52-001

11#3

GE Nuclear Energy

ABWR

Date 8/31/92

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Subject RPV Surveillance - Resubmittal

Message We have change our weld specimen definition in accordance with Barry Elliot's suggestion (see bottom of page 5.3-4.

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Preparation of impact testing procedures, calibration of test equipment, and the retention of the records of these functions and test data comply with the requirements of the ASME Code, Section III. Personnel conducting impact testing are qualified by experience, training or qualification testing that demonstrates competence to perform tests in accordance with the testing procedure.

(4) Charpy-V Curves for the RPV Beltline (G-IIIA and G-IVA-1)

A full transverse Charpy-V curve is determined for all heats of base material and weld metal used in the core beltline region with a minimum of three (3) specimen tested at the actual T_{NDT}. The minimum upper-shelf energy level for base material and weld metal in the beltline region is 10.4 kg fm as required by G-IVA.1.

In regard to G-III A, it is understood that separate, unirradiated baseline specimens per ASTM E 185, Paragraph 6.3.1 will be used to determine the transition temperature curve of the core beltline base material, HAZ and weld metal.

(5) Bolting Material

All bolting material exceeding one inch diameter has a minimum of 6.4 kg fm charpy-V energy and 0.64 mm lateral expansion at the minimum bolt preload temperature of 21 °C.

(6) Alternative Procedures for the Calculation of Stress Intensity Factor (Appendix G-IV A)

Stress intensity factors are calculated by the methods of ASME, Section III, Appendix G. Discontinuity regions are evaluated as shell and head areas, as part of the detailed thermal and stress analyses in the vessel stress report. Considerations are given to membrane and bending stresses, as outlined in Paragraph G-2222. Equivalent margins of safety to those required for shells and heads are demonstrated using a 1/4 T postulated defect at all locations, with the exception of the main closure flange to the head and shell discontinuity locations. Additional instruction on operating limits is required for outside surface flaw sizes greater than 6.0 mm at the outside surface of the flange to shell joint based on analysis made for ABWR reactor vessels using the calculations methods shown in WRCB 175. It will be demonstrated, using a test mockup of these areas, that smaller defects can be detected by the ultrasonic inservice examinations procedures required at the adjacent weld joint.

(7) Fracture Toughness Margins in the Control of Reactivity (Appendix G-IV A).

ASME Code, Section III, Appendix G, was used in determining pressure/temperature limitations for all phases of plan operation.

5.3.1.6 Material Surveillance

5.3.1.6.1 Compliance with Reactor Vessel Material Surveillance Program Requirements

The materials surveillance program monitors changes in the fracture toughness properties of ferritic materials in the reactor vessel beltline region resulting from exposure to neutron irradiation and thermal environment.

Reactor vessel materials surveillance specimens are provided in accordance with requirements of ASTM E-185 and 10CRF 50, Appendix H. Materials for the program are selected to represent materials used in the reactor beltline region. Specimens are manufactured from a ~~plate or~~ forging actually used in the beltline region just above or below and a weld typical of those ~~in~~ of the beltline region and thus represent base metal, weld material, and the weld heat-affected zone material. material and HAZ material The ~~plate and~~ welds are heat treated in a manner which simulates the actual heat treatment performed on the core region shell ~~plates~~ forging of the

completed vessel. Each in-reactor surveillance capsule contains 36 Charpy V-notch and 6 tensile specimens. The capsule loading consists of 12 Charpy V Specimens each of base metal, weld metal,* heat-affected zone material, and 3 tensile specimens each from base metal and weld metal. A set of out-of-reactor baseline Charpy V-notch specimens, tensile specimens, and archive material are provided with the surveillance test specimens. Neutron dosimeters and temperature monitors will be located within the capsules as required by ASTM E 185.

Four surveillance
~~Three~~ capsules are provided, ~~in accordance with requirements of 10CFR50, Appendix H, since the~~ The predicted end of the adjusted reference temperature of the reactor vessel steel is less than 38 °C.

The following proposed withdrawal schedule is ~~in accordance with~~ extrapolated from ASTM E 185.

First capsule: After 6 effective full-power years

Second capsule: After ~~15~~ 20 effective full-power years

Fourth ~~Third~~ capsule: Schedule determined based on results of first ~~two~~ three capsules per ASTM E 185, Paragraph 7.6.2. 251.4

Third capsule: With an exposure not to exceed the peak EOL fluence.

Fracture toughness testing of irradiated capsule specimens will be in accordance with requirements of ASTM E 185 as called out for by 10CFR50, Appendix H.

5.3.1.6.2 Neutron Flux and Fluence Calculations

A description of the methods of analysis is contained in Subsections 4.1.4.5 and 4.3.2.8.

5.3.1.6.3 Predicted Irradiation Effects on Beltline Materials

Transition temperature changes and changes in upper-shelf energy shall be calculated in accordance with the rules of Regulatory Guide 1.99. Reference temperatures shall be established in accordance with 10CFR50, Appendix G, and NB-2330 of the ASME Code.

Since weld material chemistry and fracture toughness data are not available at this time, the limits in the purchase specification were used to estimate worst-case irradiation effects.

These estimates show that the adjusted reference temperature at end-of-life is less than 34 °C, and the end-of-life upper-shelf energy exceeds 69 kg·m. (See response to Question 251.5 for the calculation and analysis associated with this estimate.) 251.5

5.3.1.6.4 Positioning of Surveillance Capsules and Methods of Attachment (Appendix H.II B (2))

Surveillance specimen capsules are located at two ~~three~~ azimuths at a common elevation in the core beltline region. The sealed capsules are not attached to the vessel but are in welded capsule holders. The capsule holders are mechanically retained by capsule holder brackets welded to the vessel cladding. Since reactor vessel specifications require that all low-alloy steel pressure vessel boundary materials be produced to fine-grain practice, underclad cracking is of no concern. The capsule holder brackets allow the removal and reinsertion of capsule holders. Although not code parts, these brackets are designed, fabricated, and analyzed to the requirements of ASME Code Section III. A positive spring-loaded locking device is provided to retain the capsules in position throughout any anticipated event during the lifetime of the vessel. See Subsection 5.3.4.2 for interface requirements pertaining to materials and surveillance capsules.

The capsule placement is designed to produce a lead factor of approximately 1.2 to 1.5.

In areas where brackets (such as the surveillance specimen holder brackets) are located, additional nondestructive examinations are performed on the vessel base metal and stainless steel weld-deposited cladding or weld-buildup pads during vessel manufacture. The base metal is ultrasonically examined by straight-beam techniques to a depth at least equal to the thickness of the bracket being joined. The area examined is the area of width equal to at least half the thickness of the part joined. The required stainless steel weld-deposited cladding is similarly examined. The full penetration welds are liquid-penetrant examined. Cladding thickness is required to be at least 3.2 mm. These requirements have been successfully applied to a variety of bracket designs which are attached to weld-deposited stainless steel cladding or weld buildups in many operating BWR reactor pressure vessels.

Inservice inspection examinations of core beltline pressure-retaining welds are performed from the outside surface of the reactor pressure

* Weld metal specimens will be made from the same heat of weld wire and lot of flux (if applicable) and by the same welding practice as used for the beltline weld.

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