December 10, 2002

10 CFR 50.4

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

Gentlemen:

In the Matter of ) Docket Nos. 50-327
Tennessee Valley Authority )

**SEQUOYAH NUCLEAR PLANT (SQN) - STEAM GENERATOR REPLACEMENT PROJECT - TOPICAL REPORT NO. 24370-TR-C-001, "ALTERNATE REBAR SPLICE - BAR-LOCK MECHANICAL SPLICES," RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION**

Reference: NRC letter to TVA dated December 4, 2002, "Sequoyah Nuclear Plant, Units 1 and 2 - Request for Additional Information Concerning Unit 1 Steam Generator Replacement Topical Reports and Associated Technical Specification Amendment (TAC NOS. MB5370, MB5371, MB5387)"

The purpose of this submittal is to provide additional information in response to the staff's referenced letter. Based on discussion with the staff during a meeting between TVA, Bechtel, and NRC on October 24, 2002, TVA understands that the additional information will allow the staff to complete their review of the subject topical report. The approval of the topical report supports SQN's Unit 1 steam generator replacement outage that is scheduled to begin in March 2003.

Enclosed is the additional information that supports Topical Report No. 24370-TR-C-001. The additional information requested for Topical Report Nos. 24370-TR-C-002 and 24370-TR-C-003 will be submitted by separate letters.

This letter is being sent in accordance with NRC RIS 2001-05. There are no commitments contained in this letter.

If you have any questions about this change, please telephone me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

Sincerely,

*Original signed by*

Pedro Salas
Licensing and Industry Affairs Manager

Enclosure

**ENCLOSURE**

**TENNESSEE VALLEY AUTHORITY**
**SEQUOYAH NUCLEAR PLANT (SQN)**
**UNIT 1**
**DOCKET NO. 327**

**ADDITIONAL INFORMATION FOR TOPICAL REPORT NO. 24370-TR-C-001, "ALTERNATE REBAR SPLICE - BAR-LOCK MECHANICAL SPLICE"**

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NRC Question No. 1

Provide a copy of the Bechtel/Idaho National Engineering and Environmental Laboratory (INEEL) test report for the Bar-Lock Mechanical Splices. The report should include information on who performed the splice tests, their qualifications, and how the tests were performed.

TVA Response

A copy of the Bar-Lock test report prepared by INEEL is provided as Attachment 1. This report summarizes the test plan, results of rebar material testing, couplers tested, and results of the tensile and cyclic testing of the couplers.

Based on the INEEL test plan, Bechtel developed a specification that defined the testing requirements. These test requirements were incorporated into the work plan and inspection record (WPIR) for controlling the Satec test machine setup, preparation of the Bar-Lock test specimens, and performance of the testing.

Bechtel personnel performed testing of the Bar-Lock couplers at the SQN site using a Satec 600VTL test machine. These personnel were trained by Instron/Satec in the use of the test machine.

Calibration of the test machine was performed prior to its use and after completion of the Bar-Lock testing. Bechtel Quality Control (QC) personnel reviewed the calibration documentation for acceptability.

Rebar and coupler test specimens were prepared in accordance with Bar-Lock guidelines and the requirements of the Bechtel specification by personnel trained either by a Bar-Lock representative or by Bechtel personnel certified by Bar-Lock. TVA and Bechtel Quality Assurance (QA) QC personnel periodically monitored the preparation and testing of the test specimens.

An INEEL representative was present during the initial setup of the Satec machine, programming of the test software, and witnessed the coupler testing.

NRC Question No. 2

Describe TVA's involvement, if any, in the Bechtel/INEEL test program.

TVA Response

TVA was heavily involved in the Bechtel/INEEL test program

- TVA reviewed and approved the following specifications, procedures and test plans associated with the procurement, testing, and installation of the Bar-Lock couplers.

