UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W.
ATLANTA, GEORGIA 30323

Report Nos.: 50-327/92-09 and 50-328/92-09

Licensee: Tennessee Valley Authority
3B Lookout Place
1101 Market Street
Chattanooga, TN 37402-2301

Docket Nos.: 50-327 and 50-328 License Nos.: DPR-77 and DPR-79

Facility Name: Sequoyah 1 and 2

Inspection Conducted: March 23 - April 10, 1992

Inspector: _____ 4/22/92
for J. L. Coley, Jr. Date Signed

Approved by: _____ 4/22/92
J. J. Blake, Chief Date Signed
Materials and Processes Section
Engineering Branch
Division of Reactor Safety

SUMMARY

Scope:

This routine unannounced inspection was conducted in the areas of inservice inspection (ISI)-observation of work activities, review of procedures, and review of data and evaluations associated with Units 1 and 2 feedwater nozzle to transition piece cracks, review of radiographs for plant modifications, followup on TVA corrective action quality report (CAQR) SQQ-900054, Bulletin 87-02 followup, and independent inspection of erosion/corrosion weld repairs.

Results:

During this inspection the licensee identified significant programmatic weaknesses in the ISI program which combined with minimal ultrasonic examiner evaluation techniques resulted in the failure to detect thermal fatigue cracking prior to

a through wall crack failure on the Unit 1 loop 3 steam generator feedwater nozzle to transition weld. Radiographic examination of all eight feedwater nozzle to transition piece welds apparent on Units 1 and 2 revealed that this was not an isolated instance since significant cracking was discovered on four additional nozzle to transition welds (apparent Violation 50-327,328/92-09-01, Failure of Ultrasonic Examiners to Discern Crack from Weld Root Geometry, paragraph 2). The inspectors' audit of other special processes also revealed other similar weaknesses: Apparent (Violation 50-327,328/92-09-02, Inadequate Procedural Requirements for Repair and Replacement Acuivities, paragraph 4, Apparent Violation 50-327,328/92-09-04, Failure to Follow Procedure for Placement of Lead Letter "F" on Radiographic Film, paragraph 3, Inspector Followup Item 50-327,328/92-09-03, Improper Surface Preparation for Ultrasonic Examination of Erosion/ Corrosion Weld Overlay Repairs, paragraph 5). While areas of significant concern were identified during inspection, the inspector also noted areas of excellence such as management and investigation teams' aggressive efforts to discern facts, in order to effectively manage corrective action. Personnel contacted during this audit were professional and knowledgeable in their areas of responsibility.

Within the areas examined, no deviations were observed.

REPORT DETAILS

1. Persons Contacted

Licensee Employees

*R. Beecken, Plant Manager
*G. Belew, ISI Program Manager
*J. Bynum, Vice President of Nuclear Operations
*M. Cooper, Site Licensing Manager
*M. Cutlip, Site Coordinator
*D. Goetcheus, Outage Support Manager
*S. Johnson, Site QA Technical Support Manager
*N. Kazanas, Vice President of Completion and Assurance
*P. Lydon, Operation Manager
*J. Maciejewski, Quality Assurance Manager
*M. Meade, Compliance Licensing Engineer
*W. Pruett, Jr. Monitoring Manager
*R. Rausch, Modification Manager
*R. Rogers, Technical Support Manager
*J. Smith, Regulatory Licensing Manager
*R. Thompson, Compliance Licensing Manager
*P. Trudel, Engineering Manager
*M. Turnbow, Manager, Inservice Operations
*W. Vanosdale, Maintenance Programs Manager
*J. Ward, Engineering and Modifications Manager
*N. Welch, Operations Units 1 and 2 Manager
*J. Wilson, Site Vice President

Other licensee employees contacted during this inspection included craftsmen, engineers, technicians and administrative personnel.

Other Organizations

V. Morton, Southwest Research Institute, Level III Examiner
S. Walker, Electric Power Research Institute, Consultant

NRC Resident Inspectors

*B. Holland, Senior Resident Inspector
*R. McWhorter, Resident Inspector
S. Shaffer, Resident Inspector

2. Cracks on Steam Generator Feedwater Nozzle to Transition Ring Welds Units 1 & 2 (73050, 73753, 73755 & 92700)

On March 19, 1992, with Unit 1 in Mode 3, hot standby, Unit 1 control room received a high level alarm for the reactor building pocket sump and dispatched operations personnel to containment to investigate the problem. At approximately the same time, TVA personnel performing inspections in the lower ice condenser bays observed water streaming from the area of the No. 3 steam generator (S/G) inside the polar crane wall. They immediately notified operations. A subsequent inspection revealed a through wall crack in the feedwater nozzle weld to transition piece of the No. 3 S/G. Radiographic examination (RT) of all eight nozzles for Units 1 and 2 showed that five out of the eight nozzles had significant cracking.

