August 1, 2012

Mr. Pedro Salas, Manager
U.S. EPR New Plants Regulatory Affairs
AREVA NP Inc.
3315 Old Forest Road
P.O. Box 10935
Lynchburg, VA 24506-0935

SUBJECT: SAFETY EVALUATION REPORT FOR THE AREVA U.S. EPR PRESSURE AND TEMPERATURE LIMITS REPORT

Dear Mr. Salas:

By letter dated April 30, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML091270302), AREVA NP, Inc. (the applicant), submitted ANP-10283P, Revision 1, "U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown," to provide the generic basis for the use of the pressure-temperature (P-T) limit curves found in the U.S. EPR Final Safety Analysis Report (FSAR), Figures 5.3-1 and 5.3-2. By letter dated April 13, 2012, the applicant provided Revision 2 to ANP-10283P (ADAMS Accession No. ML12108A093). The United States Nuclear Regulatory Commission (NRC) staff has completed its review of the methodology described in U.S. EPR Pressure Temperature Limits Report (PTLR) and documents its finding in the enclosed safety evaluation report (SER).

The enclosed SER concludes that the contents of the U.S. EPR PTLR conform to the staff's technical criteria for PTLRs, as defined in Attachment 1 of Generic Letter (GL) 96-03, "Relocation of the Pressure Temperature Limit and Low Temperature Overpressure Protection Limits." and that the PTLR has satisfied the requirements of Title 10, *Code of Federal Regulations* (10 CFR) Part 50, Appendix G, "Fracture Toughness Requirements." Furthermore, the NRC staff determined that the U.S. EPR PTLR is compatible with the U.S. EPR Technical Specifications (TSs) and that the PTLR-related TS provisions meet the technical criteria of GL 96-03.

Based on this evaluation, the NRC staff concludes that the methodology described in the U.S. EPR PTLR (ANP-10283P, Revision 2) is acceptable for generic use by U.S. EPR combined license (COL) applicants and licensees for establishing limiting P-T limit curves, Low Temperature Overpressure Protection (LTOP) system limits, and related input parameters. Pursuant to TS requirement 5.6.4c, future U.S. EPR COL licensees will be required to provide the PTLR to the NRC upon issuance for each reactor vessel fluence period and for any PTLR revision or supplement thereto. Finally, in accordance with GL 96-03, any subsequent changes in the methodology used to develop the P-T limits must be approved by the NRC.

The enclosed Safety Evaluation will be referenced in Section 5.3.2 of the NRC staff's Final Safety Evaluation for the U.S. EPR FSAR. If you have any questions regarding this matter, I may be reached at 301-415-3361.

Sincerely,

/RA/

Getachew Tesfaye, Senior Project Manager
Licensing Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No.: 52-020

cc: See next page

The enclosed Safety Evaluation will be referenced in Section 5.3.2 of the NRC staff's Final Safety Evaluation for the U.S. EPR FSAR. If you have any questions regarding this matter, I may be reached at 301-415-3361.

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SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS
REVIEW OF THE UNITED STATES EVOLUTIONARY POWER REACTOR (U.S. EPR)
GENERIC PRESSURE-TEMPERATURE LIMITS REPORT
AREVA NP Inc.

1.0 INTRODUCTION

By letter dated April 30, 2009 (ML091270302), AREVA NP Inc. (AREVA or the "applicant") submitted ANP-10283P, Revision 1, "U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown." This report was submitted in support of the U.S. EPR design certification application to provide the generic basis for the use of the pressure-temperature (P-T) limit curves found in the U.S. EPR Final Safety Analysis Report (FSAR), Figures 5.3-1 and 5.3-2. As such, this pressure-temperature limits report (PTLR) presents the methodology for developing the P-T limits for the reactor coolant pressure boundary (RCPB) of the U.S. EPR and contains an evaluation of the reactor vessel including the beltline, closure head, and nozzle regions. The information provided in this report is generic to the U.S. EPR design and is expected to apply to all combined license (COL) applicants referencing the U.S. EPR design certification.

The April 30, 2009, submittal did not contain sufficient technical information for the NRC staff to review the PTLR and calculate the P-T limits independently. This additional information was provided to the NRC staff in the applicant's responses to the NRC staff's requests for additional information (RAIs) (ML102390581, ML12104A220). Subsequently, in a letter dated April 13, 2012, the applicant provided Revision 2 to ANP-10283P (ML12108A093) which incorporated the proposed revisions documented in the applicant's RAI responses.

