SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS
REVIEW OF APR1400 GENERIC PRESSURE-TEMPERATURE LIMITS REPORT
KOREA HYDRO & NUCLEAR POWER CO., LTD.

1.0 INTRODUCTION

By letter dated December 23, 2014, Korea Hydro & Nuclear Power Co., Ltd. (KHNP or the applicant) submitted Technical Report APR1400-Z-M-NR-14008-P, Revision 0, "Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown," in support of the APR1400 design certification application. The purpose of this report is to provide the generic basis for the use of the pressure-temperature (P-T) limit curves found in APR1400 Design Control Document (DCD) Figure 5.3-7. As such, this P-T limits report (PTLR) contains an evaluation of the entire reactor vessel (RV), including beltline, closure flange, and nozzle regions. The information in this report is generic to the APR1400 design and is expected to apply to all combined license (COL) applicants referencing the APR1400 design certification.

The first part of the staff's review was to ensure that the information in the proposed PTLR and the revised technical specification (TS) pages is in accordance with the guidance in Generic Letter (GL) 96-03, "Relocation of Pressure Temperature Limit Curves and Low Temperature Overpressure Protection System Limits," dated January 31, 1996. The second part of the staff's review was to verify that the proposed P-T limits have been developed appropriately using the methodology in Technical Report APR1400-Z-M-NR-14008-P, Revision 0. The report was revised and submitted on March 19, 2018, to the U.S. Nuclear Regulatory Commission (NRC) as APR1400-Z-M-NR-14008-P, Revision 1 (non-proprietary version is accessible at Agencywide Documents Access and Management System (ADAMS) Accession No. ML18087A112), hereafter referred to as the APR1400 PTLR.

2.0 REGULATORY EVALUATION

2.1 10 CFR Part 50 Requirements for Generating Pressure-Temperature Limits and Low Temperature Overpressure Protection System Limits for Pressurized-Water Reactors

The NRC has established requirements in Appendix G, "Fracture Toughness Requirements," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," in order to protect the integrity of the reactor coolant pressure boundary (RCPB) in nuclear power plants. Appendix G to 10 CFR Part 50 requires the P-T limits for an operating light-water nuclear reactor to be at least as conservative as those that would be generated using the methods of Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME Code). For conditions with the core critical, P-T limits must be more conservative than the limits in ASME Code, Section XI, Appendix G. Table 1 of 10 CFR Part 50, Appendix G, summarizes the requirements for P-T limits relative to the criteria in ASME Code Section XI, Appendix G, as well as the minimum temperature requirements for bolting up the RV during normal and pressure testing operations. Appendix G to 10 CFR Part 50 also requires that applicable surveillance data from 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. Appendix G to 10 CFR Part 50 also establishes conservative requirements for determining the temperature and pressure setpoints for low temperature overpressure protection (LTOP) systems. P-T limits and LTOP system limits are subject to General Design Criterion (GDC) 14, "Reactor Coolant

Pressure Boundary"; GDC 15, "Reactor Coolant System Design"; GDC 30, "Quality of Reactor Coolant Pressure Boundary"; and GDC 31, "Fracture Prevention of Reactor Coolant Pressure Boundary," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50.

Appendix H, "Reactor Vessel Material Surveillance Program Requirements," to 10 CFR Part 50 provides the NRC's criteria for the design and implementation of RV material surveillance programs for operating light-water reactors. The requirements for protecting the RVs of pressurized-water reactors against pressurized thermal shock (PTS) events appear in 10 CFR 50.61, "Fracture Toughness Requirements for Protection against Pressurized Thermal Shock Events." Regulatory Guide (RG) 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," issued May 1988, contains staff regulatory guidance related to determining the effects of radiation embrittlement on RV material parameters and P-T limit curves. Staff guidance related to the review of P-T limit curves and PTS criteria appears in Section 5.3.2, "Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized, Thermal Shock," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," while NUREG-0800, Section 5.2.2, "Overpressure Protection," contains staff guidance related to the review of LTOP system limits.

GDC 14, 30, and 31 specify the regulatory requirements for RV neutron fluence calculations. In March 2001, the staff issued RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence." The staff has approved RV fluence calculation methods that satisfy the requirements of GDC 14, 30, and 31 by adhering to the guidance in RG 1.190. Neutron fluence calculations are acceptable if they are done with approved methods or with methods that are shown to conform to the guidance in RG 1.190.