On March 23, 1992, the inspector arrived at the Sequoyah site and after being briefed by the licensee as to their plans to cut out and perform metallurgical examinations on the Unit 3 nozzle to transition weld and transition to elbow weld, the inspector decided to perform an ultrasonic examination on the feedwater nozzle to transition weld on S/G 4. This was the other Unit 1 weld on which RT had identified significant cracking. Accompanied by two TVA Level III ultrasonic examiners, the inspector conducted half node shear wave examinations of the weld in question and discovered significant reflectors at the toe of the weld on both sides of the pipe. A Licensee Level III then sized the indications with a refracted longitudinal wave transducer and found the indications to be approximately 50% through wall. In addition to the major crack reflectors, other lower amplitude reflectors were noted in the base material adjacent to the weld on the transition ring. No attempt was made to layout or size these indications since they were of minor consequence. Based on the response of the crack reflectors, it was difficult at this point to believe that examiners had inspected this weld 5 months earlier and had dispositioned the reflectors as root geometry without conducting supplemental examinations utilizing refracted longitudinal wave transducers to determine whether the reflectors had any through wall dimensions.

On March 24, the inspector visited TVA's metallurgical laboratory to review the specimens of the failed weld. The results were consistent with the findings reported by licensees in response to examinations performed in accordance with NRC Bulletin 79-13. The cause of the cracking was attributed to stresses induced by thermal stratification of the water in the pipe when using the relatively cold auxiliary feedwater in Mode 3 operation. In addition to significant cracking noted at the base metal to weld metal interface for the nozzle to transition weld, the transition ring had multiple

circumferential cracking of less magnitude on the base material between the two welds of the transition ring. Discussions with the chief metallurgist also established that the cracks appeared to be slow in propagating through the metal. This information also appears to establish that failure to detect these indications as cracks was an inspection failure and not a plant operation problem since all of the nozzles on Units 1 & 2 had been examined several times during the time period that it would have taken for the cracks to grow.

The inspector then concentrated his investigation on the examination procedures and the previous inspection data. This review revealed that although an enhanced procedure was used that would have allowed recommendations provided by the Electric Power Research Institute (EPRI) for the detection of intergranular stress corrosion cracking (IGSCC) and considered by industry to be the state of the art in ultrasonic crack detection and evaluation, the procedure also had enough latitude to allow the very minimal of ASME Code requirements to be used.

Review of the previous examinations reports revealed that the examinations were conducted using the very minimal of Code requirements during the NRC Bulletin 79-13 examinations and every outage since. In each of these examinations root geometry was reported which established a mind-set in the evaluation process since the examiners were given the examination data from the previous examinations prior to performing an examination. In addition, this allowed 1979 ultrasonic techniques to be transferred to the next inspection rather than using the present enhanced techniques for crack detection and evaluation.

As a result of the above reviews, and discussions with cognizant engineers and plant management, the inspector concluded that the following programmatic weaknesses resulted in the failure to identify geometric indications as cracks.

* There was no integrated evaluation of all factors which impacted selection of the most effective examination technique for the nozzle welds. No single organization (contact) was cognizant of all the following factors: (1) the nozzle welds on both units had exceeded the fatigue factor of 1 in 1988, (2) the actual batch feed operation of the auxiliary feedwater and its impact on cyclic thermal fatigue, (3) the techniques other PWR utilities were using to inspect and identify cracking, (4) the condition of the surface areas being inspected, and (5) stress points of the materials in the nozzle, weld, and transition piece.