The first part of the NRC staff's review was to ensure that the information provided in the proposed PTLR and the revised TS pages met the guidance in Generic Letter (GL) 96-03, "Relocation of Pressure Temperature Limit Curves and Low Temperature Overpressure Protection System Limits." The second part of the NRC staff's review was to verify that the proposed P-T limits have been developed appropriately using the methodology provided in ANP-10283P (hereafter, referred to as the U.S. EPR PTLR).

2.0 REGULATORY EVALUATION

2.1 10 CFR Part 50 Requirements for Generating P-T Limits and Low Temperature Overpressure Protection (LTOP) System Limits for Pressurized Water Reactors

The U.S. Nuclear Regulatory Commission (NRC) has established requirements in 10 CFR Part 50, Appendix G in order to protect the integrity of the reactor coolant pressure boundary (RCPB) in nuclear power plants. 10 CFR Part 50, Appendix G requires that the P-T limits for an operating light-water reactor be at least as conservative as those that would be calculated using the methods of Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code (ASME Code, Section XI, Appendix G). For conditions with the core critical, P-T limits must be more conservative than the ASME Code, Section XI, Appendix G limits. Table 1 of 10 CFR Part 50, Appendix G provides a summary of the requirements for P-T limits relative the ASME Code, Section XI,

Appendix G criteria, as well as the minimum temperature requirements, for bolting up the reactor vessel (RV) during normal and pressure testing operations. 10 CFR Part 50, Appendix G also requires that applicable surveillance data from reactor vessel (RV) material surveillance programs be incorporated into the calculations of plant-specific P-T limits, and that the P-T limits for operating reactors be generated using a method that accounts for the effects of neutron irradiation on the RCPB. The rule also establishes conservative requirements for determining the temperature and pressure setpoints for LTOP systems. P-T limits and LTOP system limits are subject to General Design Criteria (GDC) 14, GDC 15, GDC 30, and GDC 31 in 10 CFR Part 50, Appendix A.

10 CFR Part 50, Appendix H provides the NRC's criteria for the design and implementation of RV material surveillance programs for operating light-water reactors. The NRC's requirements for protecting the RVs of pressurized water reactors (PWRs) against pressurized thermal shock (PTS) events are given in 10 CFR 50.61.

The NRC staff's regulatory guidance related to determining the effects of radiation embrittlement on RV material parameters and P-T limit curves is found in Regulatory Guide (RG) 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials." NRC staff guidance related to the review of P-T limit curves and PWR PTS criteria is found in Standard Review Plan (SRP) Section 5.3.2. NRC staff guidance related to the review of LTOP system limits is found in SRP Section 5.2.2.

The regulatory requirements for RV fluence calculations are specified in GDC 14, 30, and 31 of 10 CFR Part 50, Appendix A. In March 2001, the NRC staff issued RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." The NRC staff has approved RV fluence calculation methodologies that satisfy the requirements of GDC 14, GDC 30 and GDC 31 by adhering to the guidance in RG 1.190. Fluence calculations are acceptable if they are obtained using approved methodologies or methods that are shown to conform to the guidance in RG 1.190.

2.2 Technical Specification (TS) Requirements for P-T Limits and LTOP System Limits

Section 182a of the Atomic Energy Act of 1954 requires applicants for nuclear power plant operating licenses to include TSs as part of the operating license. The Commission's regulatory requirements related to the content of the TSs are set forth in 10 CFR 50.36. That regulation requires that TSs include items in five specific categories: (1) Safety limits, limiting safety system settings and limiting control settings; (2) limiting conditions of operation (LCOs); (3) surveillance requirements (SRs); (4) design features; and (5) administrative controls.

10 CFR 50.36(c)(2)(ii) requires that LCOs be established for the P-T limits and LTOP system limits because the parameters fall within the scope of Criterion 2 identified in the rule:

> Criterion 2: A process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

The P-T limits and LTOP system limits for PWR-designed light-water reactors fall within the scope of Criterion 2 of 10 CFR 50.36(c)(2)(ii) and are, therefore, ordinarily required to be included within the TS LCOs for a plant-specific facility operating license.