The most recent version of ASME Code, Section XI, Appendix G, that the NRC has endorsed in 10 CFR 50.55a, "Code and Standards," and therefore by reference in Appendix G to 10 CFR Part 50, is the 2007 Edition through the 2008 Addenda of the ASME Code. The P-T limit methodology based on this edition and addenda of ASME Code, Section XI, Appendix G, incorporates the provisions of ASME Code Cases N-588 and N-640. Additionally, 10 CFR Part 50, Appendix G, imposes minimum head flange temperatures when the system pressure is at or above 20 percent of the preservice hydrostatic test pressure.

GL 96-03 addresses the technical information necessary for a licensee to implement a PTLR. It establishes the information that must be included in (1) an acceptable PTLR methodology (with the P-T limit methodology as its subset) and (2) the PTLR itself. Technical Specification Task Force-419, "Revise PTLR Definition and References in ISTS 5.6.6, RCS PTLR," dated September 16, 2001 (ADAMS Accession No. ML012690234), provides additional guidance that gives an alternative format for documenting the implementation of a PTLR in the "Administrative Controls" section of a facility's TS.

2.2 Technical Specification Requirements for Pressure-Temperature Limits and Low Temperature Overpressure Protection System Limits

Section 182a of the Atomic Energy Act of 1954, as amended, requires applicants for nuclear power plant operating licenses to include TSs as part of the operating license. The Commission sets forth its regulatory requirements related to the content of the TSs in 10 CFR 50.36, "Technical Specifications." That regulation requires that the TSs include items in five categories: (1) safety limits, limiting safety system settings and limiting control settings,

(2) limiting conditions of operation (LCOs), (3) surveillance requirements, (4) design features, and (5) administrative controls.

In 10 CFR 50.36(c)(2)(ii), the NRC 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 pressurized-water reactor 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 staff issued GL 96-03, which informed 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 TS. COL applicants referencing previously certified standard designs may include the design-limiting P-T limits, LTOP system limits, and related input parameters in a PTLR that is generic to the certified design. GL 96-03 indicated that licensees or applicants seeking to locate P-T limits and LTOP system limits for their reactors in PTLRs would need to generate their limits in accordance with an NRC-approved methodology, and that the method used to generate the limits would need to comply with the requirements of Appendices G and H to 10 CFR Part 50. Furthermore, the method 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 mandated that the TS "Administrative Controls" section for the PTLR would need to reference the staff's safety evaluation issued on the PTLR methodology and that the PTLR be defined in Section 1.0 of the TS. Attachment 1 to GL 96-03 listed the criteria that the approved PTLR methodology and PTLR application would need to meet.

3.0 TECHNICAL EVALUATION

3.1 APR1400 Generic Technical Specification Requirements for Implementation and Control of a Pressure and Temperature Limits Report

The staff reviewed the APR1400 generic TS to ensure that they contain all of the necessary provisions required for the implementation and control of a PTLR. Chapter 16 of the APR1400 DCD provides the APR1400 generic TS. The relevant generic TS requirements include the TS definition of the PTLR (TS Section 1.1); the TS LCOs for the reactor coolant system (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). The staff found all of the TS pages related to the implementation and control of a PTLR acceptable, pending the approval of a PTLR that is generic to the APR1400 design.

3.2 Evaluation of the APR1400 Generic PTLR Contents and Methodology against the Seven Criteria for PTLR Contents in Attachment 1 of GL 96-03

The APR1400 PTLR provides the generic P-T limits and LTOP system limits for the APR1400 RV and the methodology for their development. This report is generic for the APR1400 design and is specifically referenced in Section 5.6.4 of the APR1400 generic TSs as the controlling document governing future changes to PTLRs for APR1400 plants. Accordingly, the PLTR uses 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 APR1400 design; they represent the maximum allowable limits on the input parameters for any specific APR1400 plant. Therefore, any COL holder referencing the APR1400 design will substantiate these generic inputs for use in a PTLR in order to verify that 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 to which the contents of PTLRs should conform if P-T limits and LTOP system limits are to be located in a PTLR. The subsections that follow give the staff's evaluations of the contents of the APR1400 PTLR against the seven criteria in Attachment 1 of GL 96-03.

