

July 7, 2004

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, EXEMPTION FROM THE
REQUIREMENTS OF 10 CFR PART 50, APPENDIX G
(TAC NOS. MB7321 AND MB7322)

Dear Mr. Singer:

The U. S. Nuclear Regulatory Commission (NRC) has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix G, for the Sequoyah Nuclear Plant (SQN), Units 1 and 2. This action is in response to your letter of September 6, 2002, as supplemented by letters dated December 19, 2002, March 28, 2003, June 24, 2003, and December 18, 2003. The first proposed exemption requested the use of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI Code Case N-640, "Alternative Requirement Fracture Toughness for Development of P-T [pressure-temperature] Limit Curves for ASME Section XI, Division 1" as the basis for the revised reactor pressure vessel pressure-temperature limit curves. The second exemption requested the use of Westinghouse Report WCAP-15984 Revision 1, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Sequoyah Units 1 and 2" in lieu of 10 CFR Part 50, Appendix G for determining the reactor pressure vessel flange minimum temperature requirements.

The first exemption for SQN Unit 2 was previously approved via separate correspondence (ADAMS Accession No. ML032060558) dated July 30, 2003. This same exemption request is no longer required to be approved by the NRC as Table 1 of Regulatory Guide 1.147, Revision 13 (January 2004) lists N-640, "Alternate Reference Fracture Toughness for Development of P-T Limit Curves, Section XI, Division I" as acceptable to the NRC for

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application in licensees' ASME section XI inservice inspection programs. This regulatory guide is approved for licensee use by reference in 10 CFR 50.55a(b). The second exemption has been approved for SQN Units 1 and 2.

A copy of the exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA/

Robert J. Pascarelli, Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-327 and 50-328

Enclosure: Exemption

cc w/enclosure: See next page

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Mr. Karl W. Singer
Tennessee Valley Authority

SEQUOYAH NUCLEAR PLANT

cc:

Mr. Ashok S. Bhatnagar, Senior Vice President
Nuclear Operations
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Pedro Salas, Manager
Licensing and Industry Affairs
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

Mr. James E. Maddox, Vice President
Engineering & Technical Services
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. David A. Kulisek, Plant Manager
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

Mr. Randy Douet
Site Vice President
Sequoyah Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Soddy Daisy, TN 37379

Senior Resident Inspector
Sequoyah Nuclear Plant
U.S. Nuclear Regulatory Commission
2600 Igou Ferry Road
Soddy Daisy, TN 37379

General Counsel
Tennessee Valley Authority
ET 11A
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. Lawrence E. Nanney, Director
Division of Radiological Health
Dept. of Environment & Conservation
Third Floor, L and C Annex
401 Church Street
Nashville, TN 37243-1532

Mr. T. J. Niessen, Acting General Manager
Nuclear Assurance
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

County Mayor
Hamilton County Courthouse
Chattanooga, TN 37402-2801

Ms. Ann P. Harris
341 Swing Loop Road
Rockwood, Tennessee 37854

Mr. Mark J. Burzynski, Manager
Nuclear Licensing
Tennessee Valley Authority
4X Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-327 AND 50-328
EXEMPTION

1.0 BACKGROUND

The Tennessee Valley Authority (TVA, the licensee) is the holder of Facility Operating License Nos. DPR-77 and DPR-79, which authorize operation of the Sequoyah Nuclear Plant (facility or SQN), Unit Nos. 1 and 2, respectively. The licenses provide, among other things, that the facility is subject to all rules, regulations, and orders of the Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of two pressurized water reactors located in Hamilton County, Tennessee.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix G requires that pressure-temperature (P-T) limits be established for reactor pressure vessels (RPVs) during normal operating and hydrostatic or leak rate testing conditions. TVA requested that they be able to use Westinghouse Report WCAP-15315, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Operating PWR [Pressurized-Water Reactor] and BWR [Boiling-Water Reactor] Plants" in lieu of 10 CFR, Appendix G, Footnote 2 to Table 1.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50 when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security, and (2) when special circumstances are present. Therefore, in determining the acceptability of the licensee's exemption request, the staff has performed the following regulatory, technical, and legal evaluations to satisfy the requirements of 10 CFR 50.12 for granting the exemption.