On January 31, 1996, the NRC staff issued GL 96-03, "Relocation of the Pressure-Temperature Limit Curves and Low Temperature Overpressure Protection System Limits," to inform licensees that they may request a license amendment to relocate the actual P-T limit curves and LTOP system limit values from the TS LCOs on P-T limits and LTOP system limits and into a PTLR or other licensee-controlled document that would be administratively controlled through the Administrative Controls Section of the TSs. For the case of COL applicants referencing previously certified standard designs, the design-limiting P-T limits, LTOP system limits, and related input parameters may be included in a PTLR that is generic to the certified design. GL 96-03 indicate that licensees or applicants seeking to locate P-T limits and LTOP system limits for their reactors in PTLRs would need to generate their P-T limits and LTOP system limits in accordance with an NRC-approved methodology and that the methodology used to generate the P-T limits and LTOP system limits would need to comply with the requirements of 10 CFR Part 50, Appendices G and H. Furthermore, the methodology used to generate the P-T limits and LTOP system limits would need to be incorporated by reference in the administrative controls section of the TS. The GL also states that the TS administrative controls section for the PTLR would need to reference the staff's safety evaluation (SE) issued on the PTLR methodology and that the PTLR be defined in Section 1.0 of the TS. Attachment 1 to GL 96-03 provides a list of the criteria that the approved PTLR methodology and PTLR application would need to meet.

3.0 TECHNICAL EVALUATION

3.1 U.S. EPR Generic Technical Specification Requirements for Implementation and Control of a PTLR

The U.S. EPR Generic Technical Specifications (TSs) contain all of the necessary provisions required for the implementation and control of a PTLR. The U.S. EPR Generic TSs are provided in Chapter 16 of the U.S. EPR FSAR. The relevant generic TS requirements include the TS definition of the PTLR (TS Section 1.1); the TS LCOs for the RCS P-T limits (LCO 3.4.3) and the LTOP System (LCO 3.4.11), including LCO Action Statements, Surveillance Requirements, and related applicability criteria; and the necessary administrative controls governing the PTLR content and reporting requirements (TS 5.6.4). All of the TS pages related to the implementation and control of a PTLR are acceptable to the staff, pending the approval of a PTLR that is generic to the U.S. EPR standard plant design. U.S. EPR PTLR, Section 6.1, states that the PTLR has been prepared to meet the requirements of U.S. EPR Generic Technical Specifications Section 5.6.4 and the technical criteria of GL 96-03.

3.2 Evaluation of the U.S. EPR Generic PTLR Contents and Methodology against the Seven Criteria for PTLR Contents in Attachment 1 of GL 96-03

The U.S. EPR PTLR provides the generic P-T limits and LTOP system limits for the U.S. EPR RV and the methodology for their development. This PTLR is generic for the U.S. EPR design and is specifically referenced in Section 5.6.4 of the U.S. EPR Generic TSs as the controlling document governing future changes to PTLRs for U.S. EPR standard plants.

Accordingly, the PLTR utilizes generic inputs for RV beltline material chemistry, initial nil-ductility reference temperature (RT_{NDT}) values, and projected neutron fluence, to determine the P-T limit curves. These generic inputs are intended to be bounding for the U.S. EPR standard plant design and represent the maximum allowable limits on the input parameters for any specific U.S. EPR standard plant. Therefore, these generic inputs will be substantiated for use in a PTLR by any COL licensee referencing the U.S. EPR standard plant design in order to verify that the actual plant-specific RV beltline properties remain bounded by the generic inputs contained in the PTLR.

Attachment 1 of GL 96-03 contains seven technical criteria (PTLR criteria) for which the contents of PTLRs should conform if P-T limits and LTOP system limits are to be located in a PTLR. The staff's evaluation of the contents of the U.S. EPR PTLR against the seven criteria in Attachment 1 of GL 96-03 are given in the subsections that follow.

3.2.1 *PTLR Criterion 1*

PTLR Criterion 1 states that the PTLR contents should include the neutron-fluence values that are used in the calculations of the adjusted reference temperature (ART) values for the P-T limit calculations. Accurate and reliable neutron-fluence values are required in order to satisfy the provisions GDC 14, GDC 30, and GDC 31 of 10 CFR Part 50, Appendix A, as well as the specific fracture toughness requirements of 10 CFR Part 50, Appendix G and 10 CFR 50.61. U.S. EPR PTLR, Section 3.1, "Neutron Fluence Methodology," states that the methodology for determining the projected fluences used in the ART calculation is defined in Topical Report BAW-2241P-A, "Fluence and Uncertainty Methodologies," and conforms to the guidance of RG 1.190. In addition, AREVA provided peak RV neutron fluence values projected to 60 effective full-power years (EFPY) of facility operation in Table 6-1 of the PTLR. The NRC staff determined that these 60 EFPY neutron-fluence values were calculated using an NRC-approved methodology that is consistent with the guidelines in RG 1.190. The inclusion of valid peak RV neutron fluence values calculated using a neutron-fluence methodology that conforms to with RG 1.190 satisfies the provisions of PTLR Criterion 1. Therefore, the NRC staff concluded that PTLR Criterion 1 is satisfied.

