds possibly should have been classified as AWS welds. TVA's review of the design drawings revealed that the welds were properly classified. These welds were installed as TVA Class B welds which are equivalent to ASME Code Class MC; therefore, there was no impact on hardware.

The NRC team found TVA's review and disposition of this issue acceptable.

4.3.2.3 Conclusions

The NRC team concluded that TVA's Phase II reinspection effort was an effective sampling effort and thus the inspection results can be used to assess the welding quality at Watts Bar Unit 1. In addition, TVA's current corrective action plans have been adequately implemented and the welding issues associated with the pipe and spiral duct area have been properly addressed.

4.3.3 Nondestructive Examination

4.3.3.1 Inspection Scope

TVA rereviewed all radiographs associated with the ASME Section III pipe welds as a part of its Phase II reinspection effort. This involved approximately 2700 welds. The NRC team reviewed a total of 74 welds involving 740 radiographs in order to verify the adequacy of the TVA's Phase II radiographic review. The welds were selected from the DOE/WEP computer-generated list, Bechtel NDE logs, and TVA's Final Report log books.

4.3.3.2 Inspection Findings

TVA rereview of all ASME Section III pipe welds (2700 welds) was accomplished during two separate efforts, that is, one rereview by a Level II examiner and one by a Level III examiner. An estimated 500 radiographs were rejected, representing about 350 welds. Of these, 185 welds have unacceptable indications. The remainder were rejected because of radiographic technique discrepancies. (This includes 58 socket welds which were radiographed at the request of Westinghouse.)

All indications that deviate from ASME Section III requirements have been identified. Corrective actions, including repair of unacceptable indications and radiography for technique and film quality discrepancies, are approximately 95 percent complete. TVA has identified two welds in the containment sleeves at the residual heat removal (RHR) sump suction with radiographic indications that exceed the acceptance criteria of the ASME Section III Code. 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, they would be extremely difficult to repair. TVA has requested approval in accordance with 10 CFR 50.55a(a)(3) of an alternative to ASME Section III Code requirements. See Section 4.4.2 of this report for additional details concerning these two welds. All corrective actions, hydrostatic testing, and final documentation of repairs on Unit 1 will be completed before fuel loading. To prevent recurrence of this deficiency for both Units 1 and 2, 100 percent of the radiographs for all new ASME Section III Code piping welds are required to be evaluated by both Level II and Level III film interpreters. The site radiographic procedure, QCP-4.13 RTM, "Radiographic Examination," has been revised to require the documentation of all indications requiring evaluation, and to require a Level II or Level III review. Training has been completed for QC radiographic interpreters to encompass the lessons learned. Radiography is to be included within the scope of all future corporate NDE audits. The QA surveillance group is to include radiography as part of its surveillance schedule. To improve management oversight, the number of personnel authorized to review radiographs has been limited.

The NRC review of the sample of 74 welds revealed no deviations from the results reported on the TVA's radiographic reader sheets. Therefore, the NRC findings are in general agreement with the results reported in TVA's Phase II report. See Table 10 for details. The NRC team review of the NDE activities at Watts Bar found TVA's review and associate corrective actions acceptable.

4.3.3.3 Conclusions

The NRC team concluded that TVA's Phase II effort was an effective inspection effort and, thus, the inspection results can be used to assess the weld quality at the Watts Bar Unit 1. In addition, the identified NDE issues were adequately addressed and the current corrective action plans have been properly implemented.

4.3.4 Review of Engineering Calculations

4.3.4.1 Inspection Scope

The NRC team reviewed TVA's response to open item No. 2 which was identified in NRC Inspection Report 50-390/87-09. The NRC team also reviewed the engineering calculations to welds found deficient during the Phase II reinspection effort. A total of 51 TVA items involving approximately 500 pages of engineering calculations were reviewed for completeness, consistency of documentation, engineering evaluation, and mathematical accuracy. The NRC inspectors did not review structural member stresses and the design loads used in the calculations since such a review is considered to be outside the scope of this inspection.

4.3.4.2 Inspection Findings

The NRC team reviewed open item No. 2 which was identified in NRC Inspection Report 50-390/87-09. The concern stated that the engineering reviews of deviation reports did not include the review of deficiencies identified in the "999" and welding task group (WTG) reports. These two reports document additional welding deficiencies found by EG&G and TVA inspectors, respectively. In addition, these reviews did not consider the cumulative effects of all identified deficiencies related to the affected weld connections. To close this NRC team concern, TVA needed to ensure that engineering reviews of weld deficiencies included the deficiencies identified in the "999" and WTG reports and consider the cumulative effects of all identified deficiencies related to the affected weld connections.

TVA responded to this concern in its transmittal from R. Gridley to the NRC, dated October 16, 1987. In the transmittal, TVA committed that to ensure that the cumulative effect of all deficiencies are considered, the suitability for service (SFS) calculations prepared for the original weld deviation report and any other independent deviation report (DR) for a particular component will be cross-referenced to or combined with the original design calculations for the component. In accord with engineering procedures NEP-3.1 and WBEP-5.11, the calculations will be revised and issued to ensure that all analysis for that component becomes a permanent TVA record and is retrievable through the TVA RIMS system. NEP-3.1 now requires each line organization discipline lead engineer to maintain a calculation log that will provide access to the appropriate calculations by drawing number or component identification. In addition, WTG will maintain a temporary log cross-referencing the original WDR number to a RIMS number.

The NRC welding team reviewed TVA's response to this concern and found it acceptable. In addition, the NRC team reviewed a sample of five "999" engineering calculations for the following attributes: ensurance that: (1) all analysis for a component considered the cumulative effect of all identified deficiencies related to the affected weld connections, (2) the analysis for that component becomes a permanent TVA record, (3) the analysis is retrievable through the TVA RIMS system, and (4) TVA maintains a log for cross-referencing the original WDR number to a RIMS number. In all cases, the NRC concerns with regard to the "999" and WTG reports as discussed above, were satisfactorily addressed by TVA. In addition, no discrepancies were identified during the review of the five "999" calculations for the above attributes. This item is considered closed.

The reviewed engineering calculations were generally found to be well organized, complete, and conservative in evaluating the deficient weld conditions identified during the TVA reinspection efforts. However, the NRC welding team identified two welds that were overstressed in TVA's calculation No. WB-227-009. In the calculation, the incorrect allowable stress was used in comparing it against the combined loading. In addition, the NRC team identified isolated administrative errors, in which comments from the EG&G review were not transferred to the final TVA calculation. As a result of these findings, Quality Information Reports (QIR) Nos. MTBWBP89010 and MTB89011 were issued to track and resolve these items. See Table 11 for details. These findings appear to be isolated cases and the administrative errors did not change the end result or the overall conclusion for the TVA items reviewed.

4.3.4.3 Conclusion

With the exception of the isolated case of overstressed welds and administrative errors, the reviewed calculations were generally found to be well organized, complete, accurate, and conservative in evaluating deficient welds identified during the TVA reinspection effort.

4.4 Miscellaneous Welding-Related Issues

The NRC team also reviewed the following welding-related issues: (1) application of later versions of the ASME Section III Code, (2) alternative acceptance criteria for two welds in the containment sleeves, (3) radiographic film reevaluation of the refueling water storage tanks, (4) review of vendor welds, (5) definition of work activities covered by ASME Section III and ASME Section XI Codes, and (6) welds in mortar-lined pipe of the essential raw cooling water system (ERCWS). Each of these is addressed in the sections that follow.

4.4.1 Application of Later Versions of the ASME Section III Code

TVA's interpretation of Paragraph NA-1140, "Use of Code Editions, Addenda, and Cases," of Section III of the ASME Code was that formal notification to the NRC was not necessary when code cases and later code editions than the code of record were used in the design and construction of the Watts Bar nuclear plant as long as those code cases and code editions were accepted by the NRC through incorporation into 10 CFR 50.55a.

In a letter to the NRC dated December 24, 1987, TVA committed to the identification and justification of areas in which the licensee currently is using potentially less-restrictive provisions of later ASME Section III Code editions. TVA also committed to revise the FSAR to address the use of less-restrictive provisions of later versions of the ASME Section III Code. In addition, documentation will be maintained on site and available for review addressing all adopted provisions of later ASME Section III Code versions.

In letters to the NRC, dated August 21, 1987 and July 6, 1988, TVA submitted the completed evaluations for 21 specific welding process specifications and 5 general construction specifications. The evaluations of these specifications (1) included a discussion of whether specific provisions of later editions and addenda used at Watts Bar are more, less, or as restrictive as the Watts Bar code of record (ASME Section III-1971 through Summer 1973 Addenda) and (2) provided technical justification for the use of less-restrictive provisions. The NRC team reviewed TVA's evaluation of the specific provisions of later code editions and the technical justification for the use of those editions at Watts Bar and found them acceptable. The applicable TVA specification, specific provisions from later code editions, and the materials specifications reviewed and found acceptable by the NRC welding team for Watts Bar are listed below:

(1) Process Specification 1.M.1.2(R5) "General Welding Procedure Specification for ASME and ANSI"
Later code editions used: 1974 Edition, ND-4231.2, "Temporary Attachments and Their Removal;" Summer 1983 Addenda, NB, NC, ND-4453.1, "Defect Removal"

(2) Detail Weld Procedures: (a) GT-SM11-0-2A-R1, (b) GT-SM11-0-3B-R8, (c) GT-SM13-2-R0, (d) GT-SM88-1A-R5, (e) GT-SM88-0-2-R3, (f) GT11-0-1A-R8, (g) GT88-0-1-R6
Later code editions used: 1974 Edition Section IX, QW203, "Limits of Qualified Positions for Procedures"

(3) Process Specification 1.M.3.1(R7), "Specification for Welding Materials Control for Nuclear Power Plants"
Later code editions used: None

