



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

Report Nos.: 50-259/88-06, 50-260/88-06, and 50-296/88-06

Licensee: Tennessee Valley Authority  
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Docket Nos.: 50-259, 50-260 and 50-296

License Nos.: DPR-33, DPR-52,  
and DPR-68

Facility Name: Browns Ferry 1, 2, and 3

Inspection Conducted: March 14-21, 1988

Inspector: B. R. Crowley for 4/8/88  
J. L. Coley Date Signed

Approved by: B. R. Crowley for 4/12/88  
J. J. Blake, Chief Date Signed  
Materials and Processes Section  
Division of Reactor Safety

SUMMARY

Scope: This routine, announced inspection was in the areas of ultrasonic examination of Unit 2 reactor vessel shroud access cover as referenced in NRC Information Notice No. 88-03 and General Electric (GE) Surveillance Instruction Letter (SIL) No. 462 and inservice inspection status for Units 1 and 3.

Results: One violation was identified - Failure to Follow Procedure for Prevention of Foreign Material in Reactor Vessel Cavity.

## REPORT DETAILS

### 1. Persons Contacted

#### Licensee Employees

- \*D. Brown, Nondestructive Examination Engineer
- \*T. Gilbert, Nondestructive Examination Unit Supervisor
- \*E. Hartwig, Project Manager
- \*C. Madden, Regulatory Compliance
- \*J. Martin, Assistant to Plant Manager
- \*J. Robert, Fuel Inspection Project Manager
- \*J. Whitaker, Nondestructive Examination Engineer

Other licensee employees contacted included construction craftsmen, engineers, technicians, operators, mechanics, security force members, and office personnel.

#### Other Organization

##### General Electric

- \*J. Steininger, Site Manager
- \*J. Self, Manager Inspection Services

##### NRC Resident Inspectors

- \*G. Paulk, Senior Resident Inspector
- \*E. Christnot, Resident Inspector, Resident Inspector

\*Attended exit interview

### 2. Exit Interview

The inspection scope and findings were summarized on March 21, 1988, with those persons indicated in paragraph 1 above. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee. The following new item was identified during this inspection:

Violation 50-260/88-06-01, Failure to Follow Procedure for Prevention of Foreign Material in Reactor Vessel Cavity, paragraph 5.c.

The licensee did not identify as proprietary any of the materials provided to or reviewed by the inspector during this inspection.

### 3. Licensee Action on Previous Enforcement Matters

This subject was not addressed in the inspection.

#### 4. Unresolved Items

Unresolved items were not identified during this inspection.

#### 5. Ultrasonic Examination of Unit 2 Reactor Vessel Shroud Access Cover

##### a. Background Information

Jet pump BWRs are designed with access holes in the shroud support plate which is located at the bottom of the annulus between the core shroud and the reactor vessel wall. Each reactor vessel has two such holes which are located 180 degrees apart. These holes are used for access during construction and are subsequently closed by welding a plate over the hole. The covers and shroud support ledge are Inconel Alloy 600 material. The connecting weld material is also Inconel 600 (Alloy 182 or 82).

The high residual stresses resulting from welding, along with a possible crevice geometry of the weld, when combined with less than ideal water quality, present a condition conducive to intergranular stress corrosion cracking (ISGCC). This has been recognized by General Electric and, as a result, they have developed a remotely operated ultrasonic testing capability for detecting cracks in the cover plate welds. The first use of this custom ultrasonic testing fixture was at Peach Bottom Unit 3.

On January 21, 1988, intermittent short cracks were found in the weld heat-affected zone around the entire circumference of the covers at Peach Bottom Unit 3. It is estimated that cracking exists over 50% to 60% of the circumference with cusps as deep as 70% through the wall. It is believed that cover plate welds have not been inspected previously on any other BWR. It is possible that the cracking is generic and may, therefore, affect all BWRs with jet pumps.

General Electric has identified three concerns if failure of the access hole cover plates is postulated due to weld cracking:

- (1) Loose parts - In the event of complete failure of the access cover weld during normal reactor operation, the slightly higher bottom head anna pressure would lift the cover out its recess. It would most likely fall to one side, but there is a potential for it to be swept into the recirculation pump suction line causing severe pump damage.
- (2) Core flow bypass (normal operation) - Loss of one or both cover plates would allow some recirculation system flow to bypass the core, from the jet pump discharge through the open access hole to the recirculation pump suction. This flow transient would be readily detectable and would require reactor shutdown.

- (3) Core flow bypass (Loss of Coolant Accident) - If the access hole cover plate welds were to fail as a direct consequence of a recirculation suction line break, the bypass path would prevent the emergency core cooling system from reflooding the core to the 2/3 level. The core spray system would be capable of maintaining adequate core cooling provided there has been no degradation in the core spray piping.

In reply to the generic concern of IGSCC in the shroud access cover addressed in NRC Information Notice No. 88-03 and GE SIL No. 462, TVA scheduled GE to perform the ultrasonic (UT) examination of Browns Ferry Unit 2 access covers during the week of March 14-18, 1988.

GE has performed the shroud access cover examinations for several utilities since their identification of cracks at Peach Bottom and no additional cracks have been identified. TVA's Browns Ferry Unit 2, however, is the first vessel to be inspected that has the same access cover configuration and thickness as Peach Bottom. In addition, like Peach Bottom, the access covers at Browns Ferry do not have a centering hole for the GE test fixture. This makes centering the fixture on the access cover a critical operation. The GE automated ultrasonic SMART system bases all measurements on the assumption that the fixture is centered. The examiner's evaluation as to whether an indication is actually a crack or perhaps a crevice area will depend on critical measurements based on the fixture being centered. Therefore, the inspector had made prior arrangements with TVA to be notified when these examinations would be performed in order that NRC could be assured that the UT examinations and evaluation of data was as accurate as technically possible.

b. Review of Procedures and Certification/Qualification Record (73052)

The inspector reviewed GE's examiner certification and qualification records to ensure that personnel used for data acquisition, analysis and sizing of IGSCC had been qualified in accordance with the Electric Power Research Institute (EPRI)/Boiling Water Reactors Owners Group (BWROG)/NRC training agreement. The examination procedure was reviewed to determine if the procedure adequately described the method of examination, extent of inspection coverage and techniques necessary to ensure defect detection in Inconel plate and weld metal materials. Two TVA procedures were also reviewed as a result of foreign material being discovered and recovered from the reactor vessel cavity during the pre-examination work activities. Procedures reviewed and the inspector's comments regarding these procedures are listed below:

<u>Procedure No.</u>	<u>Title</u>
GE-UT-57R1	Remote Ultrasonic Examination Procedure for Detection of IGSCC in Shroud Support Access Cover Plate
TVA - Standard Practice BF-7.8	Prevention of Foreign Material in the Reactor Vessel Cavity and Torus
TVA - Standard Practice BF-7.7	Lost or Unsecured Article Recovery

The inspector's review of UT-57 R1 revealed that this procedure was technically adequate. However, paragraphs 6.5.1 and 7.5 incorrectly stated that: "all reflectors which exceed 15 percent full screen height (FSH) above the average noise level shall be recorded on the floppy disk." The GE SMART System actually only records the first signal inside the gate that exceeds 15% FSH above the average noise level (similar to a strip recorder) on the floppy disk. Therefore, the procedure statement could mislead the licensee as to exactly how much data they are saving. Some systems (TVA's Intraspect-98 included) will record on the floppy disk all signals inside the gate above a threshold amplitude. Clarification of the procedure statement was discussed with TVA and GE's Level III Examiners. Both agreed that a note should be added to the procedure to clarify the SMART System's recording capabilities. Addendum 1 to the procedure was subsequently approved and issued incorporating this clarification. The inspector's review of TVA's Standard Practice 7.7 and 7.8 revealed both procedures to be administratively and technically adequate documents.

During the above reviews, the inspector also noted that GE's "in vessel" IGSCC procedure, which uses immersion testing technique, has not been demonstrated at EPRI and GE does not have EPRI qualified examiners for sizing IGSCC using an automated system. GE has qualified the SMART automated system for IGSCC examination but not for immersion testing. GE also has qualified IGSCC sizing examiners but they are only qualified to use the manual method. However, TVA is not required, but has elected, to perform the IGSCC examinations of the access cover as stated in NRC information Notice 88-03. The qualification of procedure and personnel for immersion testing and automated system sizing has not been addressed in the EPRI/BWROG/NRC training agreement because the access cover examinations are outside the initial work scope of the agreement. The examinations are basically a "best effort attempt" to obtain information concerning the soundness of the access covers and the GE examiners have demonstrated at EPRI their ability to identify, evaluate and size IGSCC. The inspector recognizes that differences in examination techniques

may add some additional percentage of error to the examinations results. However, significant and appreciative information can be obtained using the procedure and personnel as qualified. The inspector discussed this training oversight with GE's manager of inspection service and was informed that GE is presently considering setting up an in-vessel defect detection and sizing demonstration at a GE facility in the near future and that NRC would be notified. The inspector also intended to witness the system's calibration, scanner positioning, examination and sizing methods for accuracy.

Certification/qualification records were reviewed for the following GE examiners:

<u>Examiners</u>	<u>Data Acquisition</u>	<u>Analysis</u>	<u>Sizing</u>
B.L.N.	✓	✓	
W.C.	✓	✓	✓
S.W.	✓	✓	
R.W.A	✓		

In addition to the review of procedures and examiner certification/qualification records, the inspector also requested the following information for review:

- Fabrication weld records to determine if the weld root was welded with 82 or 182 inconel
- Construction radiographs, if available, to determine the position and orientation of any crevice
- Drawing of the access cover

Only the access cover drawings were provided to the inspector during the inspection.

c. Observation of Work Activities (73753)

GE was scheduled to start the ultrasonic examination of the shroud access covers on March 15, 1988. However, delays were experienced in shipping of the necessary ultrasonic test equipment to site. When the equipment arrived GE discovered that the motor to the transducer manipulator was broken. In addition to other equipment problems encountered by GE, delays occurred because TVA's site NDE personnel were not aware that their contract with GE required TVA to perform all in-vessel camera and fixture positioning work. The site NDE examiners were not experienced with working in-vessel and work proceeded in a cumbersome manner. On March 17, 1988, at approximately 4:00 p.m., the ultrasonic scanner was removed from the vessel

annulus region at zero degrees azimuth in order to trouble shoot a problem with the translator (radial position) of the UT head. The underwater TVA camera had been left pointing at the access cover when the scanner was removed. It was later noticed, on the TV monitor, that a small screw or bolt-like object was resting on top of the access cover.

Prior to the foreign object being seen, part of the troubleshooting involved installing screws in pre-existing holes on the front-right and back-left of the scanner. The screws were added in an attempt to stabilize the front end plate movement that resulted in the problem with the translator. Once the foreign object was seen on the monitor, all work on the scanner was stopped. On March 18, 1988, GE sent for in-vessel workers and equipment technicians from San Jose, California to retrieve the objects observed in-vessel and to fix the equipment problems that were delaying the examinations.

By 6:00 p.m. Saturday, March 19, 1988, the objects had been removed from the vessel and the UT scanner inspected and tentatively found to be satisfactory. The articles found in the vessel were thought to be parts of a rivet since loose rivets were found on the refueling floor inside the control zone. The UT scanner was lowered back in the vessel annulus and positioned on the access hatch cover. The examination started at approximately 7:00 p.m. and had proceeded several inches, when the UT examiner observed on the TV monitor, that the transducer was not indexing with the SMART System Display. The apparent cause was mechanical slippage in the worm gear on the UT fixture. The ultrasonic scanner was again removed from the vessel annulus to investigate the problem. The inspector observed the disassembly of the scanner and noted a number of holes in the apparatus that did not have screws. In addition, a roll pin was missing from the shaft. The inspector inquired as to whether there had been a roll pin in the scanner prior to the examinations. GE's equipment technician responded that, a roll pin was not required because the shaft was pressed into the housing but no one could answer the inspector's question. However, GE later determined that one of the objects in the vessel was the roll pin and the other object was a head of a rivet off the scanner. The inspector inquired also as to who had the accountability records on the scanner and which of the holes that were missing screws were recorded as missing a screw in that area. Neither GE nor TVA personnel could answer the question even though the scanner was supposed to have been examined thoroughly as a result of the recovery plan within the previous 24 hours and loose or missing parts identified. The inspector also inquired as to why the screws installed in the scanner were not tight and why lanyards or some failsafe method of attaching the screws to the mechanism had not been used. The inspector was informed that the scanner cover screws were not tightened because when they were tight they would bind the mechanism and prevent its operation. The inspector noted that all TVA equipment such as lights, etc, in the control zone that were going in or had been in the vessel did have

lanyards or locking devices. Accountability records on the in-vessel lights had sketches showing each screw or missing screw. The inspector concluded from his review of TVA equipment and records that the only equipment that had been in-vessel and not adequately documented or protected from loose parts becoming detached was the UT equipment GE was using. GE, however, was working to TVA's Quality Assurance Program.

The inspector, informed the licensee that loose parts inside the control area (rivets on refueling floor), inadequate accountability of missing or attached parts on the scanner, failure to insure loose screws were attached with a lanyard or some form of locking device, and failure of GE or TVA to properly inspect the scanner for loose or missing parts prior to putting this mechanism back into the reactor vessel after the first event, is a violation of TVA Standard Practice BF-7.8. This violation was reported to the licensee as item no. 50-260/88-06-1, Failure to Follow Procedure for Prevention of Foreign Material in Reactor Vessel Cavity.

As a result of the continuous equipment problems encountered with their examination of the shroud access cover during the week of March 14-20, 1988, GE requested and permission was granted from the licensee for the examination effort be halted until GE could complete development of an updated ultrasonic system for these examinations. This work is presently in-process in San Jose, California and should be available within the next thirty days.

Within the areas examined, no violations or deviations were identified except as noted in paragraph 5.c above.

6. Inservice and Inspection Status - Units 1 and 3

The inspector held discussions with the NDE Unit supervisor concerning inservice inspection activities on Units 1 and 3. The inspector was informed that most of TVA's efforts are focused on Unit 2 at the present time. However, some visual and surface examination work was being performed on Unit 3. The supervisor stated that the next large job for the NDE unit would be the replacement of the 12 inch riser piping safe-ends.