3.2.2 *PTLR Criterion 2*

10 CFR Part 50, Appendix H provides the NRC requirements for designing and implementing RV material surveillance programs. The rule requires that RV material surveillance programs for operating reactors comply with the specifications of American Society for Testing and Materials (ASTM) Standard Procedure E 185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels." The rule requires that the program design and the surveillance capsule withdrawal schedules for the programs must meet the edition of E 185 that is current on the issue date of the ASME B&PV Code to which the RV was purchased, although the rule permits more recent versions of E 185 to be used, up through the 1982 version.

To ensure conformance with these requirements, PTLR Criterion 2 states that the PTLR should either provide the RV surveillance capsule withdrawal schedule or provide references, by title and number, for the documents containing the RV surveillance capsule withdrawal schedule. The criterion also states that the PTLR should reference, by title and number, any applicable

surveillance capsule reports that have been placed on the docket by the licensee requesting approval of the PTLR for its units. This criterion assures that the adjusted reference temperature (ART) calculations will appropriately follow the RV material surveillance program requirements of 10 CFR Part 50, Appendix H. A discussion of the U.S. EPR RV material surveillance program is provided in Sections 3.3 and 6.3 of the U.S. EPR PTLR. Section 3.3 states that the material surveillance program complies with Appendix H to 10 CFR Part 50 and ASTM E 185-82. The surveillance program description states that the capsule withdrawal schedule is outlined in Table 6-3, and each surveillance capsule will be tested in accordance with 10 CFR Part 50, Appendix H. The applicant also states that the material data will be evaluated using the guidance of RG 1.99, and the P-T limits will be recalculated or the applicable EFPY will be adjusted, as necessary, to confirm that the ART values of the P-T limits are not exceeded.

Table 1 of ASTM E 185-82 identifies the requirement for four capsules to be withdrawn for a maximum projected RT_{NDT} shift (ΔRT_{NDT}) of the beltline materials exceeding 100 °F. The staff reviewed the recommended surveillance capsule withdrawal schedule and determined that it in accordance with the specifications of ASTM E 185-82. On this basis, the NRC staff concluded that the provisions of PTLR Criterion 2 are satisfied. However, the NRC staff notes that all provisions of PTLR Criterion 2 will remain applicable to specific plants referencing the U.S. EPR standard plant design. As such, future U.S. EPR plants that incorporate the U.S. EPR PTLR will be expected to update their PTLRs in accordance with PTLR Criterion 2 as plant-specific surveillance capsule reports become available.

3.2.3 *PTLR Criterion 3*

PTLR Criterion 3 states that the LTOP System lift setting limits for the power-operated relief valves (PORVs) developed using NRC-approved methodologies may be included in the PTLR. The detailed methodology for developing the LTOP system limits is described in PTLR Section 5.0. The applicant has also provided the maximum pressure-safety-relief-valve (PSRV) lift setpoints and arming temperature for LTOP in PTLR Table 6-4.

The U.S. EPR LTOP mode of operation controls the reactor coolant system (RCS) pressure at low temperatures so that the integrity of the RCPB is not compromised by violating 10 CFR Part 50, Appendix G. The LTOP mode of operation for pressure relief of the U.S. EPR standard plant design consists of two PSRVs with each valve equipped with two solenoid-operated pilot valves in series that control the lifting of the PSRV. Although PTLR Criterion 3 addresses only PORVs that may be included in the PTLR, the PTLR may also include the LTOP capable PSRVs with lift settings which are equated to the solenoid-operated pilot valve activation setpoints. Furthermore, when the two LTOP-capable PSRVs are used during LTOP mode of operation, then the U.S. EPR TS LCO 3.4.11.d requires that the lift settings are within the limits specified in the PTLR. On this basis, the NRC staff concluded that the provisions of PTLR Criterion 3 have been satisfied.