(4) Process Specification 2.M.1.1(R4) with Addendum 1 and Appendices A and B, "Specification for Post Weld Heat Treatment for ASME and ANSI"
Later code provisions used: 1974 Edition, NB-4623-PWHT, "Heating and Cooling Rate Requirements"; NB-4624.3, "Local Heating"; Table NB-4622.1-1, "Mandatory Requirements for Post Weld Heat Treatment of Welds"

(5) Process Specification 3.M.1.1(R4) with Addenda 1 and 2 and Appendices A-G, "Liquid Penetrant Examination Color Contrast Method"
Later code editions used: 1974 Edition, NB, NC, ND-5112, "Non-destructive Examination Procedures"; Winter 1979 Addenda, NB, NC, ND-5112, "Nondestructive Examination Procedures"; Winter 1974 Addenda, NB, NC, ND-5112, "Nondestructive Examination Procedures"

(6) Process Specification 3.M.2.1(R3) with Appendices A, B, and C, "Dry Magnetic Particle Examination of Welds and Weld Edge Preparation"
Later code editions used: 1974 Edition, NB, NC, ND-5112, "Non-destructive Examination Procedures"; 1977 Edition, NB, NC, ND-5342, "Acceptance Standards"

(7) Process Specification 3.M.3.1(R3) with Addenda 1, 2, and 3 and with Attachments 1 and 2, "Radiographic Examination of Welded Joints"
Later code editions used: 1974 Edition, paragraph NB, NC, ND-5112, "Nondestructive Examination Procedures"

(8) Process Specification 3.M.5.1(R6) with Addendum 1 and Appendices A-D, "Examination of Weld Ends, Fitup and Visual and Dimensional Examination of Weld Joints"
Later code editions used: Summer 1981 Addenda, Figure NB, NC, ND-4427-1, "Fillet Weld Dimension"

(9) Process Specification 3.M.7.1(R3) Appendices A and E, "Ultrasonic Examination of Weld Joints"
Later code editions used: 1974 Edition, NB, NC, ND-5112, "Nondestructive Examination Procedures"

(10) Process Specification 3.M.9.1(R6) with Addendum 1 and Appendix A, "Specification for Hydrostatic Testing of Piping Systems"
Later code editions used: Summer 1981 Addenda, NX-6211, "Elimination of Air Pockets"; Summer 1980 Addenda, NX-6211, "Elimination of Air Pockets"; Summer 1978 Addenda, NB, NC, ND-6128 "Special Provisions for Spray Systems"; Code Case N-237-2, "Hydrostatic Testing of Internal Piping Section III, Division 1, Class 1, Class 2 and 3"; Code Case N-241, "Hydrostatic Testing of Piping, Section III, Division 1"; Code Case N240, "Hydrostatic Testing

of Open Ended Piping, Section III, Division 1; Code Case N-32-4, "Hydrostatic Testing of Embedded Pipe, Section III, Division 1"; Winter 1978 Addenda, NC-6129, "Provisions for Embedded or Inaccessible Weld Joints in Piping"; Winter 1981 Addenda, NB, NC, ND-4436, "Installation of Attachments to Piping Systems After Testing"

(11) Process Specification 3.M.11.1 (R1) with Appendices A and B, "Process Bubble Leak Test"
Later code editions used: None

(12) Process Specification 3.M.12.1(R3), "Pneumatic Testing of Piping Systems"
Later code editions used: 1980 Edition NC, ND-6322, "Test Pressure Holding Time"

(13) Process Specification 4.M.1.1 (R10), Addenda 1, 2, 3, 4, and 5, "Material Fabrication and Handling Requirements - Austenitic Stainless Steel"
Later code editions used: None

(14) Process Specification 4.M.1.2(R0) with Addendum 1, "Control of Microbiologically Induced Corrosion in Nuclear Power Plants"
Later code editions used: None

(15) Process Specification 4.M.2.1(R7), Addenda 1-7 and Attachments A, B(R3), and C, and Appendix A, "Bending and Alignment of Pipe and Tubing"
Later code editions used: 1974 Edition, NB, NC, ND-4651, "Conditions Requiring Heat Treatment After Bending or Forming"; NB, NC, ND-4652, "Exemption from Heat Treatment After Bending or Forming"

(16) Process Specification 4.M.3.1(R1), Appendix A, "Specification for Arc Strike Removal for ASME and ANSI"
Later code editions used: None

(17) Process Specification 4.M.3.2(R0), "Specification for Arc Strike Removal for ASME and ANSI"
Later code editions used: None

(18) Process Specification 4.M.4.1(R4) with Addenda 1, 2, & 3 and Appendices A and B, "Surface Cleanliness of Austentic Stainless Steel Piping and Components"
Later code editions used: None

(19) Process Specification 4.M.5.1(R4), "Elimination and Repair of Base Material Defects for ASME and ANSI"
Later code editions used: 1974 Edition NC, ND-2578, "Elimination of Surface Defects"; Winter 1976 Addendum, NB-4131, NC, ND-4130, "Rules Covering Elimination and Repair of Defects"

(20) Process Specification 5.M.1.1(R7) with Appendix A, "Thickness Measurement"
Later code editions used: None

(21) Process Specification 5.M.1.2(R1) with Appendix A, "Specification for Wall Thickness Measurement With DM-2 Portable Digital Ultrasonic Thickness Gage"
Later code editions used: None

(22) General Construction Specification G-62, "Material Documentation and Acceptability Requirements for ASME Section III Applications"
Later code editions used: 1974 Edition, NA-3767.4(c), "Certification of Material Supplier"; 1974 Edition through Winter 1981 Addenda, NA-1140, "Use of Code Editions, Addenda, and Cases"; Winter 1981 Addenda, NA-3700/ NCA-3800, "Metallic Material Manufacturer's and Material Suppliers Quality System Program"

ASTM materials used: A36-75, 77a, 81a; A515-74b, 78, 79b, 82; A516-74a, 76, 77, 79b, 82, 84; A283-75, 81; A500-74a, 76, 78, 80, 82a, Grades B and C; A501-74, 76, 80, 81, 83, 84; A572-73, 74b, 77a, 79, 80, 82a, 84, Grades 42 and 50; A572-76, Grade 55; A570-72, 75, Grades C and E; A570-79 and 84a, Grades 36 and 45; ASTM 668-72, 77, 79a, 82, 83, Grades B, C, D, F, K, L, M, and N; A479-75, 76, 77, 77e, 78, 79, 80, 82b, 83; ASTM A358-75, 76, 77, 78 with the additional ASME SA 358, S5 supplementary requirements; A588-71, 74a, 77a, 79a, 80a, 82, 84a, Grades A and B

(23) General Construction Specification G-53, "ASME Section III and non-ASME Section III Bolting Material"
Later code editions used: None

(24) General Construction Specification G-85, "On-line Leak Sealing"
Later code editions used: None

(25) General Construction Specification G-43, "Support and Installation of Category 1 and 1(L) Piping Systems"
Later code editions used: Code Case 1968, "Permanent Attachments to Containment Vessels Class MC"

(26) General Construction Specification G-39, "Cleaning During Fabrication of Fluid-Handling Components"
Later code editions used: None

4.4.2 Alternative Acceptance Criteria for Two Welds in the Containment Sleeves

In January 1987, TVA committed that all Watts Bar Nuclear Plant Unit 1 and Unit 2 piping welds fabricated by TVA that have already been radiographed shall have a second independent evaluation of the radiographs, and that a 100-percent overinspection of these welds using Level III inspectors shall be performed.

In a letter from R. Gridley to the NRC, dated August 1988, TVA advised the NRC staff that the Unit 1 review of radiographs by Level II inspectors and the review of all Unit 1 radiographs by independent Level III inspectors is complete. Of the approximately 12,000 radiographs reviewed, which represent 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.

On the basis of these reviews, TVA initiated corrective actions to bring deficient welds into compliance with ASME Section III Code radiographic requirements. The corrective actions will include: (1) repair of unacceptable indications, (2) radiography of unacceptable radiographic technique, and (3) radiography for

film quality discrepancies. Applicable corrective actions and final documentation of the repairs will be completed before fuel loading.

As a result this review, TVA has also identified two welds in the containment sleeves around the residual heat removal (RHR) sump suction lines with radiographic indications, which are now interpreted to exceed the acceptance criteria of ASME Section III Code. Because these two welds are embedded in reinforced concrete behind the stainless steel containment sump liner wall, they would be extremely difficult to repair. For this reason, TVA has evaluated the acceptability of these two welds using the rules of Section XI of the ASME Code.

TVA has also requested, in accordance with the provisions of 10 CFR 50a(a)(3), that the NRC staff approve the use of ASME Section XI acceptance criteria in lieu of the ASME Section III requirements for these two welds.

Section 3.8.2.2.1 of the Watts Bar FSAR states that, "All containment penetrations, within the jurisdiction of NE-1140, are designed to Section III, Class MC of the 1971 ASME Code. The penetration assemblies for those penetrations which attach to the nozzles out to and including the valve or valves required to isolate the system and provide a pressure boundary for the containment function are designed to Section III, Class 2 of the ASME Code."

The containment sump, where these suction lines are located, is actually formed as part of the bottom assembly of the containment liner. Although this bottom assembly was designed to the requirements of the ASME Section VIII Code, the penetration assemblies were designed, fabricated, and installed in accordance with the ASME Section III, subsection NE Code, "Metal Containments." Had these penetrations been fabricated to ASME Section VIII requirements, the requirements for radiography would have been excluded, and the fabrication as it exists would be acceptable. TVA fabricated these welds to meet the criteria of ASME Section III, Class 2, as required by subsection NE, Class MC components. The visual inspections found the welds acceptable and, in the opinion of the original Level II radiograph film interpreter, the welds were also acceptable.