* The weld re-enforcement on the feedwater nozzle to transition and transition to elbow had not been ground such that it was conductive in each case to the preferred UT method, i.e., a half node examination technique. This was the situation primarily on Unit 2, however the less effective one and one half node technique from one side of the weld was used on both units. The fundamental problem with this technique is that with the changes in thickness and geometry of the nozzle, the transition piece, and the elbow all within 4 inches, there were no parallel surfaces on the inside diameter of the pipe for the sound to bounce from; therefore, there was decreased accuracy when plotting the indications for evaluation. In addition, when the one and one half node examination technique is used, and the scanning is from the nozzle and the elbow surfaces, the crack reflectors come up as a single reflector with the root geometry signal, since nearly all of the significant cracking occurred on the transition side of the weld at the base metal/weld metal interface. TVA's IGSCC procedure N-UT-18, Paragraph 8.1.1 states that, " Examination surfaces shall be free of irregularities, loose foreign material, or coatings which interfere with sound transmission to the point of test degradation. The weld crown should be ground flush where practical to provide adequate search unit coupling for examinations performed from the weld surface". Since the two welds on the transition are only 1/2 inch apart on the outer pipe surface this criteria would be applicable and more practical than the technique used.

* The examination procedure (N-UT-18, paragraph 4.2.6) requires that, a TVA level III has to give approval in order for an examiner to use supplemental angles or different wave mode transducers to evaluate an indication. Simply changing to a sizing transducer (refracted longitudinal wave) would have confirmed the indications as cracks.

* There was complacency of Level II and III examiners. Mindset of the level II examiners was caused by giving out the results of the previous examination and allowing the examiner to see that root geometry had been documented for the indications in question. The inspector found only one case where the Level III went out to evaluate the root geometry call (Unit 1 Locp 2 which was not cracked). The examiner then used the results he obtained to conclude that the root geometry calls on the two locps that were cracked were also satisfactory.

The licensee was notified that the failure of examiners to identify the cracks in the feedwater nozzles welds was caused by programmatic weaknesses that did not provide direction for aggressive resolution of the indications and that this failure was an apparent violation of 10 CFR 50 Appendix B, Criteria

IX, which states in part, that measures shall be established to assure that special processes including nondestructive testing are controlled and accomplished in accordance with applicable codes, criteria, and other special requirements. In addition 10 CFR 50 Appendix B, Criteria II, states in part, that the quality assurance program shall take into account the need for special controls, processes, test equipment, and skills to attain the required quality. The apparent violation was reported as 50-327,328/92-09-01, Failure of Ultrasonic Examiners to Discern Crack from Weld Root Geometry"
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On April 3, 1992 TVA management and NRC met in the Atlanta Regional Office to discuss TVA's feedwater nozzle findings, replacement plans, welding processes, and the basis for the selection of TVA's expanded inspection population. Eighteen welds had been selected to best represent unique or abnormal conditions such as, other welds which could experience thermal stratification, previously examined welds with recordable root geometry, and welds identified as problems at other plants and had been reported in NRC Bulletins or Information Notices. NRC concluded that TVA's evaluation of the failure was satisfactory and that the sample of welds to be re-examined should challenge the evaluation process to determine its integrity.

On April 6, 1992, the inspector arrived back at the Sequoyah plant to review the examination data packages on the eighteen welds. During the inspectors' review two welds stood out as possible problems (Weld No. CVCS 213 and CVCS 246). Both welds had been selected because they addressed cracking due to thermal stratification problems reported in NRC Bulletin 88-08. The inspector noted that the previous examinations of these welds had reported root geometry at the 50% DAC level and 55% DAC level and that the indications plotted at the near side of the root. However, the present examinations did not record any root geometry. Discussions with TVA's Level III examiner revealed that the examiner had been questioned concerning the difference and had stated that he had seen root geometry but it was not 50% DAC so by procedure he was not required to record the reflectors. The inspectors' review of other welds examined by the same examiner revealed he had in fact recorded reflectors less than 50% DAC and evaluated them as root geometry. The inspector was also concerned that the examiner was making the evaluation that a reflector was root geometry and not crack when the ability of examiners to make this distinction was questionable as a result of the miscalls on the feedwater nozzles. The inspector suggested that the TVA Level III and himself go in containment and investigate the differences. The inspector was told that the scaffolding had been torn down and that re-inspection was impossible at this time. This reply was unsatisfactory and senior management was

notified of the inspectors' concern with the examination differences. Senior management immediately took the necessary actions to have the scaffolding rebuilt and the weld examined. The re-examination established that the low level indication was probably low level root geometry. However, now the licensee has a base line on the indications so that if they were miscalled the growth differences could be monitored.

Within the areas examined, no violation or deviation was identified with the exception of the apparent violation identified above.