The staff notes that U.S. EPR FSAR, Section 5.3.2 provides generic, not plant-specific, heatup and cooldown pressure-temperature curves. Therefore, a COL applicant that references the U.S. EPR design certification will provide a plant-specific PTLR, consistent with an approved methodology (U.S. EPR FSAR Tier 2, Table 1.8-2, “U.S. EPR Combined License Information Items,” Item No. 5.3-2, action required by COL Holder). As described in U.S. EPR FSAR

Section 5.2.2.1, “Design Bases,” for low-temperature operations, the set pressure for the PSRVs is established based on the low-temperature pressure limit for the reactor vessel with respect to ASME Code, Section XI, Appendix G, analyses. The pressure-temperature limits identified in ASME Code Section XI, Appendix G requires that the applicant’s analytical results obtained are from an approved methodology equivalent to methods of analysis described in Appendix G and that the resulting limits are at least as conservative as limits obtained by following the methods of analysis and the margins of safety described in Appendix G. Furthermore, whenever the P-T limit curves are revised, the PSRV setpoint must be reevaluated to confirm the validity of the existing pressure setpoint or re-analyzed to determine a new pressure setpoint of the PSRV based on the revised P-T limit curves.

3.2.4 *PTLR Criterion 4*

10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors be generated using a method that accounts for the effects of neutron embrittlement on the fracture toughness of RV beltline materials. For P-T limits, the effects of neutron embrittlement on the fracture toughness of RV beltline materials is defined in terms of the shift in the RT_{NDT} values resulting from neutron irradiation over a given period of facility operation, expressed in effective full-power years (EFPY). The final ART value for a material resulting from neutron embrittlement over a certain period of facility operation is defined as the sum of the initial (unirradiated) reference temperature (initial RT_{NDT}), the mean value of the shift in reference temperature caused by irradiation (ΔRT_{NDT}), and a margin term. RG 1.99, Revision 2 provides the NRC staff’s recommended methodologies for calculating ART values used for P-T limit calculations. ΔRT_{NDT} is a product of a chemistry factor (CF) and a fluence factor. The CF is dependent upon the amount of copper and nickel in the material and may be determined from tables in RG 1.99, Revision 2 or from surveillance data. The fluence factor is dependent upon the neutron fluence at the maximum postulated flaw depth. The margin term is dependent upon whether the initial RT_{NDT} is a plant-specific or generic value and whether the CF was determined using the tables in RG 1.99, Revision 2 or surveillance data. The margin term is used to account for uncertainties in the values of the initial RT_{NDT}, the copper and nickel contents, the fluence, and the calculational procedures. Appendix G to Section XI of the ASME Code requires that licensees determine the ART at the 1/4T and 3/4T locations.

To ensure compliance with the requirements of 10 CFR Part 50, Appendix G, PTLR Criterion 4 states that PTLR contents should identify the limiting materials and limiting ART values at the 1/4T and 3/4T locations in the wall of the RV. To ensure compliance with the PTS requirements of 10 CFR 50.61, PTLR Criterion 4 also states that the PTLR contents should identify the limiting RT_{PTS} value for the RV. The methodology used to determine the ART values at the 1/4T and 3/4T locations is provided in Section 3.2 of the report. Tables 6-1, 6-2, and 6-5 of the EPR PTLR provide the inputs for the ART and RT_{PTS} calculations, including RV beltline material chemistry values, initial RT_{NDT} values, and peak RV-beltline neutron-fluence projections at 60 EFPY. However, the applicant did not clearly identify the limiting material used in the development of the P-T limits. Therefore, in RAI 05.03.02-10, the NRC staff requested that the applicant identify both the limiting adjusted reference temperature (ART) values and limiting materials at the 1/4T and 3/4T locations (T= vessel beltline thickness) used in the development of the P-T limits. In response to RAI 05.03.02-10, the applicant stated that the limiting materials were the circumferential seam weld (weld #2) and the shell forgings (upper and lower) and provided the ART values for each material. Based on the information provided in the PTLR, it

was unclear to the NRC staff how these materials would be used to develop a P-T limit curve that represents the EPR reactor vessel. Therefore, the NRC staff issued RAI 05.03.02-11 requesting the applicant to explain specifically how these materials would be used to develop the bounding P-T limit curves. The applicant responded that for normal heatup and inservice leak and hydrostatic heatup (ISLH) conditions, the pressure-temperature limits for the entire temperature range are controlled by the reactor vessel closure head as shown in Figure 6-1. The applicant also stated that for normal cooldown, different components are controlling during different temperature ranges. In the low-temperature range (50^{o}F to 116^{o}F) the closure head is the controlling component. From 116^{o}F to 138^{o}F, the upper/lower core shell is the controlling component. At temperatures above 138^{o}F, the controlling component is weld #2.