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 of GDC 14, 30, and 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. Section 3 of the APR1400 PTLR, on the reactor vessel neutron fluence calculation method, indicates that the neutron flux calculation methodology for the APR1400 RV is in accordance with RG 1.190 and is described in Technical Report APR1400-Z-A-NR-14015-P, "Neutron Fluence Calculation Methodology for Reactor Vessel." The staff discusses its evaluation of that technical report in the safety evaluation report for APR1400 DCD Section 4.3. In addition, KHNP provided peak RV neutron fluence values projected to 60 years of facility operation in Table 4-2 of the PTLR. The staff has determined that these 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 is in conformance with RG 1.190 fulfills the provisions of PTLR Criterion 1. Therefore, the staff determined that PTLR Criterion 1 is satisfied.

3.2.2 PTLR Criterion 2

Appendix H to 10 CFR Part 50 provides the staff's requirements for designing and implementing RV material surveillance programs. It requires that RV material surveillance programs for operating reactors comply with the specifications of American Society for Testing and Materials (ASTM) E 185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels." Appendix H requires that the program design and the surveillance capsule withdrawal schedules for the programs must meet the edition of ASTM E 185 that is current on the issue date of the version of the ASME Code to which the RV was purchased, although the rule permits more recent versions of ASTM 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 ART calculations will appropriately follow the RV material surveillance program requirements of 10 CFR Part 50, Appendix H.

Section 7 of the APR1400 PTLR discusses the APR1400 RV material surveillance program. PTLR Section 7 states that the surveillance capsule program adheres to all requirements of 10 CFR Part 50, Appendix H, and satisfies ASTM E 185-82. PTLR Table 7-1 gives the capsule withdrawal schedule. For a predicted transition temperature shift of less than 100 degrees Fahrenheit (F) (56 degrees Celsius (C)), Table 1 of ASTM E 185-82 requires a minimum of three surveillance capsules. For the APR1400 RV, six identical surveillance capsule assemblies are provided. Four assemblies are for retrieval and two are for standby. Four primary surveillance capsules are provided for the APR1400 surveillance program because the design life of the APR1400 RV (60 years) is longer than the design life indicated in ASTM E 185-82 (40 years or 32 effective full-power years (EFPYs)). The staff determined that the APR1400 withdrawal schedule is acceptable because it is consistent with the intent of the withdrawal schedule recommended in ASTM E 185-82, even though the design life is different. PTLR Section 7.1 also states that surveillance test specimens are made from actual material used in fabricating the beltline region of the RV and judged most likely to be controlling with regard to radiation embrittlement. This is acceptable because it is in accordance with ASTM E 185-82.

In APR1400 Final Safety Analysis Report, Section 5.3.1.6.7, the applicant stated that when data from the surveillance capsules become available, they will be used to adjust the P-T limit curves. However, the PTLR did not include this statement. The staff discussed this issue with the applicant in a public meeting on June 30, 2015, and the applicant responded that it would revise the PTLR to include the aforementioned statement. This is acceptable because it provides a reasonable assurance that the plant operating limits will meet the requirements of Appendix G to 10 CFR Part 50 throughout the operating life of the APR1400. The applicant also included a marked-up copy of the proposed changes in a letter dated July 17, 2015 (ADAMS Accession No. ML15198A557). The staff confirmed that the next revision of the PTLR included the proposed changes.

Based on the review described above, the staff determined that the provisions of PTLR Criterion 2 are satisfied. The staff notes that all provisions of PTLR Criterion 2 will remain applicable to specific plants referencing the APR1400 design. As such, future APR1400 plants that incorporate the APR1400 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

The reactor pressure vessel and connected components of the RCPB are designed to withstand the effects of system P-T variations introduced by controlled heatup and cooldown operations, and operational transients for a specific RV neutron fluence period or the EFPYs in accordance with the DCD TS 5.6.4. However, the RV is considered the most critical component susceptible to nonductile failure because of the neutron fluence experienced over the RV's lifetime. GL 96-03 Criterion 3 states that the PTLR may include the LTOP system lift-setting limits

developed using NRC-approved methodologies. The PTLR and the APR1400 PTLR describe the detailed analytical methodology for developing the LTOP system limits.