3. Review of Radiographic Film for Plant Modification Welds Units 1 and 2 (57090)

The inspector reviewed radiographs of plant modification welds on the Residual Heat Removal system. These Class 2 welds were performed in accordance with TVA's Radiographic Procedure NRT-1, Rev. 15. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, 1986 edition, was applicable. Radiographs for the following welds were examined to determine whether they were prepared, evaluated, and maintained in accordance with the approved procedure.

Unit 1 Weld ID No.	Unit 2 Weld ID No.
1 RHR-38A	2 RHR 221
1 RHR-38C	2 RHR 228
1 RHR-38D	2 RHR 223
1 RHR-38E	2 RHR 227
1 RHR-56E	2 RHR 229
1 RHR-56A	* 2 RHR 233
1 RHR-56D	* 2 RHR 224
1 RHR-79B	* 2 RHR 232
1 RHR-79C	* 2 RHR 231
1 RHR-79E	* 2 RHR 226

The inspectors' review of the above radiographs revealed that the radiographic quality and examiners' evaluation of the Unit 1 radiographs was very good. However, the inspectors' review of the Unit 2 radiographs revealed the radiographer had placed the lead letter "F" (which indicates a film side penetrameter) on the penetrameter. Radiographs for the five welds indicated with an asterisk above, had the "F" placed so close to the 4T hole that it tended to mask the inspectors' resolution of the hole. In addition the "F" had been glued in a position where the lower horizonal leg of the "F" was pointing at the hole. This gave the perception that the radiographer

was trying to enhance this lightly defined hole by establishing a pointer to aid in its detection when reviewed for acceptance by the film interpreter. After very careful review the inspector concluded that the essential 4T hole could be seen on at least one film in each package therefore not necessitating the need to re-radiograph any of the welds. TVA's radiographic procedure NRT-1, paragraph 7.8.1 required that a lead letter "F" be adjacent to the penetrameter. This is not in accordance with the 1986 ASME Code which states that, "A lead letter "F" at least as high as the penetrameter identification numbers shall be placed adjacent to or on the penetrameter, but shall not mask the essential hole". The radiographic supervisor in reviewing this problem found the penetrameter with the "F" glued in the area of interest and discarded it. In addition, the supervisor issued a temporary change to NRT-1 to have it revised to meet the 1986 Code requirements for penetrameter placement. The inspector notified the licensee that failure of the examiner to follow the requirements of the procedure that he was using an apparent violation of 10 CFR 50, Appendix B, Criteria V, and was reported as Apparent Violation No. 50-327,328/92-09-04, " Failure to Follow Procedure for Placement of Lead Letter "F" on Radiographic Film.

Within the areas examined, no violation or deviation was observed with the exception of the Apparent Violation noted in the above paragraph.

4. Followup on Licensee Identified Corrective Action Quality Report (CAQR) SQQ-900054 Units 1 & 2 (92701)

The inspector reviewed CAQR SQQ-900054 which dealt with weld maps not being updated in a timely manner. The root cause analysis revealed conflicting and inadequate procedure requirements specifying similar or identical responsibilities for two different organizations, DNE (Division of Nuclear Engineering) and DCRM (Document Control and Records Management) in maintaining weld records. For corrective action the licensee assigned the work to a central organization, Site Welding Section, and revised the procedures. The CAQR was not schedule to be closed until July 1992, because the weld maps were still in the process of being updated. The inspector was concerned however, over how this programmatic problem may impact on implementation of the ISI program.

The inspector went to the supervisor of the site welding section to discuss what progress was being made to correct the weld maps. These discussions revealed that the welding section had identified all of drawing errors since operation of the plant started. This was a population of 780 modifications requiring changes. Further discussions also revealed that although the population was not expected to get any larger due to the

controls in effect, the welding section was only 30% complete in updating the weld maps.

The inspector decided to reconcile the completed drawings with the weld maps in the ISI program. Of the updated weld maps only two were applicable to the ISI program. A comparison of the two completed weld maps with the ISI program weld maps revealed that one ISI weld map was missing two welds. The weld map that was in error was on the Unit 1 safety injection system and had been worked on Maintenance Work Order C003957. In earlier discussion with the ISI supervisor, the inspector was warned that if problems were to be found they would be in Maintenance Work Requests (MWR) or Maintenance Work Orders (MWO) and not on Modification Work Plans because ISI was on the front end and back end review cycle for Modification Work Plan packages and this was not the case for MWR's or MWO's.