The two welds are butt welds between a spool piece extension to the 24-inch-diameter, stainless steel, flued-head fitting and a 24-inch-diameter carbon steel pipe with a 0.375-inch wall thickness which forms the containment penetration for the RHR pump suction line. The radiographic interpretation performed by independent Level III inspectors revealed that: (1) weld 1-074B-D045-01A has an area of incomplete fusion less than 1/2-inch long, aligned-rounded indications and incomplete fusion with a combined flaw length of 3/4 inch, and one rounded indication less than 1/8-inch diameter and (2) weld 1-074B-D045-08A has one incomplete fusion indication 3/16 inch long.

TVA evaluated the flaws using the method described in a proposed revision to ASME Section XI, paragraph IWB-3650, which provides flaw evaluation criteria for ferritic steel welds. Because the welds are made with stainless steel filler metal and the flaws appear to be in the weld, the criteria of IWB-3640 would normally be used for evaluation. However, TVA has elected to use the more conservative criteria proposed in IWB-3650 to provide additional confidence that, if the flaws were located in the carbon steel base metal, they would still be suitable for service. The conclusions, based on results of the TVA calculations, was that the flaws will not propagate and cause failure throughout the design

life of the plant. Therefore, TVA has established, through conservative analysis techniques and flaw size criteria, that the integrity of the containment at the RHR system penetration will be maintained throughout the design life of the plant.

The NRC team concluded that TVA has adequately demonstrated through conservative analysis that the integrity of the two welds will be maintained because the flows will not propagate and cause failure during the design life of the plant.

4.4.3 Radiographic Film Reevaluation of the Refueling Water Storage Tanks

In a letter to the NRC dated December 5, 1986, TVA committed to evaluate vendor welds at Watts Bar. A review of radiographs supplied by Pittsburgh-Des Moines Steel Corporation (PDM) identified radiographs that did not meet the ASME Code requirements because of poor film quality or because rejectable indications were present in the weld. The radiographs were from two refueling water storage tanks that were fabricated by PDM in 1978. PDM no longer possesses a valid ASME Section III Certificate of Authorization. Therefore, TVA is considering having PDM make the necessary repairs under TVA's ASME Section XI program using the ASME Section III technical requirements from the original construction code.

This plan would allow PDM as a noncertificate holder to perform work on an ASME Section III stamped component using TVA's Section XI program. TVA's Section XI QA program has controls which are equivalent to the ASME Section III QA program controls. This ensures that the technical requirements of the original construction code, for example, fabrication and installation, examination, testing, authorized nuclear inspector (ANI) inspection, and authorized nuclear in-service inspector (ANII) inspection, will be met. The initial acceptance of repair or rework activities will be PDM's responsibility; PDM is to complete the final radiographic acceptance. The tanks have been documented as complete through generation of N-5 data reports. To utilize PDM's expertise for completion of the necessary repairs, TVA used PDM to make the necessary repairs within the framework of TVA's ASME Section XI program.

Repairs will be documented as committed to in TVA's letter to the NRC dated December 24, 1987. Repair activities will be documented by supplementing the N-5 data reports for each tank.

Two additional tanks, primary makeup water storage tanks, were also fabricated by PDM at Watts Bar in accordance with the requirements of the ASME Section III Code. TVA's review of these radiographs has identified discrepancies similar to those found in the refueling water storage tank radiographs. At the time of this inspection, TVA had not completed its evaluation of these two tanks. However, TVA is considering the same approach as the one discussed for the refueling water storage tanks.

The NRC team found this approach acceptable. The NRC team also reviewed a sample of PDM radiographs during its review of vendor radiographs. The NRC inspection results generally agreed with TVA's inspection results and are documented in Section 4.4.4 below.

4.4.4 Review of Vendor Welds

TVA's Nuclear Quality Assurance (NQA) group reviewed the quality of vendor welds at Watts Bar. To determine which vendor welds should be reinspected, TVA implemented a program plan that provided the steps necessary to evaluate vendor-welded components. The vendors considered for review were extracted from the total population of vendors at Watts Bar. As a first step, TVA's NQA identified the vendors of safety-related equipment that had been previously identified as having weld problems. This was done by performing an evaluation of quality indicators related to vendor weld concerns. This evaluation consisted of reviewing site-generated documents and indicators assembled by the TVA welding project (WP). These indicators also provided the bases for welding evaluations performed under the WP. The following material represents the data base from which the quality indicators were derived:

- Construction Appraisal Team Reports: This review did not reveal any problems with vendors supplying welded components to Watts Bar.
- NRC Inspection Reports: Deficiencies identified through NRC inspection reports concerning vendor welds were tracked by TVA using nonconformance reports.
- Department of Energy/Welding Evaluation Project (DOE/WEP) Concerns: Vendor welding was not included in this group's scope of activities.
- Corrective Action Reports: One audit identified deficiencies in the radiation monitoring system.
- Generic Employee Concerns: Vendors who could be identified from these concerns were evaluated, for example, Yuba, Opeilaka Tank, Westinghouse (SIS accumulators), Bergen-Paterson.
- Nonconformance Reports (NCRs): There were 66 NCRs reviewed for vendor weld issues.

From the total population of quality indicators developed by WP, 98 quality indicators were reviewed to determine if past corrective actions had addressed the generic implications for vendor quality, such as rework, repair, or "use as is." Indicators were also reviewed for duplicate indicators by the same vendor.

This review of quality indicators resulted in the identification of 16 vendors who exhibited potential welding problems. This list of vendors was submitted to TVA's Nuclear Engineering (NE) group to determine if previous efforts had indeed been sufficient to resolve vendor weld quality or to identify the scope of vendor welding still requiring corrective action. NE was also asked to provide specific weld acceptance criteria for the vendors identified as requiring additional inspections. This assessment determined that 5 of 16 vendors identified required reinspection.

NQA then determined the total population for these five vendors and generated sample population sizes in accordance with nuclear construction issues group procedure NCIG-02. The five vendors and the sample inspected by TVA follows:

(1) Dravo: By using a random computer generator number, a sample size of 64 was obtained from a total of 4891 piping subassemblies supplied to Watts

Bar by Dravo. NQA then reexamined 64 welds by a rereview of radiographs or the required nondestructive examinations.

(2) York: By using a random computer-generated number, a sample size of 64 was obtained from a total of 381 floor-mounted instrument panels supplied by York. These panels were visually inspected and the results were given to NE for its evaluation.

(3) Masoneilan: A total of eight 2-inch valves with 6-inch socket-welded nipples involving 16 welds, was visually reinspected for weld size.

(4) Pittsburgh-Des Moines Steel: The radiographs for four tanks fabricated by PDM were reviewed by TVA.

(5) Broadline: A 100-percent rereview of radiographs for both 175-ton polar cranes has been completed.

The NRC team selected a sample of 13 of these 16 vendors for review to determine the acceptability of TVA's review. A discussion of the vendors selected follows:

- The floor-mounted instrument panels supplied by York Electro-Panel were reviewed because welding deficiencies were identified in CAQR WBP-871191. The welds on 64 panels had been reinspected and the results had been subjected to an engineering evaluation. All of the panels were determined to be acceptable for "use as is."

- Welds on Type SB-1 valve operators supplied by Limitorque Corporation were reviewed because a welding deficiency was identified in NCR-6454. TVA determined that there are only three such operators per unit at Watts Bar. Of the three at Unit 1, the originally identified operator has been repaired, a second was inspected and found to be acceptable, and the third will be disassembled and inspected before fuel load.

- Welds on 2-inch flow control valves supplied by Masoneilan were found to be undersized. The welds identified are socket welds connecting the valve bodies to 6-inch-long, 2-inch-diameter, schedule 80 nipples. Of the 16 valves purchased for Watts Bar, 3 exhibited undersized welds, were documented on NCR-3555R, and were subjected to engineering evaluation, which determined that, when Code Case N-316 is applied, these welds are acceptable for "use as is".

- Radiographs supplied by PDM for the refueling water storage tanks were found to be deficient by TVA's reviewers. CAQR WBP-880190 and WBP-880746 have been initiated for the identified deficiencies. The NRC team reviewed a sample of 100 feet from 19 welded seams involving approximately 110 films. The NRC inspection results agreed with TVA's results. The NRC team concludes that TVA's corrective actions, if properly implemented, will correct the problem and the tanks will be in compliance with the ASME Code requirements.

- Radiographs supplied by broadline for both 175-ton polar cranes were found to be deficient by TVA: CAQR WBP-880749 and WBP-880750 were initiated for the identified deficiencies. The NRC team reviewed a sample of 50 feet from 5 welded seams involving approximately 55 films. The NRC team results agreed with the TVA's results. However, the team noted that this problem was

originally reported in 1985 and that to date no dispositions have been made to determine the status of the two polar cranes. The NRC team concluded that TVA has been slow in evaluating this item.

- The NRC team reviewed the available information related to the following nine vendors: (1) Bergen-Paterson, (2) Chicago Bridge and Iron (CBI), (3) Tube Turus, (4) WRO-NTD, (5) Stern Rogers, (6) Yuba, (7) Westinghouse (8) Opeilaka, and (9) Julius Mock. TVA did not reinspect the welds supplied by these nine vendors because TVA determined that previous corrective actions had adequately addressed weld-related deficiencies. The NRC team did not identify any new concerns, therefore, it concluded that TVA has adequately reviewed the weld problems associated with equipment supplied by these vendors.

The NRC team concluded that the diversity and quantity of quality indicators included within TVA's sample selection process appear to be sufficient to identify appropriate areas of concern and provide reliable conclusions. In addition, although, as stated above, all corrective actions are not yet complete, those that have been completed appear adequate to ensure that the components in question will be able to perform their intended function.