  - 24370-C-311, “Technical Specification for Purchase of Bar-Lock Couplers”

  - 24370-C-312, “Technical Specification for Installation of Bar-Lock Rebar Splices”

  - 24370-C-602, “Technical Specification for Qualification Testing of Bar-Lock Mechanical Rebar Splices”

  - Construction Procedure CP-C-13, “Bar-Lock Rebar Splices”

  - “Test Program Plan for Qualification of Bar-Lock Coupler System for Use in Nuclear Safety-Related Applications,” prepared by Idaho National Engineering and Environmental Laboratory
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- TVA Civil Engineers attended the vendor training session conducted at SQN on August 21, 2001.

- TVA Engineering and QA personnel witnessed the preparation of several test assemblies on August 21-22, 2001.

- TVA Engineering and QA personnel also witnessed testing of several specimens throughout the duration of the test program from October 11, 2001 to October 19, 2001.

- TVA reviewed and approved the Mechanical Testing Program and Performance Analysis, prepared by INEEL.

NRC Question No. 3

Clarify whether TVA has evaluated and determined that the Quality Assurance (QA) programs of the reinforcing bar supplier (Consolidated Power Supply), the reinforcing bar fabricator (Birmingham Steel Corporation), the manufacturer of the Bar-Lock coupler (including lockshear bolt, and serrated rail), and the contractors who performed the tests (Bechtel/INEEL), meet the Title 10, *Code of Federal Regulations* (10 CFR) Part 50, Appendix B requirements? Provide the results of TVA's evaluations of theses QA programs.

TVA Response

TVA has reviewed and approved Bechtel's Sequoyah Steam Generator Replacement (SGR) Project Nuclear Quality Assurance Manual. The policies in this manual correspond to each of the 18 criteria of 10 CFR 50, Appendix B and meet the requirements of ANSI N45.2 and N45.2 series standards and QA-related NRC regulatory guides.

Bechtel, in its role as a contractor to TVA, imposed the applicable 10 CFR 50 Appendix B requirements along with the technical and document submittal requirements on the subcontractors involved in the material supply, fabrication, and testing of the rebar and Bar-Lock couplers. Bechtel reviewed the quality programs for the rebar supplier (Consolidated Power Supply), the manufacturer of the Bar-Lock coupler (Valley Machining), and INEEL, and where appropriate, required changes to these programs to bring them into compliance with the requirements of 10 CFR 50, Appendix B. Bechtel specifications required their subcontractors to extend the specification requirements to their contractors.

NRC Question No. 4

On page 10 the report states that Bechtel witnessed and verified implementation of Bar-Lock's manufacturing quality control processes and procedures for compliance with the applicable provisions of American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME) N45.2. Identify and submit for staff's review the applicable provisions of ANSI/ASME N45.2 that were considered. Discuss how the Bar-Lock's manufacturing quality control processes and procedures comply with the 10 CFR Part 50, Appendix B requirements.

TVA Response

The provisions/requirements of ANSI/ASME N45.2-77 that were considered applicable to the manufacturer of the Bar-Lock couplers (Valley Machining) are:

2. Quality Assurance Program
3. Organization
5. Procurement Document Control
6. Instructions, Procedures, and Drawings
7. Document Control
8. Control of Purchased Material, Equipment, and Services
9. Identification and Control of Materials, Parts, and Components
10. Control of Special Processes
11. Inspection
12. Test Control
13. Control of Measuring and Test Equipment
14. Handling, Storage, and Shipping
15. Inspection, Test, and Operating Status
16. Nonconforming Items
17. Corrective Action
18. Quality Assurance Records
19. Audits

Review of the Bar-Lock manufacturing processes along with the provisions of the specification for the purchase of the Bar-Lock couplers as described below assures that the corresponding requirements of 10 CFR 50, Appendix B are also met.

A specification, written for the purchase of the Bar-Lock couplers, identified the technical requirements the Bar-Lock manufacturer was required to meet. These requirements covered applicable codes and standards, quality, shipping, handling, storage, critical processes and parameters, and documentation. Bechtel QA personnel performed surveillances during the manufacturing of the Bar-Lock couplers to verify that the manufacturing process was performed in a manner that was consistent with the specification. The critical processes identified in the specification and the results of the Bechtel QA surveillances are summarized below:

a. Application of material traceability identification on bolt, tube, and saddle material

The material traceability of each heat lot of material for the tubing, hex stock for bolting, and square stock for the saddles was verified by review of the mill tag affixed to each bundle of material and visual verification of the physical markings on the stock. The material test reports were reviewed to verify material composition and strength were as required by the specification.

b. Tapping of bolt hole

The drilling and tapping of bolt holes was performed in one machine operation. The hole locations were checked initially by the machinist and by the inspector when the machine was set up. Set up pieces were identified as such and were not included as part of the production run. When the production run began, the finished holes were checked on a random basis by the machinist and by the roving inspector using a calibrated go/no go plug gauge. In addition, 100 percent of the threaded holes were verified as completely drilled and tapped since each coupler is fully assembled with the bolts installed at final assembly and inspection. This process was monitored by Bechtel QA and Bar-Lock personnel throughout the drilling and tapping process. No deviations from the design drawing were noted.

c. Induction heating of bolt tip

The induction heating process was monitored on a periodic basis by Bechtel QA personnel and by the operator and QC inspector. Six samples were taken by the operator and verified by the QC inspector at approximately four-hour intervals during the induction hardening process. The tested bolts all fell within the specified hardness range.

d. Fusion of saddles to tube

The weld of the saddle to the tube is critical only to the extent that it needs to hold the saddles in position until the bar is inserted and the bolts set. There is no credit taken for the weld in the ability of the coupler to withstand the required tensile and cyclic performance criteria. The weld is tested on a random basis by the QC inspector by dropping the coupler from a

height of 5 feet onto concrete. If there is no weld failure, the weld is considered acceptable. There were no failures noted during these tests.

e. Bolt shear testing

Each shear value bolt test was witnessed by Bechtel QA personnel. Unique heat lot numbers were assigned to each batch of bolts sent to the heat treatment facility. After heat treating and quench, the bolts were tested at the heat treatment facility for hardness to determine the amount of time and temperature required in the draw furnace. After final treatment the bolts were again checked for hardness to verify conformance with the required hardness. The shear testing for each lot resulted in satisfactory results. Each bolt was stamped during the machining operation with the letters VMC to help assure that no other bolts would be co-mingled with those produced for Sequoyah.

f. Heat treatment condition of saddles

After machining, the saddles were heat treated and case hardened. Bechtel QA personnel witnessed the furnace load time and verified the furnace temperature. Fifty-three saddles of each size were tested to verify that the required minimum case hardening depth and hardness were achieved. The results were satisfactory.

The critical parameters identified in the specification were:

a. Length of tube
b. Inside diameter of tube
c. Outside diameter of tube
d. Number of bolts
e. Saddle location
f. Bolt spacing
g. Bolt edge distance
h. Bolt threads
i. Bolt tip hardness
j. Diameter of bolt shear plane
k. Actual bolt break-point torque values.

The critical parameters listed above were verified by Valley Machining machine operators and QC personnel. Bechtel QA personnel verified each of these parameters during regular monitoring throughout the manufacturing process.

All measurements were made using equipment calibrated under a controlled calibration program with standards of calibration being traceable to NIST or another nationally recognized standard. Calibration records were reviewed by Bechtel QA personnel.

The supplier procurement documents from Bar-Lock to Valley Machining were reviewed by Bechtel QA personnel for the coupler design for nuclear safety-related applications. In addition, the procurement documents for the tube material, hex stock for bolts, and square stock for the saddles were reviewed.

Bechtel QA personnel examined a completed container of couplers for shipping preparation and container identification. The preparation was found to comply with the requirements of ANSI N45.2.2, Level C, as required by the specification.

NRC Question No. 5

On page 11 of the report it states that, "Since the Bar-Lock couplers will be used in a nuclear safety-related application, they are subject to a commercial grade dedication program." Describe and submit the commercial grade dedication program for staff's review.