The corresponding 60 EFPY ART values of the limiting materials at the 1/4T and 3/4T locations are shown in Table 6-2 of the U.S. EPR PTLR. The staff confirmed the applicant's controlling materials for heatup (closure head) and cooldown (closure head, upper/lower core shell, and weld #2) conditions and performed an independent calculation of the ART values for the beltline materials using the RG 1.99, Revision 2 methodology. On the basis of this evaluation, the NRC staff found that the applicant's response to RAI 05.03.02-11 was acceptable and confirmed that the U.S. EPR PTLR has been updated with the information provided. Therefore, RAI 05.03.02-10 and RAI 05.03-02-11 are closed. The staff also verified that the RT_{PTS} calculations, shown in Table 6-5 of the U.S. EPR PTLR, complied with the requirements of 10 CFR 50.61. The limiting RT_{PTS} value of 141.1 °F at 60 EFPY corresponds to weld #2.

As discussed above, the NRC staff verified that the ART calculations were consistent with RG 1.99, Revision 2 and the RT_{PTS} calculations met the requirements of 10 CFR 50.61. In addition, the applicant clearly identified the limiting materials and limiting ART values at the 1/4T and 3/4T locations, as well as the limiting RT_{PTS} value for the RV. Therefore, the NRC staff concluded that the provisions of PTLR Criterion 4 are satisfied.

3.2.5 *PTLR Criterion 5*

Section IV.A.2 of 10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors and the minimum temperatures established for the stressed regions of RVs (i.e., for the RV flange and stud assemblies) be met for all conditions. The rule also requires that the P-T limits for operating reactors must be at least as conservative as those that would be generated if the methods of analysis in the ASME Code, Section XI, Appendix G were used to generate the P-T limit curves. Table 1 of 10 CFR Part 50, Appendix G provides a summary of the required criteria for generating the P-T limits for operating reactors.

To ensure that PTLRs are in compliance with the above requirements, PTLR Criterion 5 states that the PTLR contents should provide the P-T limit curves for heatup and cooldown operations, core critical operations, and pressure testing conditions for operating light-water reactors. The P-T limit curves for heatup and cooldown operations, core critical operations, and inservice leak and hydrostatic (ISLH) testing are provided in Figures 6-1 and 6-2. In response to RAI 05.03.02-7, the applicant provided the data points (pressure and temperature) corresponding to the P-T limit curves provided in the report. This meets the provisions of PTLR Criterion 5, which specifies that the PTLR include the P-T limit curves for reactor heatup, cooldown, critical operations, and pressure testing conditions.

The NRC staff performed independent analyses for the derivation of P-T limits curves and obtained almost identical solutions as those provided in the U.S. EPR PTLR for heat-up and cool-down operations, core critical operations, and hydrostatic and pressure testing; thus, providing verification of the P-T limits for the U.S. EPR standard plant design. Based on this independent verification, the NRC staff concluded that the applicant's proposed P-T limits were developed in accordance with ASME Code, Section XI, Appendix G and, therefore, satisfy the requirements of 10 CFR Part 50, Appendix G. Therefore, the applicant's proposed P-T limit curves are acceptable for operation of the EPR RV. On this basis, the NRC staff concluded that the provisions of PTLR Criterion 5 are satisfied.

3.2.6 *PTLR Criterion 6*

Section IV.A.2 of 10 CFR Part 50, Appendix G requires that the P-T limits for operating reactors and the minimum temperature requirements for the highly stressed regions of the RVs (i.e., for the RV flange and stud assemblies) be met for all conditions. Table 1 of 10 CFR Part 50, Appendix G provides required the criteria for meeting the minimum temperature requirements for the highly stressed regions of the RV.

PTLR Criterion 6 states that the minimum temperature requirements of 10 CFR Part 50, Appendix G shall be incorporated into the P-T limit curves, and the PTLR shall identify minimum temperatures on the P-T limit curves such as the minimum boltup temperature and the hydrotest temperature. The NRC staff concluded that the P-T limit curves met the minimum temperature requirements of 10 CFR Part 50, Appendix G. Furthermore, the PTLR clearly identifies the minimum boltup temperature and hydrotest temperature on the P-T limit curves. Therefore, the NRC staff concluded that the provisions of PTLR Criterion 6 are satisfied.