4.4.5 Definitions of Work Activities Covered by ASME Section III and Section XI Codes

On June 26, 1987, a meeting was held in Bethesda, Maryland, at the request of TVA between the NRC staff and representatives of TVA for the purpose of discussing TVA's commitment to the requirements of the ASME Section III Code for welding activities at Watts Bar Unit 1.

At the meeting, the NRC staff stated its position regarding Section III welding activities as follows:

- All work should be performed to the code of record for construction, Section III-1971 through Summer 1973.

- TVA shall review any repairs/modifications performed following closure of the N-5 packages. If cases are identified where work was performed in accordance with Section XI or by an organization that was not a stamp holder, TVA shall identify these as exceptions to the code of record. For these exceptions, TVA shall request approval from the NRC staff for the proposed alternatives as prescribed by 10 CFR 50.55a(a)(3).

- The N-5 packages may be completed by supplementing the current N-5 packages. This method is acceptable to NRC for resolving nonconformances; it is consistent with code interpretation III-1-83-175.

On October 13, 1988, TVA submitted to the NRC its review of the repairs/modifications welding activities that were performed following closure of the N-5 packages and provided comparison between the Section III and Section XI programmatic requirements. TVA also identified the work representing exceptions to the code of record and requested the NRC staff's approval of those exceptions in accordance with the provisions of 10 CFR 50.55a(a)3.

TVA has also revised Site Director Procedure AI-9.15 to incorporate the NRC staff positions stated above. Activities within the scope of ASME Section III now must be performed by a stamp holder organization in accordance with TVA's "Quality Assurance Manual for ASME Section III Nuclear Power Plant Components" (Nuclear Construction Manual). Activities outside the scope of ASME Section III but within the scope of ASME Section XI may be performed by a non-stamp-holder organization. These Section XI activities are being performed and documented in accordance with the Nuclear Quality Assurance Manual as implemented by the licensee's Section XI Repair and Replacement Program.

TVA has further categorized and defined which specific activities must be handled in accordance with the requirements of the ASME Section III Code and which activvities may be performed in accordance with the requirements of Section XI of the Code. The NRC team reviewed TVA's definitions and categorization of ASME Section III and Section XI activities and found them acceptable.

TVA's review of programmatic requirements revealed that the ASME Section XI welding activities at Watts Bar Unit 1 provide a level of quality and safety comparable to ASME Section III requirements. The comparison of technical requirements identified some provisions of ASME Section XI in the area of pressure testing that are less restrictive than the pressure testing requirements of ASME Section III. For those items, TVA has committed to perform pressure testing in accordance with the requirements of Section III of the Code. TVA has reviewed all work representing exceptions to the code of record (ASME Section III, 1971 Edition through Summer 1973 Addenda) and has committed to perform additional work and additional testing in compliance with the requirements of Section III of the Code. TVA will also supplement the N-5 data reports in accordance with the requirements of ASME Section III of the Code. The NRC team reviewed the work representing exceptions to the code of record and concluded that after the additional testing is performed and the N-5 data reports are supplemented in accordance with ASME Section III requirements, the proposed alternatives to the code of record would be acceptable. The NRC team concluded that TVA has adequately demonstrated that the proposed alternatives to the code of record will not impair the integrity of the affected plant hardware.

4.4.6 Welds in Mortar-Lined Piping of the Essential Raw Cooling Water System

During its review and comparison of the ASME Section III and Section XI requirements, TVA identified the work representing exceptions to the code of record. See Section 4.4.5 above for additional discussion of this issue. As a part of this review, TVA evaluated the testing requirements for the essential raw cooling water (ERCW) system mortar-lined piping. During this review, TVA identified welds that can not be examined for leakage during hydrotest because they were buried and made unaccessible. TVA has evaluated this issue and submitted its evaluation and proposed alternatives in a letter from R. Gridley to the NRC, dated March 21, 1989. TVA's evaluation identified that four populations of welds exit within the hydrotest boundary of the mortar-lined piping: (1) welds originally made to the requirements of ASME Section III for which no unacceptable indications have subsequently been identified as a result of the licensee's radiographic rereview effort, (2) welds originally made to the requirements of ASME Section III for which unacceptable radiographic indications have subsequently been identified and repaired, (3) welds made or to be made in accordance with ASME Section III as a result of recently identified modifications, and (4) welds originally made to the requirements of ASME Section XI for which no unacceptable indications have subsequently been identified.

In order to address these four populations of welds, TVA will institute the following test program for the welds in the ERCW supply line to the building:

(1) The ERCW mortar-lined piping will be brought to the ASME Section III hydrostatic test pressure and will be maintained using a hydrostatic test pump. After satisfying the ASME Section III hold time requirements, the welds that are exposed inside the building will be examined in accordance with the requirements of ASME Section III. Since all welds that have been repaired or modified under ASME Section III are exposed inside the building, this action will ensure compliance with ASME Section III requirements for these welds.

(2) After the exposed welds have been examined, ASME Section III examination pressure will be maintained until the total time at pressure is 1 hour or more. This will ensure that all welds originally made to the requirements of ASME Section XI which are now buried will have been exposed to ASME Section III examination pressure for 1 hour.

(3) After the system has been returned to service and before fuel load, a visual examination (VI-2) will be performed in accordance with ASME Section XI, IWA-5244, for buried components.

TVA provided the following justification for using such a test program:

(1) Welds in the ERCW supply line to the building originally made in accordance with the requirements of ASME Section XI:

- These welds were originally made in accordance with the requirements of ASME Section XI rather than Section III following the completion of the ASME Section III N-5 data report. No rejectable indications were known to exist at that time nor have any been identified in these welds.

- These welds were originally tested by vacuum box testing, even though this type of testing was not required or recognized by ASME Section III or XI. Vacuum box testing increases the assurance that pinhole or other minor leakage paths do not exist in the welds.

- By the time the described hydrostatic test program is completed, these welds will have been exposed to the ASME Section III required examination pressure for a 1-hour period. This pressure will be held using a hydrostatic test pump to provide makeup water for leakage from the test boundary through the butterfly valves used for boundary isolation. The possibility of large leaks indicative of major leakage paths is small because of the limited capacity of the makeup pump.

- To perform an ASME Section III hydrostatic test on these welds would require one of the following two actions:

  - Excavation of the ERCW piping in approximately 20 separate places, approximately 8 of which are under concrete missile shields which would have to be chipped out and repoured. Additionally, the other protective coating on the piping would have to be removed in order to allow visual examination and, subsequently, replaced.

- Removal of approximately seven line valves per header in order to install blind flanges for a leakproof pressure boundary. In order to remove these valves, the entire train of the ERCW system will have to be removed from service and drained. Since ERCW interfaces with many plant systems, the ripple-down effect will be tremendous.

  Because of the extremely large volume confined by this test boundary, it is conceivable that the ASME Section III acceptance criteria of no pressure loss for a 1-hour period could not be met even with a leaktight system. Any volume changes due to thermal effects would be reflected as a corresponding change in pressure.

(2) Welds originally made to the requirements of ASME Section III where unacceptable indications have subsequently been identified and repaired:

- All rejectable indications will have been repaired to the requirements of ASME Section III.
- All repaired welds will have been hydrostatically tested in accordance with the requirements of ASME Section III.

(3) Welds originally made to the requirements of ASME Section III where no unacceptable indications have been identified will still be in compliance with the requirements of ASME Section III.

(4) Welds made or to be made in accordance with ASME Section III as a result of recently identified modifications will have met the requirements of ASME Section III.

(5) The open-ended welds in the ERCW discharge lines are exempt from hydrostatic testing according to ASME Section III, Code Case N-240.

The NRC team reviewed a sample of the available documentation and interviewed responsible TVA personnel in order to obtain any additional information related to issue. The NRC team review established the following:

(1) In December 1980, TVA became concerned that the carbon steel piping of the ERCW system may experience corrosion to such a degree that pressure drop and flows may fall outside of the design condition after some period of operation. Nonconformance Report (NCR)-WBN-NEB-8017 was written to document this concern.

(2) The proposed corrective actions for addressing NCR WBN-NEB-8017 involved applying a cement mortar lining to the existing carbon steel yard piping, changing selected pipe segments within the building to stainless steel, and requalifying certain components for lower flows.

(3) Engineering Change Notice (ECN)-2756 was prepared in October of 1981 to implement the corrective actions for NCR-WBN-NEB-8017.

(4) The work covering ECN-2756 was performed under Work Plan No. 1649 which defined the scope and extent of the mortar lining of the ERCW system piping.

(5) The detail requirements for the mortar lining of the ERCW system were specified by TVA's Construction Specification N3M-921, "Cement Mortar Lining of the Essential Raw Cooling Water System."

(6) Various laboratory and field tests were required to be performed on several sections of piping and the test procedure requirements were included as an attachment in TVA's memorandum from F. Van Meter to R. O. Barnett, dated July 30, 1981.

(7) The welds associated with the ERCW mortar lining were categorized as follows:

(a) Eight welds are located in the ERCW discharge header and are excluded from hydrostatic testing by ASME Code Case N-240

(b) Twenty-four 1/4-inch fillet welds are located on the interior of the pipe attaching mortar termination rings. Those welds are non-pressure-retaining welds and do not require hydrotesting.

(c) Eight welds are located in the pipe chase and are accessible. For those welds, all ASME Section III hydrotest requirements will be met.

(d) One hundred four welds are buried and cannot be examined for leakage during hydrotest. For those welds, the hydrotest pressure will be maintained for 1 hour to ascertain that the welds do not leak.

(e) Two welds (1-067H-T055-07C2 and 2-067H-T049-05C1) are located in the ERCW supply header and are also inaccessible. Those two welds will be examined as described in d above.

(f) For one weld (1-067H-T049-07C1), documentation has not been located to confirm that this weld was vacuum box tested. This weld will be examined as described in c or d above, as applicable.

The NRC inspection confirmed that the fabrication and mortar lining of welds in the ERCW system was performed in accordance with an acceptable work plan. The welds were also nondestructively examined using magnetic particle examination and vacuum box testing after completion and the results of those examinations indicated an acceptable weld quality. The NRC team concluded that the proposed hydrotest program is acceptable to verify the integrity of the welds in the ERCW system.

4.5 Review of TVA's Corrective Action Program Plan

TVA submitted its CAP plan for welding in a letter from O. D. Kingsley, Jr., to the NRC, dated January 13, 1989. The objective of the CAP plan is to provide assurance that safety related welds at Watts Bar meet (or will meet upon completion of corrective action programs) TVA licensing commitments.

This objective was to be accomplished by conducting a comprehensive review of the TVA welding program to determine the adequacy of TVA welded, safety-related structures, systems, and components currently in place at Watts Bar. In addition, TVA was to determine any remedial actions that may be needed, and to

take those actions deemed necessary to strengthen the TVA welding program and to ensure that future welding activities at WBN are in accordance with licensing requirements.

Evaluation of the welding program at Watts Bar is being approached in three phases as discussed below. The TVA WP maintains responsibility for all work performed during these phases:

- Phase I was a programmatic assessment of the Watts Bar welding program.
- Phase II was an in-depth review of the implementation of the welding program at Watts Bar.
- Phase III is an evaluation, integration, and upgrading of welding-related programs and procedures to ensure that TVA's future welding activities, including those at Watts Bar, are conducted in accordance with licensing requirements.

The NRC team reviewed the information contained in the CAP plan, including Revision 1, and found it acceptable. The team also reviewed the information provided in TVA's Phase I and Phase II weld reports. See Sections 4.2 and 4.3 of this report for details. The NRC team concluded that the Watts Bar CAP plan contained the essential elements to achieve its goals and objective. Further, the results of the NRC review of TVA's Phase I and Phase II reports indicated that the CAP plan is being properly implemented and thus, upon completion of the ongoing corrective action programs, the quality of the welds at Watts Bar would be adequate. However, the NRC team noted that the work under the scope of TVA's Phase III effort which provides for recurrence control has not yet been completed.

5 PERSONS CONTACTED AND DOCUMENTS REVIEWED

5.1 Persons Contacted

Licensee Employees:

J. Adair, Lead Civil Engineer
G. Ashley, Compliance Licensing Support Supervisor
S. Boney, Welding Engineer
G. Boyd, TVA Engineering
J. Cruise, TVA Construction
H. Culver, TVA Construction
T. Dean, Compliance Engineer
A. Elliott, TVA Construction
P. Etzler, Materials Engineer
D. Garland, TVA Maintenance
J. Gibbs, Coordinating Project Engineer
K. Hasting, Welding Engineer
R. Heatherly, Assistant Site Representative
A. Halton, Jr., Engineering Aide
R. James, Staff Specialist
H. Johnson, Site Quality Manager
M. Jones, Technical Support Superintendent
B. Lamb, TVA Engineering

F. Laurent, Project Manager
J. Lewis, Materials Engineer
D. McCloud, Acting Site Licensing Manager
P. Mandava, Project Engineer
G. Mauldin, Engineering Assurance Site Representative
D. Mickler, Welding Engineer
C. Nelson, Acting Maintenance Support Supervisor
C. Obst, Assistant Project Engineer, Bechtel
J. Oravitz, Materials Inspector
L. Pauley, TVA Construction
R. Pedde, Site Director
L. Peterson, Quality Control Manager
M. Presley, Materials Unit
J. Roach, Senior Materials Manager
J. Rogers, Jr., Nuclear Quality Assurance
J. Rose, Weld Surveillance Unit
D. Tumble, Welding Engineer
N. Wamack, Nuclear Quality Assurance
L. Willis, Principal Engineer
P. Wilson, Special Project Manager
T. Woods, Lead Material Engineer

NRC Resident Inspectors:

M. Branch, Sr. Resident Inspector, Operation
G. Humphrey, Resident Inspector
G. Walton, Sr. Resident Inspector, Construction

5.2 Documents Reviewed

(1) Watts Bar Corrective Action Program Plan for Welding

(2) Watts Bar Phase I Weld Report

(3) Watts Bar Phase II Weld Report

(4) General Construction Specifications

- G-62, Material Documentation Requirements, ASME Section III Applications
- 3.M.2.1 (R3) with Appendices A, B, and C — Dry Magnetic Particle Examination of Welds and Weld Edge Preparations
- 3.M.3.1 (R3) with Addenda 1, 2, and 3 and with Attachments 1 and 2 — Radiographic Examination of Welded Joints
- 3.M.5.1 (R6) with Addendum 1, and with Appendices A, B, C, and D — Examination of Weld Ends, Fit-Up, and Dimensional Examination of Weld Joints
- 3.M.7.1 (R3) with Appendices A to E — Ultrasonic Examination of Weld Joints

- 3.M.9.1 (R6) with Appendix A and Addendum 1 — Hydrostatic Testing of Piping Systems
- 3.M.11.1 (R1) with Appendices A and B — Pressure Bubble Leak Testing
- 3.M.12.1 (R3) — Pneumatic Testing of Piping Systems
- 4.M.1.1 (R10) with Addenda 1, 2, 3, 4, and 5 — Material Fabrication and Handling Requirements - Austenitic Stainless Steel
- 4.M.1.2 (R0) with Addendum 1 — Control of Microbiologically Induced Corrosion in Nuclear Power Plants
- 4.M.2.1 (R7) with Addenda 1-7 and Attachments A, B (R3), and C with Appendix A — Bending and Alignment of Pipe and Tubing
- G-53, ASME Section III and Non-ASME Section III (including AISC, ANSI/ASME B31.1, and ANSI B31.5) Bolting Material
- G-85, On-Line Leak Sealing
- G-43, Support and Installation of Category I and I(L) Piping Systems
- G-39, Cleaning During Fabrication of Fluid Handling Components

(5) Detail Weld Procedures

- GT-SM11-0-2A, Rev. 1
- GT-SM11-0-3B, Rev. 8
- GT-SM13-0-2, Rev. 0
- GT-SM88-0-1A, Rev. 5
- GT-SM88-0-2, Rev. 3
- GT11-0-1A, Rev. 8
- GT88-0-1, Rev. 6
- SM11-B-3, R7
- SM88-B-1, R2
- GT-SM13-0-1, R0
- GT-SM18-0-1, R4
- GT11-0-1A, R7
- GT18-0-1, R5
- GT88-0-1A, R1

(6) Process Specifications

- 1.M.1.2 — General Welding Procedure Specification for ASME and ANSI
- 1.M.3.1 (R7) — Specification for Welding Materials Control for Nuclear Power Plants
- 2.M.1.1 (R4) with Addendum 1 and Appendices A & B — Specification for Post Weld Heat Treatment for ASME and ANSI
- 3.M.1.1 (R4) with Addenda 1 and 2 and Appendices A to G — Liquid Penetrant Examination Color Contrast Method
- 4.M.3.1 (R1) with Appendix A — Specification for Arc Strike Removal for ASME and ANSI

• 4.M.3.2 (R0)	Specification for Location of Weld Metal Interfaces
• 4.M.4.1 (R4) with Addenda 1, 2, and 3 and Appendices A & B	Surface Cleanliness of Austenitic Stainless Steel Piping and Components
• 4.M.5.1 (R4)	Elimination and Repair of Basic Material Defects for ASME and ANSI
• 5.M.1.1 (R7) with Appendix A	Thickness Measurement
• 5.M.1.2 (R1) with Appendix A	Specification for Wall Thickness Measurement with the DM-2 Portable Digital Ultrasonic Thickness Gauge

(7) Other Documents

- OEDC Quality Assurance Manual for ASME Section III Nuclear Power Plant Components (NCM) Section 4.1.
- Quality Control Instruction WBNP-QC1 1.30, Control of Work on Transferred Systems, Equipment and Architectural Features
- Construction Specification N3M-921, Cement Morter Lining of the Essential Raw Cooling Water System
- Quality Control Procedure WBNP-QCP 4.55, Vacuum Box Testing
- Workplan Plan 1649
- Engineering Change Notice (ECN) 2756
- Blodgett, "Design of Welded Structures"
- AISC, Steel Construction Manual," 7th ed.
- TVA - Design Criteria WB-DC-40-31.1, Revision 4, "Seismically Qualifying Conduit Support," Table 4.4-1
- "Watts Bar Weld Evaluation Program", Revision 1, RIMS Accession No. B26 88 1201-003 - Weld Inspection Tracking System for Weld Deviation Reports and Independent Deviation Reports.
- TVA - Pipe Support Design Manual, Section 7.15, "Design of Welded Connections," Revision 2
- TVA - "Design Criteria for Pipe Whip Restraints, Jet Deflection and Sleeves," WB-DC-40-31.53

