

be met for all conditions.” Further, appendix G of 10 CFR part 50 specifies that the requirements for these limits are based on the application of evaluation procedures given in Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code). The provisions of ASME Code Case N-641 were incorporated in Appendix G of Section XI of the ASME Code in the 1998 Edition through the 2000 Addenda, which is the edition and addenda of record in the 2003 Edition of 10 CFR part 50. However, in this case, the licensee is still required to request an exemption to apply Code Case N-641 since the Seabrook licensing basis has only been updated to include the 1995 Edition through the 1996 Addenda of the ASME Code.

In order to address provisions of amendments to the Seabrook, Technical Specification (TS) P-T limit curves, FPLE Seabrook requested, in its submittal dated October 11, 2002, that the staff exempt Seabrook from application of specific requirements of appendix G to 10 CFR part 50, and substitute use of ASME Code Case N-641. ASME Code Case N-641 permits the use of an alternate reference fracture toughness curve (*i.e.*, use of “ K_{IC} fracture toughness curve” instead of “ K_{IA} fracture toughness curve,” where K_{IC} and K_{IA} are “Reference Stress Intensity Factors,” as defined in ASME Code, Section XI, Appendices A and G, respectively) for RPV materials and permits the postulation of a circumferentially-oriented flaw for the evaluation of circumferential RPV welds when determining the P-T limits. The proposed exemption request is consistent with, and is needed to support, the Seabrook TS amendment that was contained in the same submittal. The proposed Seabrook TS amendment will revise the P-T limits for heatup, cooldown, and in-service test limitations for the reactor coolant system (RCS) through 20 effective full-power years of operation.

Code Case N-641

The licensee has proposed an exemption to allow use of ASME Code Case N-641 in conjunction with Appendix G to ASME Section XI, 10 CFR 50.60(a) and 10 CFR part 50, appendix G, to establish the P-T limits for the Seabrook RPV.

The proposed TS amendment to revise the P-T limits for Seabrook relies, in part, on the requested exemption. These revised P-T limits have been developed using the lower-bound K_{IC} fracture toughness curve shown in ASME Section XI, Appendix A, Figure

A-2200-1, in lieu of the lower-bound K_{IA} fracture toughness curve of ASME Section XI, Appendix G, Figure G-2210-1, as the basis fracture toughness curve for defining the Seabrook P-T limits. In addition, the revised P-T limits have been developed based on the use of a postulated circumferentially-oriented flaw for the evaluation of RPV circumferential welds, in lieu of the axially-oriented flaw which would be required by Appendix G to Section XI of the ASME Code. The other margins involved with the ASME Section XI, Appendix G process of determining P-T limit curves remain unchanged.

Use of the K_{IC} curve as the basis fracture toughness curve for the development of P-T operating limits is more technically correct than use of the K_{IA} curve. The K_{IC} curve appropriately implements the use of a relationship based on static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a RPV, whereas the K_{IA} fracture toughness curve codified into Appendix G to Section XI of the ASME Code was developed from more conservative crack arrest and dynamic fracture toughness test data. The application of the K_{IA} fracture toughness curve was initially codified in Appendix G to Section XI of the ASME Code in 1974 to provide a conservative representation of RPV material fracture toughness. This initial conservatism was necessary due to the limited knowledge of RPV material behavior in 1974. However, additional knowledge has been gained about RPV materials which demonstrates that the lower bound on fracture toughness provided by the K_{IA} fracture toughness curve is well beyond the margin of safety required to protect the public health and safety from potential RPV failure.

Likewise, the use of a postulated circumferentially-oriented flaw in lieu of an axially-oriented one for the evaluation of a circumferential RPV weld is more technically correct. The size of a flaw required to be postulated for P-T limit determination has a depth of one-quarter of the RPV wall thickness and a length six-times the depth. Based on the direction of welding during the fabrication process, the only technically-reasonable orientation for such a large flaw is for the plane of the flaw to be circumferentially-oriented (*i.e.*, parallel to the direction of welding). Prior to the development of ASME Code Case N-641 (and the similar ASME Code Case N-588), the required postulation of an axially-oriented flaw for the evaluation of a circumferential RPV weld has provided

an additional and unnecessary level of conservatism to the overall evaluation.

In addition, P-T limit curves based on the K_{IC} fracture toughness curve and postulation of a circumferentially-oriented flaw for the evaluation of RPV circumferential welds will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operations. The operating window through which the operator heats up and cools down the RCS is determined by the difference between the maximum allowable pressure defined by Appendix G of ASME Section XI, and the minimum required pressure for the reactor coolant pump seals adjusted for instrument uncertainties. A narrow operating window could potentially have an adverse safety impact by increasing the possibility of inadvertent overpressure protection system actuation due to pressure surges associated with normal plant evolutions such as RCS pump starts and swapping operating charging pumps with the RCS in a water-solid condition.

Since application of ASME Code Case N-641 provides appropriate procedures to establish maximum postulated defects and to evaluate those defects in the context of establishing RPV P-T limits, this application of the Code Case maintains an adequate margin of safety for protecting RPV materials from brittle failure. Therefore, the licensee concluded that these considerations were special circumstances pursuant to 10 CFR 50.12(a)(2)(ii), which states: “Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.”

In summary, the ASME Section XI, Appendix G procedure was conservatively developed based on the level of knowledge existing in 1974 concerning reactor coolant pressure boundary materials and the estimated effects of operation. Since 1974, the level of knowledge about the fracture mechanics behavior of RCS materials has been greatly expanded, especially regarding the effects of radiation embrittlement and the understanding of fracture toughness properties under static and dynamic loading conditions. The NRC staff concurs that this increased knowledge permits relaxation of the ASME Section XI, Appendix G requirements by application of ASME Code Case N-641, while maintaining, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of the ASME Code and the NRC regulations to ensure an