3.2.7 *PTLR Criterion 7*

RG 1.99, Revision 2 provides the staff’s recommended methods for calculating the ART values for RV beltline materials. These ART values are calculated for the 1/4T and 3/4T locations in the vessel wall. The ASME Code, Section XI, Appendix G and 10 CFR Part 50, Appendix G requires that these values be used for the calculation of P-T limit curves for reactors.
10 CFR Part 50, Appendix G also requires that the ART values include the applicable results of the RV material surveillance program of 10 CFR Part 50, Appendix H. ART values for ferritic RV base metal and weld materials increase as a function of accumulated neutron fluence and the quantity of alloying elements in the materials; copper and nickel in particular. The procedures of RG 1.99, Revision 2 specify the use of a CF as a means for quantifying the effect of the alloying elements on the ART values. Furthermore, the RG specifies that a CF be calculated and inputted into the calculation of the final ART value for each beltline material. The RG cites two possible methods for determining the CF values for the RV beltline base metal and weld materials: (1) RG 1.99, Regulatory Position 1.1 allows the licensee to determine the CF values from applicable tables in the RG as a function of copper and nickel content or,
(2) Regulatory Position 2.1 allows the use of applicable RV surveillance data to determine the CF values if the base metal or weld materials are represented in a licensee’s RV material surveillance program and if two or more credible surveillance data sets become available for the material in question. The criteria for determining the credibility of the RV surveillance data sets are defined in the RG. To satisfy the requirements of 10 CFR Part 50, Appendix G, the RG states that if the procedure of Regulatory Position 2.1 results in a higher ART value than that

given by using the procedure of Regulatory Position 1.1, the surveillance data should be used for determining the CF and ART. If the procedure of Regulatory Position 2.1 results in a lower value for the ART, either procedure may be used for determining the CF and ART.

To ensure that PTLRs comply with the above regulatory requirements and guidelines, PTLR Criterion 7 states that if surveillance data are used in the calculations of the ART values, the PTLR contents should include the surveillance data and calculations of the CF values for the RV base metal and weld materials, as well as an evaluation of the credibility of the surveillance data against the credibility criteria of RG 1.99, Revision 2. However, the U.S. EPR PTLR is generic for the U.S. EPR standard plant design and is based on bounding embrittlement correlations for which surveillance data is not yet available. Therefore, the incorporation of surveillance data and related calculations is currently not applicable to the U.S. EPR PTLR. As previously discussed, the CF and ART values in the PTLR were determined using the procedures of RG 1.99, Revision 2, Regulatory Position 1.1. On this basis, the NRC staff concluded that the provisions of PTLR Criterion 7 are satisfied. However, the NRC staff notes that the provisions of PTLR Criterion 7 will remain applicable to specific plants referencing the U.S. EPR design certification. As such, plants that incorporate the U.S. EPR PTLR will be expected to update their PTLRs in accordance with PTLR Criterion 7 as plant-specific surveillance data becomes available.

4.0 CONCLUSION

On the basis of its review, the NRC staff finds that the contents of the latest revision of the U.S. EPR PTLR, which incorporates the applicant's responses to the staff's RAIs, conform to the NRC staff's technical criteria for PTLRs as described in Attachment 1 of GL 96-03. The NRC staff also finds that the PTLR meets the requirements of 10 CFR Part 50, Appendix G. Furthermore, the NRC staff finds that the U.S. EPR PTLR is compatible with the U.S. EPR standard plant TSs, and the PTLR-related TS provisions meet the technical criteria of GL 96-03.

On the basis of this evaluation, the NRC staff concludes that the U.S. EPR PTLR (ANP-10283P, Revision 2) is acceptable for generic use by U.S. EPR COL applicants and licensees for establishing limiting P-T limit curves, LTOP system limits, and related input parameters. Pursuant to TS requirement 5.6.4c, future U.S. EPR COL licensees will be required to provide the PTLR to the NRC upon issuance for each reactor vessel fluence period and for any PTLR revision or supplement thereto. Finally, in accordance with GL 96-03, any subsequent changes in the methodology used to develop the P-T limits must be approved by the NRC.