APPENDIX

TABLES

TABLE 1

Structural Welds

Parameter	Group/Area																																					10/20/87 Totals
	Pipe Supports/Restraints										I&C Supt.			Mec. Equip.	Electrical Support								HVAC Supports					Civil Structures											
	F	012	015	024	032	227	261	229	230	G	H	265	252	I	J	202	225	250	251	254	266	K	L	022	026	219	D	260	E	263	003	004	014	021	214	222	36
No. of Components Inspected	65	2	13	0	1	35	10	18	92	66	57	30	25	64	64	65	62	18	30	64	30	64	64	1	2	61	67	30	64	31	2	2	4	1	61	50	1375
No. of Deviant Components	14	1	4	0	1	13	4	7	18	18	24	9	21	11	33	20	26	29	11	32	20	17	27	1	0	20	18	15	37	19	1	0	2	1	16	36	526
No. of Welds Inspected	316	2	188	0	8	159	57	70	430	272	268	156	324	227	504	364	207	154	198	385	171	978	1105	58	72	833	923	1066	2105	1100	2	4	35	279	177	1741	14938
No. of Deviant Welds	23	1	12	0	2	20	5	13	47	31	45	26	155	29	167	58	40	42	30	141	97	58	97	58	0	60	98	137	549	181	1	0	5	119	30	467	2844
No. of Welds Sig. Deviant	22	0	12	0	2	19	5	6	42	29	42	26	153	24	132	45	33	42	30	140	97	41	73	0	0	54	95	137	463	151	0	0	5	95	30	426	2471
Significant	ATTRIBUTES																																					
Cracks	0	0	0	0	0	0	N	0	0	0	0	N	0	0	0	0	1	N	N	0	N	0	0	0	0	0	0	N	10	0	0	0	0	0	0	1	12
Weld Size Incomplete	7	N	7	0	2	7	3	N	26	1	9	9	71	6	38	8	0	N	12	96	97	20	38	N	0	29	22	87	237	59	0	N	3	41	11	188	1134
Fusion	0	0	0	0	0	1	N	0	1	0	0	N	0	1	0	10	6	N	N	1	N	0	4	0	0	0	2	N	8	5	0	0	2	33	2	7	83
Undercut	1	0	0	0	0	5	N	0	1	7	3	N	5	2	20	7	8	N	N	4	N	1	6	0	0	4	5	N	22	10	0	0	1	9	0	7	128
Weld Length and Location	3	0	3	0	0	1	0	0	4	16	14	12	75	3	21	7	23	1	18	17	3	10	16	0	0	6	42	16	119	53	0	0	0	5	0	57	545
Missing Welds* or Configuration	5	0	0	0	0	4	0	0	10	1	0	4	8	0	8	0	1	0	0	19	0	2	6	0	0	7	18	11	52	28	0	0	0	11	0	20	215
Wrong Weld Type	0	0	4	0	0	2	1	0	0	1	0	1	0	0	1	0	0	1	0	12	14	4	8	0	0	10	6	14	23	5	0	0	0	1	1	16	125
Profile**	7	1	0	0	0	0	1	6	4	5	22	2	7	13	60	23	10	40	0	7	0	4	0	58	0	0	1	18	43	21	0	0	0	9	16	158	536
Insignificant																																						
Overlap	0	0	0	0	0	1	N	4	1	0	2	N	9	1	5	2	3	N	N	8	N	9	9	0	0	2	0	N	11	19	0	0	1	9	5	13	114
Crater	0	0	0	0	0	0	N	1	0	0	0	N	17	0	1	0	0	N	0	0	N	1	0	0	0	0	2	N	3	2	0	0	0	0	0	4	31
Arc Strikes	0	0	0	0	0	0	N	0	0	0	0	N	0	0	0	0	0	N	N	0	N	0	0	0	0	0	0	N	0	0	0	0	0	0	0	0	0
Slag/Spatter	1	1	0	0	0	1	N	2	3	2	4	N	0	5	58	23	11	N	0	4	N	16	30	55	0	8	3	N	109	33	0	0	1	60	0	70	500
Porosity	0	0	0	0	0	0	N	0	0	0	0	N	1	0	0	0	0	N	0	0	N	0	0	0	0	0	0	N	0	0	1	0	0	1	0	0	3
Total Attributes	24	2	14	0	2	22	5	13	50	33	54	28	193	31	212	80	63	42	30	168	114	67	117	113	0	66	101	146	637	235	1	0	8	179	35	541	3426

TABLE 2

Piping Welds - (ASME, ANSI B31.1 and B31.5)

10/20/87

Parameter	Group A	B	C	2	6	8	9	13	18	20	29	34	208	210	212	220	228	252A	257	262	264	Totals 22
No. of Welds Inspected	64	74	107	2	2	6	2	26	1	1	8	2	56	60	52	5	10	29	64	86	64	721
No. of Deviant Welds	19	34	60	2	0	4	2	12	0	1	2	0	5	4	15	2	8	0	10	1	30	211
No. of Welds Sig. Deviant	5	10	12	2	0	0	1	2	0	0	2	0	1	3	15	2	0	0	2	0	25	82
									ATTRIBUTES													
Significant																						
Cracks	1	0	0	0	0	0	N	0	0	0	N	0	0	0	N	0	0	0	0	0	0	1
Lack of Fusion	0	0	0	0	0	N	N	0	0	0	N	0	0	0	N	0	0	0	1	N	0	1
Incomplete Penetration	0	1	N	N	N	N	N	N	N	N	N	N	N	0	N	2	N	0	N	N	1	4
Min Sect Thickness	3	0	3	0	N	0	1	2	0	0	N	0	1	1	15	0	0	0	0	N	0	26
[illegible]	0	0	0	N	0	N	N	0	0	N	N	0	0	0	N	N	0	0	0	N	0	0
Max Offset	N	0	0	N	N	N	N	N	N	N	N	N	N	0	N	N	N	0	0	N	0	0
Max Reinforcement	0	6	7	2	0	N	N	0	0	0	N	0	0	0	N	0	0	0	0	N	24	39
Fillet/Socket Weld size	1	2	3	N	N	N	N	N	N	N	2	N	0	1	N	N	N	0	1	N	1	11
Undercut	1	4	0	0	0	N	N	0	0	0	N	0	0	1	N	0	0	0	0	N	0	6
Insignificant																						
Overlap	0	1	0	N	0	N	N	0	0	N	N	0	N	0	N	N	N	0	0	0	0	1
Surface Slag	0	3	0	0	0	N	N	0	0	0	N	0	0	0	N	0	1	0	0	N	0	4
Porosity	3	12	7	0	0	N	N	0	0	0	N	0	4	1	N	0	7	0	8	N	13	55
Weld Spatter	1	12	14	1	0	N	N	6	0	0	N	0	0	0	N	0	0	0	0	N	0	34
Arc Strikes	18	27	49	2	0	4	1	10	0	1	N	0	0	0	N	0	0	0	0	N	0	112
Coarse Ripples	0	0	N	N	0	N	N	0	0	N	N	0	N	0	N	N	N	0	0	0	0	0
[illegible]ves	0	0	N	N	0	N	N	0	0	N	N	0	N	0	N	N	N	0	0	0	0	0
Abrupt Ridges	0	0	N	N	0	N	N	0	0	N	N	0	N	0	N	N	N	0	0	1	0	1
Valleys	0	0	N	N	0	N	N	0	0	N	N	0	N	0	N	N	N	0	0	0	1	1
Totals	28	68	83	5	0	4	2	18	0	1	2	0	5	4	15	2	8	0	10	1	40	296

Table 3 Pipe supports/restraints reviewed

TVA item no.	Drawing no.	Type and no. of welds 1/	Type of support 2/	Material shape used 3/	Note
F-0006	63-ISIS-R69	D-1, F-27	S, W	TS, AI, BP, SS	6
F-0007	47A058-77(R3)	F-3	T	U, P	1, 2
F-0008	47A053-10A(R9)	F-2, B-1	T, Ce	U, TS	
F-0020	70-1CC-R446	A-2, B-12, F-11 (G-4)	S, W	TS, BP, IB, E	
F-0038	47A059(R3)/A-(R1)	F-3	T, W	IB, P	
F-0045	1-70-218 (R0)	F-4	T, W	TS, E	
F-0057	47A053-(10),(52),(52A)	F-3, A-2	T, Ce	IB, BP	3
F-0063	47A058-49 (R0)	F-2	T, W	U, P	3
F-0075	47A058-36 (RS)	F-1	T, W	AI, BP	
012-0001	48W1707-14	D-1	S	IB	3
015-0001	03B-1AFW-R101	A-2, F-6	T, Fl	BP, IB	3
015-0012	03B-1AFW-R125	A-3, B-10, F-10	T, W	BP, TS, IB	3, 4, 7
032-0001	70-1CC-R487	F-8 (G-8)	T, W	P, TS	3, 4
227-0005	48W1703-03	A-2, F-2	S	IB, AI	3, 4
227-0009	48W1703	F-6	S	P, IB	3
227-0020	48W1703-06	A-1, F-2	S	IB, AI	
227-0043	48W1703-13	F-4	S	IB, AI, P	
229-0010	48N417	E-1	S	TS	
229-0031	48N417	E-1	S	TS	
229-0048	48N416, 17	D-1, E-1 (G-2)	S	P, IB	3
230-0003	1-30A-292 (R903)	F-12 (G-12)	T, W	P, TS	
230-0004	1-70-356	F-4	T, W	P, TS	
230-0008	47W555-210 (R6)	F-6 (G-2)	T, Ce	P, TS, SS	
230-0015	47W406-335	F-4	T, Fl	AI, SS	
230-0041	47A053-3A	F-4	T, Fl	P, TS	
230-0052	47A053-3A	F-4	T, Fl	P, TS	
230-0067	1-70-M6	F-8 (G-4)	T, Fl	AI, TS	3
230-0087	1-62A-552	F-8	T, W	P, TS	
230-0123	62-1CVC-R-39	F-4	T, W	P, TS	4
261-0004	48W1703-01, 03, 05	E-1, F-8 (G-3)	S	P, IB	3
261-0012	48W1703-06	A-1, F-2	S	AI, IB	5

Legend:

1/ A-skewed connection, B-flare, D-full penetration, E-single V butt, F-fillet, (G-portion of total number of welds having limited access)

2/ T-typical support, S-special support, W-wall, Ce-ceiling, Fl-floor

3/ TS-tube steel, BP-base plate, E-embedment, AI-angle iron, SS-strap steel, P-plate, IB-I-beam, U-unistrut

Table 3 (Continued)

Notes:

1. No original inspection documentation available; this was noted by EG&G during its review.

2. The original item configuration drawing was incorrect; this was noted by EG&G during its review and has now been corrected by TVA.

3. Anomalies were noted by EG&G for this item which had not been documented by TVA; subsequent TVA analysis indicated the item is suitable for service.

4. Material fitup was verified on this item where accessible.

5. The original TVA examination documentation was not included in the package; this was an expansion item and did not require the historical documentation.

6. QIR-CEBWBP89341 issued.

7. QIR-CEBWBP89342 issued.

Table 4 Instrument installations and supports reviewed

TVA item no.	Drawing no.	Type and no. of weld 1/	Type of support 2/	Material shape used 3/	Note
G-9	47W600-202	F-1, B-1	T, Ce	E, P, C	1
G-27	47W600-31	F-3, B-4	T, W	E, P, TS, U	1
G-39	47W848-10	F-1, B-2	T, W	P, TS, U	1
G-54	47W600-36	F-3, B-4	T, W	P, TS, U	1
G-65	47W848-10	B-2	S, Fl	TS, U	1
H-2	47W600-118	F-3, B-4	T, W	P, TS, U	1
H-7	47W600-62	B-6	T, W	TS, U	1
H-17	47W610-43-7	F-1	T, W	E, AI	1
H-37	47W600-70	F-3, B-4	T, W	P, TS, U	1
H-53	47W600-113	F-1, B-2	T, W	E, TS, U	1
H-58	47W600-38	F-1, B-2	T, W	E, TS, U	1
265-3	47W600-206	F-5, B-8	S, Fl	P, TS, U	1
265-15	47W625-4	F-1, B-2	T, Ce	IB, TS, U	1
265-35	47W625-2	F-2	T, W	E, U	1

Legend:

1/ B-flare, F-fillet

2/ T-typical support, S-special support, W-wall, Ce-ceiling, Fl-floor

3/ TS-tube steel, E-embedment, AI-angle iron, P-plate, IB-I-beam, U-unistrut, C-channel

Note:

1. Agrees with the EG&G inspection results.

Table 5 Electrical installations and supports reviewed

A item no.	Drawing no.	Type and no. of weld 1/	Type of support 2/	Material shape used 3/	Note
I-11	45N862-9	B-2	T, Co	AI, U	1
I-56	47A056-12	F-2	T, Ce	C, E	1
I-50	45N862-9	F-3	T, W	P, TS	1
J-15	48W970-2	F-2	T, W	E, AI	1
J-22	47A056-52	F-5	T	TS, U	1
J-48	47A056-53	F-3, B-4	T, W	E, TS, U	1
J-61	45W826-37	F-1, B-2	T, Ce	E, TS, U	1
J-91	48W970-1	F-1, B-4	T, W	E, TS, AI	1
202-10	47A056-12	F-4, B-2	S, Ce	E, C, AI, U	1
202-26	47A056-4	F-1, B-2	T, Ce	E, TS, U	1
202-44	47A056-79	F-1, B-4	T, Fl	P, TS, U	1
202-56	47A056-107	B-4	T, W	TS, U	1
225-4	47A056-60	F-2	T, W	E, U	1
225-5	47A056-55A	F-1, B-4	T, W	E, TS, U	1
225-47	47A056-60	F-2	T, W	E, U	1
225-77	47A056-60	B-2	T, W	IB, U	1
250-50	48N1338-2	B-2	T, Tr	TS, AI	1
250-67	48W1296-2	B-2	T, Tr	TS, AI	1
250-93	48W1298-1	B-2	T, Tr	TS, AI	1
250-99	48W1296-1	B-2	T, Tr	TS, AI	1
251-1	47A056-64	F-4, B-4	S, Ce	E, C, AI, U	1
251-27	47A056-55A	F-1, B-4	T, Ce	E, TS, U	1
254-84	48W1295-1	F-8	T, Tr	TS	1
254-101	48W1296-1	F-10	S, Tr	TS	1
254-122	48W1298-1	F-2	T, Tr	TS	1
266-4	48W1296-2	F-4	T, Tr	TS	1
366-14	48W1296-1	A-4	S, Tr	TS	1
266-32	48W1296-1	A-4	S, Tr	TS	1

Legend:

1/ A-skewed connection, B-flare, F-fillet,

2/ T-typical support, S-special support, W-wall, Ce-ceiling, Fl-floor, Tr-cable tray, Co-conduit

3/ TS-tube steel, E-embedment, AI-angle iron, P-plate, IB-I-beam, U-unistrut, C-channel

Note:

1. Agrees with the EG&G inspection results.

Table 6 HVAC supports reviewed

VA item no.	Drawing no.	Type and no. of weld 1/	Type of support 2/	Material shape used 3/	Note
K-0007	47A055-129R1	A-2, F-28	S, W	TS, BP, E	
K-0010	47A055-48R1	A-4, F-13, B-12	T, Ce	TS, BP, AI	
K-0019	47A055-10R0	F-18	T, W	BP, TE	
K-0021	47A055-35R0	A-2, F-16	T, C	IB, BP, AI	
K-0033	47A055-154R0	F-12	T, W, Ce	TE, BP	
K-0043	47A055-20R4	A-2, F-21	T, Ce	AI, BP, P, Ch	
K-0049	47A915-3-59R0	A-2, F-6	T, W	TS, BP, E	
K-0054	47A055-16R3	F-6	T, Ce	AI, BP, P	
K-0069	47A055-81R3	F-32	T, W	TS, BP, AI, P	
K-0070	47A055-144R1	F-10	T, Ce	BP, TE	1
L-0010	47A916-3-6R2	F-4	S, AT	IB, SS	
L-0011	47A055-25R0	F-2	T, W, Ce	TE, BP, P	2
L-0015	47A055-17R0	A-2, F-8	T, Ce	BP, AI	2
L-0035	47A055-6R1	F-16	T, Ce	BP, TE	
L-0038	47A055-81R2	F-43	S, W	TS, BP, AI, P	
L-0044	47A055-187R0	A-2, F-48	T, Fl	BP, IB	
L-0054	47A055-18R0	A-4, F-22	T, Ce	BP, AI	
L-0062	47A055-20R4	A-1, F-21	T, Ce	BP, AI, P	
L-0066	47A055-18R0	A-4, F-22	T, Ce	BP, AI	
L-0075	47A055-24R0	F-20	T, Ce	BP, TE, TS	
2-0001	48N1248-2R5	PP	S, Ce		
026-0002	47A055-208R1	B-32, F-4	S, W	TS	
219-0036	47A055-18R0	F-22, A-4	T, Ce	BP, AI	
219-0052	47A055-16R3	F-7	S, Ce	TS, BP, AI, P	
219-0059	47A055-64R2	A-2, F-6	S, W, Ce	TS, BP, IB	
219-0074	47W930-2HR0				3
219-0010	47A055-20R4	F-13, A-1	T, Ce	BP, AI, IB, P	4
219-0016	47A055-16R3	F-6	T, Ce	BP, AI, P	
219-0018	47A055-40R0	F-9, A-2	T, W	BP, IB	

Legend:

1/ A-skewed connection, B-flare, F-fillet, PP-partial penetration

2/ T-typical support, S-special support, W-wall, Ce-ceiling, Fl-floor

3/ TS-tube steel, BP-base plate, E-embedment, AI-angle iron, SS-strap steel, P-plate, IB-I-beam, TE-tee section, Ch-channel

Table 6 (Continued)

Notes:

1. Undercut of 3/32 inch is unacceptable per NCIG.01, Paragraph 4.1.7.1 and was not recorded by EG&G inspection. CAQR-WBP890255 issued.

2. Washer plate welds were not inspected by EG&G. Inspections are required by general notes on drawings. CAQR-WBP890255 issued.

3. Support was insulated completely and was not inspected.

4. The weld length was 3/4-inch short and was not recorded by EG&G. The top horizontal angle was cut off at brace without extension. CAQR-WBP890255 issued.

Table 7 Mechanical equipment supports reviewed

TVA item no.	Drawing no.	Type and no. of weld 1/	Type of support 2/	Material shape used 3/	Note
252-0580	47W470-11R5 47W470-12R6	F-74	S, W	BP, P	
252-0596	Bay 4, Sec. H-H 1195E53	F-8	T, C	E, AI	
252-0615	47W470-11R5 47W470-12R6	F-5	T, W	BP, P	
252-0051	47W470-11R4 47W470-12R5				1
252-0071	Bay 23, Sec. H-H 1195E53	F-8	T, C	E, AI	
252-0088	Bay 22, Sec. H-H	F-8	T, C	E, AI	
252-0185	Bay 15, Sec. H-H	F-8	T, C	E, AI	2
252-0347	Bay 20, Sec. H-H	F-8	T, C	E, AI	3
252-0487	686J492				4
252-0574	Bay 16, Sec. H-H	F-8	T, C	E, AI	

Legend:

1/ F-fillet

2/ T-typical support, S-special support, W-wall, Ce-ceiling

3/ BP-base plate, E-embedment, AI-angle iron, P-plate

Notes:

1. Support was inaccessible and not inspected.

2. (a) weld 1 - no weld 1 inch long
   (b) weld 3 - no weld 3/4 inch long
   (c) weld 4 - no weld 1 inch long
   (d) weld 5 - no weld 1 inch long
   (e) weld 8 - no weld 1 inch long
   (f) All above welds required full length and all deficiencies were not recorded by EG&G. CAQR-WBP890255 issued.

