UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 8, 2000

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 1 - ISSUANCE OF AMENDMENT REGARDING ALTERNATE STEAM GENERATOR TUBESHEET PLUGGING F-STAR CRITERION (F*), TS 99-013 (TAC NO. MA8636)

Dear Mr. Scalice:

The Commission has issued the enclosed Amendment No. 27 to Facility Operating License No. NPF-90 for Watts Bar Nuclear Plant, Unit 1. This amendment is in response to your application dated April 10, as supplemented by letter dated August 9, 2000, which requested approval to use an alternate repair criterion, F*, in the tubesheet region of the steam generator.

A copy of the safety evaluation is also enclosed. Notice of issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

Robert Martin

/Robert E. Martin, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosures: 1. Amendment No. 27 to NPF-90
2. Safety Evaluation

cc w/enclosures: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

WATTS BAR NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. **27**
License No. NPF-90

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated April 10, 2000, as supplemented by letter dated August 9, 2000, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-90 is hereby amended to read as follows:

   (2) Technical Specifications and Environmental Protection Plan

   The Technical Specifications contained in Appendices A and B, as revised through Amendment No. **27** , and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance, and shall be implemented no later than prior to startup following the Unit 1, Cycle 3 refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION

Richard P. Correia, Chief, Section 2
Project Directorate II
Division of Project Licensing Management
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical
Specifications

Date of Issuance: **September 8, 2000**

ATTACHMENT TO AMENDMENT NO. 27

FACILITY OPERATING LICENSE NO. NPF-90

DOCKET NO. 50-390

Replace the following pages of the Appendix A Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

Remove Pages	Insert Pages
5.0 - 16	5.0 - 16
5.0 - 18	5.0 - 18
5.0 - 19	5.0 - 19
5.0 - 35	5.0 - 35

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

c) A tube inspection (pursuant to Specification 5.7.2.12.f) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection and

d) In addition to the samples required in 5.7.2.12.b.2.a) through c), all tubes which have had the F* criterion applied will be inspected in the tubesheet region. These F* tubes may be excluded from 5.7.2.12.b.2.a, provided the only previous wall penetration of greater than 20% was located below the F* distance of 1.40 inches (which includes NDE uncertainty) extending from either the bottom of the steam generator tube roll transition or the top of the tubesheet, whichever is lower in elevation.

c. Examination Results - The results of each sample inspection shall be classified into one of the following three categories:

C-1 Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.

C-2 One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.

C-3 More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

----------NOTE----------
In all inspections, previously degraded tubes must exhibit significant (greater than 10%) further wall penetrations to be included in the above percentage calculations.
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d. Supplemental Sampling Requirements - The tubes selected as the second and third samples (if required by Table 5.7.2.12-1) may be subjected to a partial tube inspection provided:

1. The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found, and

2. The inspections include those portions of the tubes where imperfections were previously found.

(continued)

Amendment No. 27

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

b) A seismic occurrence greater than the Operating Basis Earthquake, or

c) A loss-of-coolant accident requiring actuation of the Engineered Safety Features, or

d) A main steam line or feedwater line break.

f. Acceptance Criteria

1. Terms as used in this specification will be defined as follows:

a) Degradation - A service-induced cracking, wastage, wear, or general corrosion occurring on either inside or outside of a tube;

b) Degraded Tube - A tube containing imperfections greater than or equal to 20% of the nominal wall thickness caused by degradation;

c) % Degradation - The percentage of the tube wall thickness affected or removed by degradation;

d) Defect - An imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective;

e) Imperfection - An exception to the dimensions, finish, or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections;

f) Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service and is equal to 40% of the nominal tube wall thickness. This definition does not apply to the portion of the tube in the tubesheet below the F* distance provided the tube is not degraded within the F* distance for F* tubes.

For tubes to which the F* criteria is applied, a minimum of 1.5 inches of the tube into the tubesheet from the top of the tubesheet or from the bottom of the roll transition, whichever is lower in elevation, shall be inspected using rotating pancake coil eddy current technique or an inspection method shown to give equivalent or better information on the orientation and length of cracking. A minimum of 1.40 inches (which includes NDE uncertainty) of continuous, sound

(continued)

5.7 Procedures, Programs, and Manuals

5.7.2.12 Steam Generator (SG) Tube Surveillance Program (continued)

expanded tube must be established, extending from either the bottom of the roll transition or the top of the tubesheet, whichever is lower in elevation, to the uppermost extent of the indication.

g) Preservice Inspection - An inspection of the full length of each tube in each SG performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed prior to initial MODE 1 operation using the equipment and techniques expected to be used during subsequent inservice inspections.

h) Tube Inspection - An inspection of the SG tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg; and

i) Unserviceable - The condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operational Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break accident as specified in Specification 5.7.2.12.e.

j) F* Distance is the distance into the tubesheet from the bottom of the steam generator tube roll transition or the top of the tubesheet, whichever is lower in elevation (further into the tubesheet), that has been conservatively chosen to be 1.40 inches (which includes NDE uncertainty).

k) F* Tube is the tube with degradation equal to or greater than 40%, below the F* distance and not degraded (i.e., no indications of degradation) within the F* distance.

2. The SG shall be determined OPERABLE after completing the corresponding actions (plug all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 5.7.2.12-1.

h. Reports - The content and frequency of written reports shall be in accordance with Specification 5.9.9.

(continued)

5.9 Reporting Requirements

5.9.9 SG Tube Inspection Report (continued)

The complete results of the SG tube inservice inspection shall be submitted to the NRC within 12 months following the completion of the inspection. The report shall include:

1. Number and extent of tubes inspected,

2. Location and percent of wall-thickness penetration for each indication of an imperfection, and

3. Identification of tubes plugged.

Results of SG tube inspections that fall into Category C-3 shall be reported to the NRC in accordance with 10 CFR 50.72. This report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

The results of the inspection of F* tubes shall be reported to the Commission in accordance with 10 CFR 50.4 prior to the restart of the unit. This report shall include:

1. Identification of F* tubes.

2. Uppermost elevation of the degradation and extent of the degradation.

NRC approval of this report is not required prior to restart.

UNITED STATES
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WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 27 TO FACILITY OPERATING LICENSE NO. NPF-90

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

1.0 INTRODUCTION

By letter dated April 10, as supplemented August 9, 2000, the Tennessee Valley Authority (the licensee) submitted a request for changes to the Watts Bar Nuclear Plant, Unit 1 (WBN), Technical Specifications (TS). The requested changes implement the F-star (F*) criterion for degraded tubes in the WBN steam generators. The F* criterion allows tubes with flaws in the tubesheet to remain in service if the degraded tubes in the tubesheet maintain a region of the tube free of defects. The technical basis for the F* criterion is presented in a Westinghouse report, WCAP-13084, "Tubesheet Region Tube Alternate Plugging (F*) Criterion for the Tennessee Valley Authority Watts Bar Units 1 and 2 Nuclear Power Plant Steam Generators," October 1991 (proprietary) and WCAP-13085 (non-proprietary). The August 9, 2000, letter provided clarifying information that did not change the initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

General Design Criterion 14 of Appendix A to Part 50 of Title 10 of the Code of Federal Regulations requires that the reactor coolant pressure boundary be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage of rapidly propagating failure and of gross rupture. Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes" (RG 1.121), provides guidance on an acceptable method for establishing the limiting safe conditions of steam generator tube degradation. RG 1.121 recommends that the margin of safety against tube rupture or pullout under normal operating conditions should not be less than three at any tube location in which defects have been detected. For a postulated accident, RG 1.121 recommends that the margin of safety against tube rupture or pullout be consistent with the margin of safety determined by the stress limits in subsection NB-3225 of Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code).

The tubes in the WBN steam generator are fastened in the tubesheet with a full penetration hardroll joint. The tube-to-tubesheet hardroll joint is made by mechanically expanding the tube wall against the tubesheet bore with an interference fit. The joint is held by elastic preload, which not only prevents tube pullout from the tubesheet, but also provides a leak-tight barrier minimizing primary-to-secondary coolant leakage. Structural loads imposed on the tube-to-tubesheet joint primarily result from the differential pressure between the primary and

secondary sides of the tubes. The peak postulated loading occurs during a main steamline break as a result of a lowering of the secondary side pressure. Normal operating loads, cyclic loading from transients (e.g., startup/shutdown), and thermal expansion loads can also be significant. The plant TS ensure the integrity of the steam generator tubes by requiring that the defective tube be plugged or repaired.

Defects have developed in tubes in the tubesheet in certain steam generators. Licensees have used the U.S. Nuclear Regulatory Commission (NRC)-approved F* criterion to allow degraded tubes in the tubesheet region to remain in service provided that the degradation is below a defect-free region in the hardroll joint. The F* region of the tube is demonstrated to maintain adequate structural and leakage integrity under loading from normal operations, anticipated operational occurrences, and postulated accident conditions.

3.0 EVALUATION

The proposed F* criterion is based on the length of hardroll engagement necessary to resist tube pullout forces during normal operation, test, upset, and faulted conditions. The licensee calculated the minimum necessary hardroll engagement length using an analytical method supported by testing of tube specimens. The analytical method was based on the ability of the region of the tube having the minimum necessary engagement length in the tubesheet to resist the applied pullout force originated from various operating conditions. The total tube resistance included the effect of interference fit, thermal expansion, tubesheet bowing, and internal pressure pushing the tube wall against the tubesheet.

The licensee conducted tests to quantify the interference fit of the hardroll joints. Each tube specimen was inserted into a collar to simulate the tubesheet, and a hardroll joint was made in the tube to the same specifications as those in the field fabrication. The licensee removed the test collar from the tube, measured the springback of the tube, and calculated a preload (tube resistance) resulting from the interference fit. The licensee combined the interference preload with preloads from thermal expansion, internal pressure, and tubesheet bowing to obtain the total tube preload. The total preload per tube length was multiplied by a coefficient of friction to obtain the net tube resistance. The licensee calculated the applied loads from primary-to-secondary pressure differential under normal operating and faulted conditions. From the applied loads and tube resistance, a bounding engagement length of 1.06 inches was obtained.

The licensee also performed pullout tests and hydraulic proof tests on several test specimens. The purpose of the pullout tests was to indirectly measure the static coefficient of friction and to verify the preload calculations. The purpose of the hydraulic proof tests was to verify the conservative nature of the calculated engagement distance. Each specimen assembly consisted of a tube specimen in a collar that simulated the tubesheet. A hardroll joint was made to fasten the tube in the collar using the same procedures as used on the tubes in the field. A throughwall circumference cut was made in the tube specimen to model three testing engagement lengths: 0.5 inch, 1.0 inch, and 2.0 inches.

In the pullout test, the specimens were loaded on a tensile testing machine until the tube was separated from the collar. In the hydraulic proof test, the specimens were subject to internal pressure until the tube specimen leaked, burst in the free span region, or separated from the collar. In both tests, the 1.0-inch engagement length specimens demonstrated their structural

integrity by achieving safety margins greater than those specified in RG 1.121 for normal operating and faulted condition loads.

In the hydraulic proof test, no leakage from any of the specimens occurred until pressure reached 5200 pounds per square inch (psi). This pressure was about 3.7 times the normal operating/upset transient differential of 1400 psi and about 2.0 times the differential pressure of the feedline break event. The 5200-psi test pressure was from a tube specimen having the engagement distance of 0.5 inch, which is much less than the proposed F* distance. For the engagement distance of 1.0 inch, the testing pressure was more than 10 times the normal operating pressure before leakage could be detected. The test data show that it is highly unlikely that the F* tube would leak during normal operation or faulted conditions.

As a part of the F* criterion, the licensee considered the measurement uncertainty for nondestructive examination (NDE), which is based on eddy current techniques. The NDE uncertainty was developed from a test program involving analysts who specialized in eddy current techniques. Once the eddy current data were collected, the analysts received specific instructions as to the data evaluation methodology and technique. All data evaluations were performed without prior knowledge of the flaw locations relative to the bottom of the roll transition. The analysis results were evaluated at one-sided, 95-percent probability, 95-percent confidence levels using standard statistical formulas for evaluation of samples from normally distributed populations. The licensee reported that NDE uncertainty for the 115-mil pancake coil, the 80-mil pancake coil, and the plus point coil were 0.28 inch, 0.30 inch, and 0.34 inch, respectively. The staff finds that the NDE uncertainties are acceptable on the basis of the licensee's testing program.

Combining the minimum engagement length of 1.06 inches and the NDE uncertainty of 0.34 inch, the licensee proposed an F* distance of 1.40 inches. The staff finds this F* distance acceptable because the structural engagement length was derived with analytical methods supported by testing. The F* distance also includes an appropriate NDE measurement uncertainty.

Proposed TS 5.7.2.12.b.2.d requires the licensee to inspect all the F* tubes in future outages. The proposed TS 5.7.2.12.f.1.f specifies that a minimum of 1.5 inches of the tube into the tubesheet from the top of the tubesheet or the bottom of the roll transition, whichever is lower, will be inspected. The staff questioned whether the 1.5-inch inspection considered the growth of the flaw. The licensee stated that circumferential cracks within the tubesheet-expanded region have historically been observed at a single elevation and have not been known to grow in oblique directions, resulting in a helical pattern up the tube. The F* distance includes allowance for reduced radial contact loads as a result of crack tip effects for 100-percent throughwall cracks. The licensee indicated that given the conservatisms included in the F* distance calculation, a flaw growth into the F* region would likely be much less than 100-percent throughwall between inspections. In addition, the licensee stated that the axial cracks in the hardroll joint have been limited to the roll overlap areas. This overlap length is about 0.25 inch and is mechanically defined by the hardroll tooling. The overlap areas occur at 1-inch intervals below the bottom of the roll transition. Any axial crack in the joint would be detected by the 1.5-inch inspection. The staff finds the 1.5-inch inspection adequate.

On a related issue, by letter dated June 7, 2000, the licensee requested the NRC to approve a proposed amendment to increase power by 1.4 percent. The licensee stated that a 1.4

percent power uprate will not change the F* distance calculated in WCAP-13084. The governing conditions for F* distance used a bounding 1400-psi pressure differential and a temperature of 600 degrees F, which bound the pressures and temperatures in the power uprate condition. The dilation of the tubesheet hole diameters as a result of bending of the tubesheet remains unchanged in the power uprate. The staff finds that the F* criterion is acceptable for the proposed power uprate.

Changes to TS pages are discussed below:

* TS 5.7.2.12.b.2.d -This section was added to page 5.0-16 of the TS to require that all F* tubes be inspected. The inspection of previously identified F* tubes is in addition to the TS required initial sample size.

* TS 5.7.2.12.f.1.f - The proposed change revises the current plugging limit of 40 percent throughwall by clarifying that it does not apply to the F* tubes and adds a plugging criterion for the F* tubes. The revision also requires that the inspection of the F* tubes start from the top of the tubesheet or from the bottom of the roll transition, whichever is lower in elevation, down 1.5 inches into the tubesheet. A rotating pancake coil or an inspection method shown to give equivalent or better information on the orientation and length of cracking is required. The inspection must establish a minimum of 1.40 inches (which includes NDE uncertainty) of sound expanded tube, extending from either the bottom of the roll transition or the top of the tubesheet, whichever is lower in elevation, to the uppermost extent of the indication.

* TS 5.7.2.12.j - This section is added to the TS to define F* distance as the distance into the tubesheet from the bottom of the steam generator tube roll transition or the top of the tubesheet, whichever is lower in elevation, that has been conservatively chosen to be 1.40 inches (which includes NDE uncertainty).

* TS 5.7.2.12.k - This section is added to the TS to define the F* tube as the tube with degradation equal to or greater than 40 percent below the F* distance and not degraded (i.e., no indications of degradation) within the F* distance.

* TS 5.9.9 - This section is revised by adding a requirement that the results of the inspection of the F* tube shall be reported to the NRC in accordance with 10 CFR 50.4 before the restart of the unit. This report shall include identification of F* tubes and the uppermost elevation of the degradation and the extent of the degradation. NRC approval of this report is not required before restart.

On the basis of the licensee's submittal, the staff has determined that the changes to the TS to incorporate the F* criterion are acceptable because implementation of the F* criterion will provide adequate structural and leakage integrity for tubes with degradation below the F* distance. The staff's determination was based on the licensee's analytical calculations of F* distance and the supporting test results. The licensee has demonstrated that under the F* criterion, the degraded F* tube will maintain the safety margins in RG 1.121. The staff concludes that tubes with degradation below the F* distance may remain in service; however, no defect is allowed within the F* distance.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Tennessee State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (65FR 34750, dated May 31, 2000). The amendment also changes record keeping or reporting requirements. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9) and (c)(10). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: John Tsao, EMEB

Date: September 8, 2000

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