3.1 Regulatory Evaluation

It is stated in 10 CFR Part 50, Appendix G that “[t]he minimum temperature requirements . . . pertain to the controlling material, which is either the material in the closure flange or the material in the beltline region with the highest reference temperature . . . the minimum temperature requirements and the controlling material depend on the operating condition (i.e., hydrostatic pressure and leak tests, or normal operation including anticipated normal operational occurrences), the vessel pressure, whether fuel is in the vessel, and whether the core is critical. The metal temperature of the controlling material, in the region of the controlling material which has the least favorable combination of stress and temperature, must exceed the appropriate minimum temperature requirement for the condition and pressure of the vessel specified in Table 1 [of 10 CFR Part 50, Appendix G].” Footnote 2 to Table 1 in 10 CFR Part 50, Appendix G specifies that RPV minimum temperature requirements related to RPV closure flange considerations shall be based on “[t]he highest reference temperature of the material in the closure flange region that is highly stressed by bolt preload.”

In order to address provisions of amendments to modify SQN Units 1 and 2 Technical Specifications (TSs) to implement a pressure-temperature limits report (PTLR) for each unit, TVA requested in its submittal dated September 6, 2002, that the staff exempt SQN Units 1 and

2 from the application of specific requirements of 10 CFR Part 50, Appendix G, as they pertain to the establishment of minimum temperature requirements, for all modes of operation addressed by 10 CFR Part 50, Appendix G, based on the material properties of the material of the RPV closure flange region that is highly stressed by the bolt preload. The licensee's initial technical basis for this exemption request was submitted on December 19, 2002. The requirements from which TVA requested that SQN Units 1 and 2 be exempted shall be referred to for the purpose of this exemption as "those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G." The proposed action is in accordance with the licensee's application for exemption contained in its September 6, 2002, submittal, and is needed to support the TS amendments that are contained in the same submittal. The proposed amendments will revise the SQN Units 1 and 2 TSs to permit the implementation of a PTLR for each unit.

TVA's final, complete technical basis for the requested exemption was submitted to the NRC by letters dated June 24, 2003, and December 18, 2003. The licensee's June 24, 2003, letter included as an attachment Westinghouse report WCAP-15984-P, Revision 1, "Reactor Closure Head/Vessel Flange Requirements Evaluation for SQN Units 1 and 2." This revision of WCAP-15984 updated information provided in WCAP-15984-P, Revision 0, which had been submitted to the staff on December 19, 2002. The licensee's December 18, 2003, letter provided responses to specific questions raised by the NRC staff to clarify information in WCAP-15984-P, Revision 1.

3.2 Technical Evaluation

WCAP-15984-P, Revision 1 included a fracture mechanics analysis of postulated flaws in SQN Units 1 and 2 RPV closure flange regions under boltup, 100 degrees Fahrenheit per hour (°F/hr) heatup, 100 °F/hr cooldown, and steady-state conditions, with the heatup and cooldown transients being modeled in accordance with what would be permissible using P-T limit curves

based on SQN Units 1 and 2 beltline materials. Westinghouse performed finite element modeling to calculate the stresses present at critical locations within the flange region and determined that the 100 °F/hr heatup transient was the most severe condition with the upper head-to-flange weld being the most limiting location. With these stresses, Westinghouse calculated the applied stress intensity ($K_{I\text{ applied}}$) for semi-elliptical, outside diameter initiated, surface breaking flaws with an aspect ratio (length vs. depth) of 6:1, and with depths ranging from 0 to 90 percent of the thickness of the component wall. The $K_{I\text{ applied}}$ values were calculated in accordance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, Appendix G, subparagraph G-2220 requirements for the analysis of flange locations. Westinghouse then compared these $K_{I\text{ applied}}$ values to ASME Code lower bound static crack initiation fracture toughness (K_{IC}) values determined from the nil-ductility transition reference temperature (RT_{NDT}) values for the SQN Units 1 and 2 RPV closure flange materials. Westinghouse also provided an assessment of the potential for changes in the material RT_{NDT} values for the SQN Units 1 and 2 RPV closure flange materials due to thermal aging resulting from exposure to the RPV operating environment.