3. Weld 8 has no weld 1 inch long and was not recorded by EG&G. CAQR-WBP890255 issued.

4. This support was nondestructively examined using liquid penetrant examination.

Table 8 Structural steel partition wall reviewed

TVA item no.	System drawing	Type and no. of weld 1/	Type of support 2/	Material shape used 3/	Note
021-0001	48N1322-1	F-108	T	IB	1
021-0001	48N1322-1	F-109	T	IB	1
021-0001	48N1322-1	F-110	T	IB	1
021-0001	48N1322-1	F-111	T	IB	1
021-0001	48N1322-1	F-112	T	IB	1
021-0001	48N1322-1	F-113	T	IB	1
021-0001	48N1322-1	F-114	T	IB	1
021-0001	48N1322-1	F-115	T	IB	1
021-0001	48N1322-1	F-127	T	IB	1
021-0001	48N1322-1	F-128	T	IB	1
021-0001	48N1322-1	F-129	T	IB	1
021-0001	48N1322-1	F-130	T	IB	1
021-0001	48N1322-1	F-169	T	IB	1
021-0001	48N1322-1	F-170	T	IB	
021-0001	48N1322-1	F-171	T	IB	1

Legend:

1/ F-fillet

2/ T-typical support

3/ IB-I-beam

Note:

1. Agrees with the results reported in the EG&G report.

Table 9 Pipe welds reviewed

Sample ID	Weld ID	Weld type 1/	Size	Class 2/	Mat'l 3/	Note
A-0069	1-067B-T511-03	Pipe to FTG	1.25x0.140	C	SS	1, 2
B-0041	1-07B-D170-04G	Pipe to Plt	4x0.237	C	CS	1, 3
C-3002	0-67L-147C-06/7-2	Pipe to FTG	0.5x0.109	G	SS	1, 2
02-002	WDR-002-0002-R1	Pipe to FTG	4x0.237	G	CS	1, 2
06-015	1-074A-D046-10	FTG to FTG	14x0.438	B	SS	1, 2
08-003	0-078A-D192-06	Pipe to FTG	8x0.322	B	SS	1, 2
09-002	1-072A-D058.10	Pipe to VLV	10x0.365	C	SS	1, 2
13-023	1-076C-1T614D02	Pipe to FTG	8x0.322	C	SS	1, 2
18-001	1-063B-D087-14	Pipe to FTG	8x0.906	B	SS	1, 2
20-001	1-003B-T080-06	Pipe to Pipe	2.5x0.203	C	CS	1, 3
29-008	1-067C-T406-02	Pipe to VLV	0.5x0.109	B/C	SS	1, 2
34-002	1-068A-D232-06	FTG to VLV	3x0.438	A	SS	1, 3
208-046	1-276-L-042A-D002	Pipe to FTG	0.5x0.147	H	SS	1, 2
210-049	1-015A-T016-24	Pipe to FTG	4x0.337	B	CS	1, 2
212-012	1-015A-T015-13-C1	Pipe to FTG	2x0.343	B	CS	1, 2
220-020	1-067B-T322-01	Pipe to Pipe	0.5x0.147	C	SS	1, 2
228-008	0-26-837-2	Pipe to FLG	6x0.280	G	CS	1, 2
252-263	1-085-CRDM-HAP-G15	Pipe to Pipe	6x0.075	A	SS	1, 2
257-050	6-PW/E33-P7-1/A1	Plug to PLT	0.24 plate	AISC	SS	1, 2
262-0118	1-62A-T143-22	Plug to FTG	0.75x0.113	B	SS	1, 4
264-1002	1-293-T001-10A	Pipe to FLG	12x0.687	MC	SS	1, 2

Legend:

1/ FTG - fitting, Plt - plant, VLV - valve, FLG - flange
2/ TVA Class C - , G - , B - , A - , H - , MC - and AISC
3/ SS - stainless steel, CS - carbon steel

Notes:

1. No discrepancies from EG&G results noted during field walkdown inspections.
2. No discrepancies noted during document review.
3. Use of ASTM materials in lieu of ASME materials noted during document review.
4. Discrepancy noted during document review. CAQR WBP8905257 initiated.

Table 10 Radiographs reviewed

Unit I

*1072A-D059-01CA	*1015A-T002-12
*1015A-T002-12	*1062A-D030-10
*1063-D087-14R1	*1063A-D07604-5
11072B-D070-10	1063B-D090-13 C1R2
1072B-D070-11	1063B-D089-07A
1047A-D051-0	1063A-D074-08A
1003B-D0002-20	1063A-D074-08B
1001A-D006-03-R2	1015A-T016-24
1068A-D234-04	1003B-D001-05 COR2
1063B-D081-14R1	1015A-T002-12 COR4
1068A-D032-06	1001A-D006-06 COR6
1068A-D232-01D	1072A-D252-07 C1R1
1074A-D046-04	1074A-D049-10 R8
1074B-D053-03	1032E-T003-05 COR4
1001A-D006-05R2	1063B-D087-04 COR2
1068B-W002-0	1072A-D056-13 COR7
1063B-D088-11A	1015A-T003-75C2
1063B-T059-02AC1R1	1015A-T001-71R1
1CLAW-T012-01	1074A-D047-06R4
1068D-W002-02	1072A-D060-7AR4
1068D-W0010-2	1072B-D069-09R4
1068D-W005-02	1001A-D009-05AR5
1062B-D034-14	1072B-D071-08COR3
1003C-D013-08	1062A-D027-10C1R1
1062A-D081-03A	1074A-D048-06
1062A-D028-06	1001A-D009-16
1072A-D064-01	1063A-D073-11A
1072A-D065-04	107B-D164-08B
1001A-D003-09R2	107B-D161-01
1003B-D372-03	105A-T016-24
1003B-D002-07	105A-T015-20C1
1063A-D080-14	1003B-D372-07A
1063A-D022-16	1003B-D372-07B
1063A-D023-05	1003B-D372-37
1003B-D001-08A R6	1074A-D051-06

Unit II

2003D-D111-07	2062A-D115-05R2
2003D-D111-04	2003D-D111-03

*Welds investigated by TVA for misidentification.

Table 11 Engineering calculations reviewed

TVA welding deviation report no.	Independent deviation report no.	Description	Note
WDR-00K-0007	DR-999-0025	INSTRUMENT SUPPORT	1
WDR-00J-0081	DR-999-0017	CABLE TRAY	1
WDR-00D-0039	DR-999-0137	STRUCTURAL STEEL	1
WDR-229-0023	DR-999-0137	STRUCTURAL STEEL	1
WDR-00J-0060	DR-999-0169	CONDUIT SUPPORT	1
NONE	DR-999-0008	PIPE ANCHOR	1
WDR-00H-0008	N/A	INSTRUMENT SUPPORT	1
WDR-00H-0021	N/A	INSTRUMENT SUPPORT	1
WDR-001-0033	N/A	INSTRUMENT SUPPORT	1
WDR-225-0071	N/A	CONDUIT SUPPORT	1
WDR-202-0068	N/A	CONDUIT SUPPORT	1
WDR-202-0010	N/A	PIPE SUPPORT	1
WDR-012-0002	N/A	STRUCTURAL STEEL	1
WDR-00F-0057	N/A	PIPE SUPPORT	1
WDR-00F-0070	N/A	PIPE SUPPORT	1
WDR-00H-0021	N/A	INSTRUMENT SUPPORT	1
WDR-00H-0033	N/A	INSTRUMENT SUPPORT	1
WDR-00H-0008	N/A	INSTRUMENT SUPPORT	1
WDR-00D-0153	N/A	MISCELLANEOUS STEEL	1
WDR-00D-0131	N/A	CABLE TRAY SUPPORT	1
WDR-00E-0085	N/A	STRUCTURAL STEEL	1
WDR-00E-1496	N/A	MISCELLANEOUS STEEL	2
WDR-00E-1171	N/A	STRUCTURAL STEEL	1
WDR-00F-0011	N/A	PIPE SUPPORT	1
WDR-00F-0064	N/A	PIPE SUPPORT	1
WDR-00F-0033	N/A	PIPE SUPPORT	1
WDR-00J-0072	N/A	CONDUIT SUPPORT	1
WDR-00J-0131	N/A	CABLE TRAY SUPPORT	1
WDR-00L-0030	N/A	HVAC SUPPORT	1
WDR-00L-0087	N/A	HVAC SUPPORT	1
WDR-00L-0040	N/A	HVAC SUPPORT	1
WDR-026-0002	NR	HVAC SUPPORT	1
WDR-219-0010	NR	HVAC SUPPORT	1
WDR-219-0016	NR	HVAC SUPPORT	1
WDR-219-0018	NR	HVAC SUPPORT	1
WDR-219-0036	NR	HVAC SUPPORT	1
WDR-00K-0007	NR	HVAC SUPPORT	1
WDR-00K-0021	NR	HVAC SUPPORT	1
WDR-00K-0043	NR	HVAC SUPPORT	1
WDR-00L-0011	NR	HVAC SUPPORT	1
WDR-00L-0015	NR	HVAC SUPPORT	1
WDR-00L-0062	NR	HVAC SUPPORT	1
WDR-015-0001	NR	PIPE SUPPORT	1
WDR-227-0009	NR	PIPE SUPPORT	3
WDR-229-0048	NR	PIPE SUPPORT	1

Table 11 (Continued)

WDR-230-0067	NR	PIPE SUPPORT	1
WDR-00D-0066	NR	STRUCTURAL STEEL	1
WDR-00E-0068	NR	STRUCTURAL STEEL	1
WDR-00E-0194	NR	STRUCTURAL STEEL	1
WDR-222-0002	NR	STRUCTURAL STEEL	1
WDR-222-0030	NR	STRUCTURAL STEEL	1

Notes:

1. Acceptable
2. Administrative error-Comments from EG&G review were not transferred to TVA's final record calculation. QIR-MTBWBP89011 issued.
3. Welds Nos. 16 and 17, and 14 and 19 are overstressed. The NRC team used TVA's Pipe Support Design Manual, Section 7.15 "Design of Welded Connections" to calculate weld stresses. QIR-MTBWBP89010 issued.

N/A - Not applicable
NR - Not reviewed for independent deviation report no.