TVA Response

The TVA dedication program for procurement and use of commercial grade items in safety-related applications is based on guidelines contained in Electric Power Research Institute (EPRI) Report No. NP-5652, “Guideline for the Utilization of Commercial Grade Items in Nuclear Safety-Related Applications.” TVA procedures require the use of one (or any combination of) the methods described in the report for dedication of commercial grade items. Based on the nature of the Bar-Lock coupler procurement (i.e., an infrequent procurement of a specialized component), the “source verification” method described in Section 3.3 of the EPRI report was used. Under this dedication process, a component-specific specification was developed (as discussed in the response to Question 4) which established the Codes, Standards and quality assurance requirements for fabrication of the couplers. The specification established minimum material and tensile strength requirements based upon the safety function performed by the coupler and identified the critical processes and parameters requiring verification to ensure compliance with the established functional requirements.

To verify conformance with the requirements of the specification, source surveillance of the manufacturer's facility and fabrication activities was performed prior to and during component manufacture. The scope of the surveillance activities verified compliance with the quality assurance and critical parameter requirements of the specification. The results of the inspections, tests, and certifications performed during source surveillance activities were documented in a material fabrication report compiled by the manufacturer. This documentation was reviewed by TVA as part of the component receipt inspection and was confirmed to be adequate to establish the component critical characteristics under the "source verification" dedication method outlined in EPRI Report No. NP-5652.

NRC Question No. 6

On page 12 of the report it states that the records of bolt shear test results were examined. Describe how the bolt shear test was conducted and submit a typical bolt shear test result, including the relationship between applied shear force and recorded shear deformation of a test bolt.

TVA Response

The bolt shear-torque test was conducted. The shear-torque was tested by gripping the end of the bolt to secure it, and then torquing the bolt until the head sheared off. The torque wrench used for the test had a memory device capable of recording shear-torque of the bolt head. The bolts were inspected and tested to meet the Bar-Lock Bolt Specifications. The major diameter, pitch, fit, and length were inspected and recorded. The shear-torque (ft-lbs) value at bolt head break was also recorded. These values were recorded for each sample set on Valley Machining Form POP-05 #3. Typical inspection and testing record sheets are provided as Attachment 2.

The shear deformation at the bolt head was not specifically tested. Any deformation that occurs due to the shear-torque test will be localized, occurring in the shear plane of the bolt head break. The bolt head break is located outside the active area of the coupler and would therefore have no impact on the strength, reliability, and function of the coupler.

NRC Question No. 7

The Bar-Lock coupler system relies on the clamping force generated on the rebars between the lockshear bolts and serrated rails. Provide the magnitude of the compressive stress and force on the tip of a lockshear bolt and the strain in the bolt after

the bolt installation. Provide the stress relaxation characteristic of the lockshear bolt (relaxation is defined as the loss of its compressive stress under strain for a period of time). Provide evidence that the clamping force generated by the lockshear bolt would not be reduced, as a result of the relaxation phenomenon, to a point that would degrade the proper function of the Bar-Lock coupler system during the life of the plant.

TVA Response

The Bar-Lock bolt tips are hardened to a level that exceed the hardness of the rebar, ensuring no plastic deformation of the bolt tips. The results of the testing performed at SQN confirmed this design, in that where the splice failure mode was rebar pull-out, the rebar had been damaged by the bolt tips, while no bolt tip failures were experienced. Note that the splice failure occurred well after the design load was reached. To show that the design properly accounts for the stress and strain is evidenced in the reliability of the couplers tested in this qualification process.

Stress relaxation is associated with materials within or very near their creep temperature ranges. For carbon and low alloy steel bolting, stress relaxation is not considered a concern at ambient temperatures. Under these conditions the stress in the Bar-Lock coupler is not time dependent.

# ATTACHMENT 1

## Idaho National Engineering and Environmental Laboratory (INEEL) Test Report

# ATTACHMENT 2

## Valley Machining
## (Typical Inspection and Testing Record Sheets)