The APR1400 LTOP mode of operation controls the RCS pressure at low temperatures so that the integrity of the RCPB is not compromised by violating the requirements in 10 CFR Part 50, Appendix G. The LTOP mode of operation for overpressure protection of the APR1400 RV consists of two shutdown cooling system (SCS) suction line relief valves (SI-179 and SI-189). Each valve provides adequate relief capacity to prevent any pressure transient from exceeding the controlling P-T limits whenever operating below the LTOP disable temperature during heatup and below the LTOP enable temperature during cooldown. APR1400 DCD Sections 5.2.2 and 5.4.7 discuss the relief valve design with a summary of the design parameters in DCD Table 5.2-3. In addition, whenever the LTOP relief valves are used during LTOP mode of operation, TS LCO 3.4.11.a is applicable and requires that the suction relief valves lift settings are within the limits specified in the PTLR.

As described in APR1400 DCD Section 5.2.2.1, for low-temperature operations, the set pressure for the SCS suction relief valves is established based on the low-temperature pressure limit for the RV with respect to the analyses under ASME Code, Section XI, Appendix G. APR1400 DCD Sections 5.2.2 and 5.3.2 discuss the analysis to determine the generic heatup and cooldown P-T limit curves for the APR1400 design, in accordance with 10 CFR Part 50, Appendix G, for normal operation of the RCS. A COL applicant that references the APR1400 design certification will develop plant-specific P-T limit curves, consistent with an approved methodology. This action item is identified as COL Item 5.3(2) in APR1400 DCD Tier 2 Table 1.8-2. The P-T limits identified in ASME Code, Section XI, Appendix G, require that the applicant obtain its analytical results using an approved methodology equivalent to methods of analysis described in ASME Code, Section XI, 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 ASME Code, Section XI, Appendix G. Furthermore, whenever the P-T limit curves are revised, the SCS relief valves setpoint must be reevaluated to confirm the validity of the existing pressure setpoint, or reanalyzed to determine a new pressure setpoint of the relief valves based on the revised P-T limit curves. On this basis, the staff has determined that the provisions of PTLR Criterion 3 have been satisfied.

3.2.4 PTLR Criterion 4

Appendix G to 10 CFR Part 50 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 are defined in terms of the shift in the RT_{NDT} values resulting from neutron irradiation over a given period of facility operation, expressed in EFPYs. 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 RT_{NDT} caused by irradiation ($\otimes RT_{NDT}$), and a margin term. RG 1.99, Revision 2, gives the staff's recommended methods for calculating ART values used for P-T limit calculations. $\otimes RT_{NDT}$ 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 a 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 neutron fluence, and the calculational procedures. ASME Code, Section XI, Appendix G, 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 (one-quarter of the RV thickness) and 3/4T (three-quarters of the RV thickness) 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. Section 4 of the PTLR provides the method used to determine the ART values at the 1/4T and 3/4T locations. Tables 4-1, 4-2, and 8-1 of the APR1400 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 years. In Table 4-2, the applicant indicated that the limiting beltline material used to develop the P-T limits is a weld conservatively assumed to be in the center of the RV beltline and subjected to a projected neutron fluence of $9.5x10^{19}$ neutrons per square centimeter (with energies greater than 1 mega electron volt (Mev), E > 1.0 Mev), which is the maximum projected neutron fluence on the vessel. The corresponding 60-year ART values at the 1/4T and 3/4T locations are 117 degrees F and 98 degrees F, respectively. Table 8-1 of the APR1400 PTLR identifies a limiting RT_{PTS} value of 122.6 degrees F at 60 years, corresponding to the beltline-region weld material. The staff confirmed the applicant's selection of the beltline-region weld as the limiting beltline material and performed an independent calculation of the ART values for this material using the method in RG 1.99, Revision 2. The staff also verified that the RT_{PTS} calculations were in compliance with the requirements of 10 CFR 50.61.

As discussed above, the staff verified that the ART calculations were consistent with RG 1.99, Revision 2, and the RT_{PTS} calculations were in compliance with the requirements of 10 CFR 50.61. In addition, the applicant has 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 staff determined 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. Section IV.A.2 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 ASME Code, Section XI, Appendix G, were used to generate the P-T limit curves. Table 1 of 10 CFR Part 50, Appendix G, summarizes 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. Figure 6-1 gives the P-T limit curves for heatup and cooldown operations, core critical operations, and hydrostatic and leak testing. The applicant has provided the P-T limit curves but not the corresponding data points, which are needed to verify the method. The staff discussed this issue with the applicant in a public meeting on June 30, 2015, and the applicant responded that it would revise the PTLR to include the data points. This meets the provisions of PTLR Criterion 5. The applicant also supplied a marked-up copy of the proposed changes in a

letter dated July 17, 2015 (ADAMS Accession No. ML15198A557). The staff confirmed that the next revision of the PTLR included the proposed changes.

The staff also performed independent analyses to verify the P-T curves for heatup and cooldown operations, core critical operations, and hydrostatic and pressure testing provided in the APR1400 PTLR. Based on this independent verification, the staff determined that the applicant developed its proposed P-T limits in accordance with ASME Code, Section XI, Appendix G, and that the limits therefore satisfy the requirements of 10 CFR Part 50, Appendix G. Hence, the applicant's proposed P-T limit curves are acceptable for operation of the APR1400 RV. Therefore, the staff determined 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 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 staff determined that the curves were in compliance with 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 staff determined that the provisions of PTLR Criterion 6 are satisfied.

3.2.7 PTLR Criterion 7

RG 1.99, Revision 2, gives the staff's recommended methods for calculating the ART values for RV beltline materials. These are calculated for the 1/4T and 3/4T locations in the RV wall. ASME Code, Section XI, Appendix G, and 10 CFR Part 50, Appendix G, require the use of these values for the calculations of P-T limit curves for reactors. Appendix G to 10 CFR Part 50 also requires the ART values to 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, particularly copper and nickel. 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 1.99, Revision 2, specifies that a CF be calculated and input into the calculation of the final ART value for each beltline material. RG 1.99, Revision 2, cites two possible methods for determining the CF values for the RV beltline base metal and weld materials: (1) Regulatory Position 1.1 in the RG 1.99, Revision 2, allows the licensee to determine the CF values from applicable tables in the RG 1.99, Revision 2, 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 RG 1.99, Revision 2, defines the criteria for determining the credibility of the RV surveillance data sets. In accordance with the requirements of 10 CFR Part 50, Appendix G, the RG 1.99, Revision 2, 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 the 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 the ART.

To ensure that PTLRs are in compliance 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 APR1400 PTLR is generic for the APR1400 design and is based on bounding embrittlement correlations for which surveillance data are not yet available. Therefore, the incorporation of surveillance data and related calculations is currently not applicable to the APR1400 PTLR. As previously discussed, the CF and ART values in the PTLR were determined using the procedures of Regulatory Position 1.1 in RG 1.99, Revision 2. Therefore, the staff determined that the provisions of PTLR Criterion 7 are satisfied. However, the staff notes that the provisions of PTLR Criterion 7 will remain applicable to specific plants referencing the APR1400 design. As such, plants that incorporate the APR1400 PTLR will be expected to update their PTLRs in accordance with PTLR Criterion 7 as plant-specific surveillance data become available.

4.0 CONCLUSION

The staff has completed its review of the APR1400 PTLR and determined that the contents of the APR1400 PTLR conform to the staff's technical criteria for PTLRs as defined in Attachment 1 of GL 96-03. The staff has also determined that the PTLR has satisfied the requirements of 10 CFR Part 50, Appendix G. Furthermore, the staff has determined that the APR1400 PTLR is compatible with the APR1400 generic TS and that the PTLR-related TS provisions meet the technical criteria of GL 96-03. Based on this evaluation, the staff concludes that the latest revision of the APR1400 PTLR is acceptable for generic use by APR1400 COL applicants for establishing limiting P-T limit curves, LTOP system limits, and related input parameters. Pursuant to TS 5.6.4c, future APR1400 COL holders will be required to provide the PTLR to the NRC upon issuance for each RV neutron fluence period and for any PTLR revision or supplement thereto. Finally, in accordance with GL 96-03, the NRC must approve any subsequent changes in the method used to develop the P-T limits.