The use of ASME Code K_{IC} as the material property for the fracture mechanics analysis represents the most significant change between the analysis provided in WCAP-15984-P, Revision 1 and the analysis which was performed as the basis for establishing the minimum temperature requirements in 10 CFR Part 50, Appendix G. The minimum temperature requirements related to Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G were incorporated into the Code of Federal Regulations in the early 1980s and were based on analyses which used ASME Code lower bound crack arrest/dynamic test fracture toughness (K_{IA}) as the parameter for characterizing a material's ability to resist crack initiation and propagation. The use of ASME Code K_{IA} is always conservative with respect to the use of ASME Code K_{IC} for fracture mechanics evaluations, and its use in the evaluations which

established the requirements in 10 CFR Part 50, Appendix G was justified based on the more limited knowledge of RPV material behavior that was available in the early eighties. However, the use of ASME Code K_{IC} , not ASME Code K_{IA} , is consistent with the actual physical processes that would govern flaw initiation under conditions of normal RPV operation, including RPV heatup, cooldown, and hydrostatic and leak testing. Based on our current understanding of the behavior of RPV materials, the NRC staff has routinely approved licensees utilization of ASME Code K_{IC} as the basis for evaluating RPV beltline materials to demonstrate compliance with the intent of 10 CFR Part 50, Appendix G through the licensees use of ASME Code Cases N-640 and N-641.

The minimum K_{IC} value given in ASME Code for a RPV steel, regardless of material RT_{NDT} value or temperature, is $33.2 \text{ ksi}\sqrt{\text{in}}$. This value represents the “lower shelf” of the ASME Code K_{IC} curve. Based on information in WCAP-15984-P, Revision 1 and the licensee’s December 18, 2003, response to NRC staff questions, it is apparent that the $K_{I \text{ applied}}$ for any flaw up to 1/4 of the wall thickness (1/4 T) at the limiting location (refer to WCAP-15984-P, Revision 1, Figure 4-2), would not exceed $33.2 \text{ ksi}\sqrt{\text{in}}$ (including staff consideration of ASME Code structural factors) until between 1 and 2 hours into the $100 \text{ }^\circ\text{F/hr}$ heatup transient. The temperature at the tip of postulated flaws up to 1/4 T size would be adequate at that point in time to ensure that the limiting SQN flange materials would exhibit fracture toughness properties in excess of ASME Code “lower shelf” behavior.

Hence, the analysis provided in WCAP-15984-P, Revision 1 has demonstrated that, for the most limiting transient addressed by 10 CFR Part 50, Appendix G, the combination of factors which would have to exist (high stresses in the RPV flange region along with the metal of the flange region being at low temperature) cannot exist simultaneously, and the structural integrity of the SQN Units 1 and 2 RPV closure flange materials will not be challenged by facility operation in accordance with P-T limit curves based consideration of SQN Units 1 and 2 beltline

materials. Therefore, the more conservative minimum temperature requirements related to Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G are not necessary to meet the underlying intent of 10 CFR Part 50, Appendix G, to protect SQN Units 1 and 2 RPVs from brittle failure during normal operation under both core critical and core non-critical conditions and RPV hydrostatic and leak test conditions.

3.3 Legal Basis for Exemption

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50, when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. The staff accepts the licensee's determination that an exemption would be required to permit TVA to not meet those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G. The staff examined the licensee's rationale to support the exemption request and agrees that based on the information provided in WCAP-15984-P, Revision 1 and TVA's December 18, 2003, letter, an acceptable technical basis has been established to exempt SQN Units 1 and 2 from requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G. The technical basis provided by TVA has established that an adequate margin of safety against brittle failure would continue to be maintained for SQN Units 1 and 2 RPVs without the application of those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G, for normal operation under both core critical and core non-critical conditions and RPV hydrostatic and leak test conditions. Hence, the staff concludes that, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of 10 CFR Part 50, Appendix G will be achieved without the application of those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G. Therefore, the staff concludes that requesting the exemption

under the special circumstances of 10 CFR 50.12(a)(2)(ii) is appropriate, and should be granted to TVA such that those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G need not be applied to SQN Units 1 and 2.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants TVA an exemption from those requirements related to the application of Footnote 2 to Table 1 of 10 CFR Part 50, Appendix G, for SQN Units 1 and 2.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not result in any significant effect on the quality of the human environment (69 FR 32372).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 7th day of July 2004.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Ledyard B. Marsh, Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation