

November 7, 2006

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

SUBJECT: SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2 - ISSUANCE OF  
AMENDMENT REGARDING NRC GENERIC LETTER 2004-02  
(TAC NOS. MD2052 AND MD2053) (TS-06-02)

Dear Mr. Singer:

The Commission has issued the enclosed Amendment No. 313 to Facility Operating License No. DPR-77 and Amendment No. 302 to Facility Operating License No. DPR-79 for the Sequoyah Nuclear Plant (SQN), Units 1 and 2. These amendments are in response to your application dated May 25, 2006, as supplemented on September 1, 2006.

The amendments revise the SQN design and licensing basis for the containment sump debris transport analysis as described in the SQN Updated Final Safety Analysis Report.

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

Sincerely,

**/RA/**

Douglas V. Pickett, Senior Project Manager  
Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-327 and 50-328

Enclosures: 1. Amendment No. 313 to  
License No. DPR-77  
2. Amendment No. 302 to  
License No. DPR-79  
3. Safety Evaluation

cc w/enclosures: See next page

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## **SEQUOYAH NUCLEAR PLANT**

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TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-327

SEQUOYAH NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 313  
License No. DPR-77

1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment by the Tennessee Valley Authority (the licensee) dated May 25, 2006, as supplemented by letter dated September 1, 2006, 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, by Amendment No. 313, Facility Operating License No. DPR-77 is amended to revise the design and licensing basis for the containment sump debris transport analysis described in the amendment application of May 25, 2006, as supplemented by letter dated September 1, 2006, and evaluated in the associated safety evaluation by the Commission's Office of Nuclear Reactor Regulation.
3. This amendment is effective as of its date of issuance. Implementation of the amendment is the incorporation into the next Updated Final Safety Analysis Report update made in accordance with 10 CFR 50.71(e), of the changes to the description of the facility as described in TVA's application dated May 25, 2006, as supplemented by letter dated September 1, 2006, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

***Evangelos C. Marinos for***

Douglas V. Pickett, Acting Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Date of Issuance: November 7, 2006

ATTACHMENT TO LICENSE AMENDMENT NO. 313

FACILITY OPERATING LICENSE NO. DPR-77

DOCKET NO. 50-327

Replace page 3 of Operating License No. DPR-77 with the attached page 3.

- (4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required, any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis, instrument calibration or associated with radioactive apparatus or components; and
  - (5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the Sequoyah and Watts Bar Unit 1 Nuclear Plants.
- C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:
- (1) Maximum Power Level

The Tennessee Valley Authority is authorized to operate the facility at reactor core power levels not in excess of 3455 megawatts thermal.
  - (2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 313, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications.
  - (3) Initial Test Program

The Tennessee Valley Authority shall conduct the post-fuel-loading initial test program (set forth in Section 14 of Tennessee Valley Authority's Final Safety Analysis Report, as amended), without making any major modifications of this program unless modifications have been identified and have received prior NRC approval. Major modifications are defined as:

    - a. Elimination of any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;
    - b. Modification of test objectives, methods or acceptance criteria for any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;
    - c. Performance of any test at power level different from there described; and

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-328

SEQUOYAH NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 302  
License No. DPR-79

1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment by the Tennessee Valley Authority (the licensee) dated May 25, 2006, as supplemented by letter dated September 1, 2006, 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, by Amendment No. 302, Facility Operating License No. DPR-79 is amended to revise the design and licensing basis for the containment sump debris transport analysis described in the amendment application of May 25, 2006, as supplemented by letter dated September 1, 2006, and evaluated in the associated safety evaluation by the Commission's Office of Nuclear Reactor Regulation.
3. This amendment is effective as of its date of issuance. Implementation of the amendment is the incorporation into the next Updated Final Safety Analysis Report update made in accordance with 10 CFR 50.71(e), of the changes to the description of the facility as described in TVA's application dated May 25, 2006, as supplemented by letter dated September 1, 2006, and evaluated in the staff's Safety Evaluation attached to this amendment.

FOR THE NUCLEAR REGULATORY COMMISSION

***Evangelos C. Marinos for***

Douglas V. Pickett, Acting Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Date of Issuance: November 7, 2006

ATTACHMENT TO LICENSE AMENDMENT NO. 302

FACILITY OPERATING LICENSE NO. DPR-79

DOCKET NO. 50-328

Replace page 3 of Operating License No. DPR-79 with the attached page 3.

- (4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
  - (5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the Sequoyah and Watts Bar Unit 1 Nuclear Plants.
- C. This license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:
- (1) Maximum Power Level

The Tennessee Valley Authority is authorized to operate the facility at reactor core power levels not in excess of 3455 megawatts thermal.
  - (2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 302, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications.
  - (3) Initial Test Program

The Tennessee Valley Authority shall conduct the post-fuel-loading initial test program (set forth in Section 14 of Tennessee Valley Authority's Final Safety Analysis Report, as amended), without making any major modifications of this program unless modifications have been identified and have received prior NRC approval. Major modifications are defined as:

    - a. Elimination of any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;
    - b. Modification of test objectives, methods or acceptance criteria for any test identified in Section 14 of TVA's Final Safety Analysis Report as amended as being essential;
    - c. Performance of any test at power level different from there described; and

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO AMENDMENT NO. 313 TO FACILITY OPERATING LICENSE NO. DPR-77  
AND AMENDMENT NO. 302 TO FACILITY OPERATING LICENSE NO. DPR-79  
TENNESSEE VALLEY AUTHORITY  
SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2  
DOCKET NOS. 50-327 AND 50-328

## 1.0 INTRODUCTION

By application dated May 25, 2006 (ML061500426 [Agencywide Document Access and Management System Accession Number]), as supplemented by letter dated September 1, 2006 (ML062500090), the Tennessee Valley Authority (TVA, the licensee) requested license amendments for the Sequoyah Nuclear Plant (SQN), Units 1 and 2. The requested changes will revise the design and licensing basis for the containment sump debris transport analysis as described in the SQN Updated Final Safety Analysis Report (UFSAR). The current transport analysis for SQN is a two-dimensional physical transport model, and TVA is requesting to update the analysis to a three-dimensional computational fluid dynamics (CFD) transport model. The results of the reanalysis will be used to size the flow area of the advanced design containment sump strainers. The licensee plans to modify the containment sump for Unit 2 during the Cycle 14 refueling outage (November 2006) and the Unit 1 containment sump will be modified during the Cycle 15 refueling outage (September 2007).

By letter dated September 13, 2004, the Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors (PWRs)." The GL identified a potential susceptibility of recirculation flow paths and sump screens to debris blockage. The GL requested that addressees perform an evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions in light of the information provided in the GL and, if appropriate, take additional actions to ensure system function. The license amendment request was submitted in response to the resolution of Generic Safety Issue No. 191 (GSI-191), "Assessment of Debris Accumulation on PWR Sump Performance" and in accordance with TVA's response to GL 2004-02.

To address the concerns contained in NRC GSI-191 the licensee reanalyzed the containment sump to address the susceptibility of the ECCS and CSS recirculation functions to the adverse effects of post-accident debris blockage and operation with debris laden fluids. The revised analysis methodology included development of a three-dimensional CFD model to establish debris transport characteristics (i.e., flow directions, velocities and turbulence) in the entire

sump pool during post-accident sump recirculation operation. The CFD calculation for the recirculation flow was performed using the Flow-3D Version 8.2 computer code.

Notice of these amendments were given in the *Federal Register* on June 20, 2006 (71 FR 35460). The supplemental letter dated September 1, 2006, provided clarifying information that did not change the initial proposed no significant hazards consideration determination.

## 2.0 REGULATORY EVALUATION

The SQN UFSAR describes the original licensing basis for SQN's containment sump screen blockage evaluations. A two-dimensional physical transport model currently confirms the ability of the containment sump to support CSS and ECCS pump operation during containment sump recirculation operation. In order to address additional concerns in response to GSI-191 and GL 2004-02, the SQN containment sump was reanalyzed. The revised analysis uses a new transport analysis methodology that includes a three-dimensional fluid dynamics model for debris transport characteristics. TVA's change to SQN's debris transport analysis from a two-dimensional model to a three-dimensional model constitutes a change in methodology affecting SQN's licensing basis. The licensee requested this amendment to their design and licensing basis based on the criteria in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.59, which specify that a licensee shall obtain a license amendment prior to implementing a proposed change if the change would "[r]esult in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses."

By letter dated May 28, 2004, the Nuclear Energy Institute (NEI) submitted a guidance report (GR), "Pressurized Water Reactor Sump Performance Evaluation Methodology," that is intended to allow PWR plant licensees to address and resolve GSI-191 in an expeditious manner. By letter dated December 6, 2004, the NRC staff concluded that the NEI GR, as modified and approved in accordance with the staff safety evaluation (SE), provides an acceptable overall guidance methodology for the plant-specific evaluation of ECCS. The review of this license amendment request was based on the guidance in the NEI GR as modified in the NRC's SE.

## 3.0 TECHNICAL EVALUATION

Debris transport occurs by four major modes: blowdown transport, washdown transport, pool fill transport and, recirculation transport. The proposed methodology addresses the four debris transport modes. The specific effect of each mode of transport is addressed for each type of debris generated in the SQN containment. The licensee developed a three-dimensional model of the SQN containment building and analyzed the sump transport flow paths to identify potential blockage points that could lead to water holdup. Debris types and size distributions were obtained from a debris generation analysis for each postulated break location, and the locations of each type/size of debris at the beginning of recirculation were determined.

The licensee used the CFD model to simulate the flow patterns that would occur during recirculation:

- a. The mesh in the CFD model was nodalized to sufficiently resolve the features of the computer aided drafting model.
- b. The boundary conditions for the CFD model were set based on the plant configuration of SQN during the recirculation phase.
- c. The ice melt and containment spray flows were included in the CFD calculation with the appropriate flow rate and kinetic energy to accurately model the effects on the containment pool.
- d. At the postulated loss-of-coolant accident break location, a mass source was added to the model to introduce the appropriate flow rate and kinetic energy associated with the break flow.
- e. A negative mass source was added at the sump location with a total flow rate equal to the sum of the spray flow and break flow.
- f. An appropriate turbulence model was selected for the CFD calculations.
- g. After running the CFD calculations, the mean kinetic energy was checked to verify that the model had been run long enough to reach steady state conditions.
- h. Transport metrics were determined based on relevant tests and calculations for each significant debris type present in the SQN containment building.
- i. A graphical determination of the transport fraction of each type of debris was made using the velocity and kinetic energy profiles from the CFD model output, along with the determined initial distribution of debris.
- j. The recirculation transport fractions from the CFD analysis were input into the logic tree.
- k. The quantity of debris that could experience erosion due to the break flow, spray flow, or ice melt drainage was determined.
- l. The overall transport fraction for each type of debris was determined by combining each of the previous steps in the logic tree.

Appendix C of the GR and Appendix III of NRC's SE of the methodology provide the guidance to be considered in the CFD analysis of the debris transport on the containment sump. The GR specifies the aspects that should be addressed in the debris transport CFD analysis. These aspects are: (1) key considerations in defining the containment geometry to be modeled by the CFD code; (2) establishment of the water level for these calculations; (3) treatment of flow paths to the containment floor; (4) treatment of flow paths to and out of the active sump regions; (5) treatment of transport restrictions such as curbs and trash racks; (6) determination of key transport metrics that include both local velocities (floor transport) and turbulent kinetic

energy (debris suspension); and (7) comparison of calculated transport metrics to threshold quantities for various debris types, and the resulting determination of overall pool transport fraction for various debris types.

The main differences between the current and the proposed transport analysis are the transport fraction. In the current transport analysis the licensee assumed 13 percent transport of unqualified Alkyd coating, 8 percent transport of qualified Epoxy coating (applied to concrete surfaces) and 16 percent transport of qualified Epoxy coating (applied to steel surfaces). In the proposed analysis, the debris transport fraction for the coating debris listed above was 100 percent. In the current model, the licensee stated that the pressurizer safety valve loop seals were temporarily wrapped with NUKON<sup>®</sup> fiberglass insulation. At the time that the CFD transport analysis was executed, all NUKON<sup>®</sup> fiberglass insulation had been removed from the SQN containment. The current model used the methodology given in NUREG/CR-2791 to determine the reflective metal insulation (RMI) debris transport fraction. The model determined that a maximum of 45 percent of the sump screen area could be blocked by RMI debris. The CFD model established the flow field velocity and turbulent kinetic energy (TKE) distribution in the containment recirculation pool. Combining the flow field analysis with the minimum tumbling velocity and TKE metrics required to transport RMI debris, the maximum debris transport fraction was determined to be 51 percent. The NRC staff concludes that the modeling of coatings, NUKON<sup>™</sup> fiberglass insulation, and RMI as described above are more conservative with respect to the former model and maximize the proposed debris transport. Therefore, the NRC staff finds the proposed modeling assumptions acceptable.

The CFD calculation for the recirculation flow was performed using the Flow-3D Version 8.2 computer code. Flow-3D is a commercially available general purpose computer code for modeling the dynamic behavior of liquids and gasses influenced by a wide variety of physical processes. The program is based on the fundamental laws of mass, momentum and energy conservation. It has been constructed for the treatment of time-dependent, multi-dimensional problems. The Flow-3D code used for SQN is configuration controlled under TVA's 10 CFR 50, Appendix B, Quality Assurance Program. Version 8.2 of the computer code has been validated and verified by the licensee in accordance with the licensee's established quality assurance requirements. Based upon the NRC staff's familiarity with the Flow-3D code along with the licensee's configuration control and validation under the TVA quality assurance requirements, the staff finds the licensee's use of the Flow-3D Version 8.2 computer code to be acceptable.

TVA's proposed revision to the SQN UFSAR regarding the debris transport evaluation for SQN's containment sump is based on methodology consistent with NEI GR as supplemented by the NRC SE. All aspects specified in the GR are present in the licensee analysis. These aspects are: (1) key considerations in defining the containment geometry to be modeled by the CFD code; (2) establishment of the water level for these calculations; (3) treatment of flow paths to the containment floor; (4) treatment of flow paths to and out of the active sump regions; (5) treatment of transport restrictions such as curbs and trash racks; (6) determination of key transport metrics that include both local velocities (floor transport) and turbulent kinetic energy (debris suspension) and; (7) comparison of calculated transport metrics to threshold quantities for various debris types, and the resulting determination of overall pool transport fraction for various debris types. The NRC staff concludes that the licensee's proposed methodology is consistent with the NEI guidance and the NRC SE. All changes in the proposed transport analysis make the debris transport more conservative and are, therefore, acceptable.

#### 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 amendments change 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 amendments involve no significant hazards consideration, and there has been no public comment on such finding (71 FR 35460). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

#### 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 these amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: Ruth Reyes

Dated: November 7, 2006