The inspector expressed his concern to senior management in a preliminary exit on April 2, 1992. When the inspector returned to the site on April 6, 1992 he found that management had established a site investigation of the concern that had worked all weekend going through MWR's, MWO's, and the 780 weld map discrepancies to determine the root cause and its effects on the ISI work activities. The cause was established as a weakness in the Repair and Replacement Procedure SSP-6.9, in that it did not fully delineate responsibilities as to who was to provide information needed for ISI to update their program.

However, an informal arrangement had been initiated between the site QC group and the site ISI group. Site QC had been requested to send a copy of all welding and NDE inspection reports to the ISI group. The investigation team discovered as a result of their audit, that this system apparently had worked well because no ISI weld map was found discrepant with the exception of the one found by the inspector.

The licensee established immediate corrective action of requiring mechanical maintenance planning provide a sign-off in MWR's for the site ISI group to perform an initial review and a final review. This will be required until SSP-6.9 can be revised. The revision of SSP-6.9 will provide for the site ISI group to perform a final review of ASME Section XI work documents so they will receive the latest information on what repairs and replacements have been performed. In addition QMP-110.1 will be revised to require the site QC group forward a copy of all welding and NDE inspection reports to the site ISI group and the investigation audit will expand its scope to verify all system work that may effect ISI including construction.

The licensee was informed that inadequate procedural requirements to assign responsibilities for repair and replacement work activities was an Apparent Violation of 10 CFR 50 Appendix B, Criteria V and was reported as Apparent Violation 50-327,328/92-09-02," Inadequate Procedural Requirements for Repair and Replacement Activities".

Within the areas examined, no violation or deviation was identified except for the item discussed in the above paragraph.

5. Independent Inspection of Erosion/Corrosion Weld Overlay Repairs Unit 2

At the request of the Senior Resident Inspector for the Sequoyah Plant, the inspector visually examined weld overlay repairs that had been applied on discharge feedwater piping on the A & B Main Feedwater Pumps. These repairs had been applied during a preceding outage to reinforce areas of the piping which had seen degradation due to erosion and corrosion during a preceding outage. The inspector's review revealed that the patches had not been ground after welding in order that a new base line UT could be taken. The patches were relatively large and obscured numerous grid intersection points for UT in areas where erosion/corrosion was apparently causing significant damage.

The inspector requested a meeting to discuss the repairs, with the cognizant engineer, to determine whether the piping had just been repaired to last one outage and if the piping was to be replaced this outage. The inspector was informed that this was not the case and that the licensee had made a mistake when the repair surface was not prepared for reinspection and base line inspections performed. The licensee took steps (issuing work authorizations) to have the weld surface prepared. However, this item will be tracked with an Inspector Followup Item 50-327,328/92-09-03 "Improper Surface Preparation for Ultrasonic Examination of Erosion /Corrosion Weld Overlay Repairs", in order that subsequent NRC inspection will be performed on this issue to determine the extent of the problem.

Within the areas examined, no violation or deviation was identified.

6. Followup on NRC Bulletin 87-02 (TI-2500/27)

(Closed) BU-87-02 "Fastener Testing to Determine Conformance with Applicable Material Specifications". The inspectors' review of CAQR Nos. SQP-871115, SQP-880082, and discussions with cognizant QC and procurement personnel revealed that TVA has taken the necessary corrective measures to insure that nonconforming fasteners are identified and cannot be utilized in plant systems. In addition, fasteners identified as

nonconforming in response to this bulletin have been accounted for and have been discarded.

Within the areas examined, no violation or deviation was identified.

7. Exit Interview

The inspection scope and results were summarized on April 10, 1992, with those persons indicated in paragraph 1. The inspector described the areas inspected and discussed in detail the inspection results listed below. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee.

(Open) Apparent Violation 50-327,328/92-09-01, Failure of Ultrasonic Examiners to Discern Crack from Root Geometry, paragraph 2

(Open) Apparent Violation 50-327,328/92-09-02, Inadequate Procedural Requirements for Repair and Replacement Activities, paragraph 4

(Open) Apparent Violation 50-327,328/92-09-04, Failure to Follow Procedure for Placement of Lead Letter "F" on Radiographic Film, paragraph 3

(Open) Inspector Followup Item 50-327,328/92-09-03, Improper Surface Preparation for Ultrasonic Examination of Erosion/Corrosion Weld Overlay Repairs, paragraph 5