REQUEST FOR ADDITIONAL INFORMATION NO. 107-1293 REVISION 0

11/24/2008

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.09.04 - Control Rod Drive Systems
Application Section: 3.9.4

QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

03.09.04-1

US-APWR Design Certification- 03.09.04, Control Rod Drive Systems (CRDS)
[Review performed against revision 0 of the US-APWR DCD Tier 2.]

RAI 1293-01
Include reference(s) that documents control rod drive mechanism (CRDM) qualification to operate in the reactor pressure vessel (RPV) environment. Based on the nature of this reference, provide one of the following for review:

1. For a new series of tests unique to the US-APWR CRDM, provide for review an operability assurance program for the US-APWR CRDM that covers all the items contained in the guidance in SRP Section 3.9.4, Part I, Item 4, or

2. If a specific previous testing program that has been approved by the USNRC is referenced, such as for the L-106A CRDM, provide the following additional information for review:

    a. Describe differences between the US-APWR and the previous design, such as the L-106A CRDM and discuss their effects on the applicability of the previous operability tests to the US-APWR CRDM. US-APWR DCD Tier 2, Section 3.9.4.1.1 (page 3.9-56) states that the US-APWR CRDM design is improved by (1) butt welding the CRDM latch housing to the CRDM nozzle on the reactor vessel closure head and (2) applying a chrome carbide coating to the latch arms.
    b. Identify any differences in the operating conditions, such as the weight of the rod control cluster assembly (RCCA) and loads imposed by hydrodynamic forces through the RCCA to the CRDM, and discuss their effects on the applicability of the previous tests to the US-APWR CRDS. US-APWR DCD Tier 2, Section 1.2.1.5.1.1 (page 1.2-11) states that the active fuel length of the US-APWR will be increased from 12 to 14 ft as compared to the current Mitsubishi-APWR design. Therefore, the rod control cluster assembly (RCCA) of the US-APWR may be heavier than in previous designs, and the increased weight may affect functionality and wear differently than in previous tests. US-APWR DCD Tier 2, Section 1.5.2.1 (page 1.5-1) indicates that there are changes in the reactor internals which may alter flow loads from those in previous designs. US-APWR

DCD Tier 2, Section 4.3.4 (Page 4.3-27) states there the number of fuel assemblies has been increased to 257 from previous designs.

c. Compare the design LOCA plus SSE loads for the US-APWR CRDS to the loads that were used in the previous design verification tests.
d. Provide the basis for the 60-year lifetime for the CRDM internals. The design lifetime for the L-106A CRDM was 40 years. US-APWR DCD Tier 2, Section 3.9.4.2.1 (Page 3.9-60) states that the design life for the US-APWR CRDM is 60 years.

General Design Criteria (GDC) 2, 26, 27, and 29, require that the CRDS be designed to withstand the effects of an earthquake, and be designed with appropriate margin to assure its functionality under conditions of normal operation, anticipated operational occurrences, and the postulated accident conditions. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part I **AREAS OF REVIEW,** Item 4 (page 3.9.4-3) states that a review of plans for the conduct of an operability assurance program or that references previous test programs or standard industry procedures for similar apparatus is performed. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part III **REVIEW Procedures,** Item 1 (page 3.9.4-8) states that, "The objectives of the review are to determine...that suitable life cycle testing programs have been utilized to prove operability under service conditions".

RAI 1293-02

Provide for review how wear and overcoming a stuck rod are addressed in the operability assurance program, including details of the improved wear resistance offered by the chrome carbide coating that has not previously been used in U.S. nuclear power plants.

General Design Criteria (GDC) 26, 27, and 29, as they relate to the CRDS, require that the CRDS be designed with appropriate margin to assure its functionality under conditions of normal operation, postulated accident conditions, and anticipated operational occurrences. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part II ***SRP Acceptance Criteria***, Item 4 (page 3.9.4-6) states that, “The operability assurance program will be acceptable provided that observed performance as to wear, functioning times, latching, and ability to overcome a stuck rod meet system design requirements.” US-APWR DCD Tier 2, Section 3.9.4.4 (page 3.9-62) states that, “The capability of the CRDM functions, including withdrawal, insertion, and trip delay are confirmed by both lead unit tests and production unit tests to demonstrate that the design specification requirements are met prior to shipment.” System design requirements for cold stepping, hot and cold trip delay times, and hot stepping are given in US-APWR DCD Tier 2 Section 3.9.4, and preoperational tests are discussed in Section 14.2, but there is no discussion on wear or overcoming a stuck rod.

RAI 1293-03

Include the acceptance criteria for the safety-related non-pressurized portion of the US-APWR. Provide for review a description and results of stress, deflection, and fatigue analyses for the non-pressurized portion of the US-APWR CRDM, including the following:

- What are the design loads and loading combinations?
- What values of material properties are used and what is the justification for their basis?
- What stress, deflection, and fatigue criteria are used and what is the justification for their basis?
- What are the design margins and how do they compare with previous designs?

General Design Criteria (GDC) 2, 26, 27, and 29, as they relate to the CRDS, require that the CRDS be designed to withstand the effects of an earthquake, and be designed with appropriate margin to assure its functionality under conditions of normal operation, anticipated operational occurrences, and postulated accident conditions. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part II ***SRP Acceptance Criteria***, Item 2.C (page 3.9.4-6) states that for “non-pressurized equipment (Non-ASME Code): Design margins presented for allowable stress, deformation, and fatigue should be equal to or greater than margins for other plants of similar design with successful operating experience. A justification of any decreases in design margins should be provided.” The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part II ***SRP Acceptance Criteria***, Item 3 (page 3.9.4-6) states that, “The stress limits applicable to...non-pressurized portions of the control rod drive system should be as given in SRP Section 3.9.3 for the response to each loading set.” US-APWR DCD Tier 2, Section 3.9.4.2.3 (page 2.9-61) states that the non-pressurized portion of the US-APWR CRDM is non-ASME Code, Section III, limited; however, no description is provided on the criteria for structural analyses, design margins, or how design margins were obtained.

RAI 1293-04

Include design basis pipe breaks (DBPB) in the ASME Code Service Level C Design Load Combinations in Section 3.9.3 or provide for review a discussion as to why DBPB is not included in the ASME Code Service Level C Design Load Combinations.

General Design Criterion (GDC) 27, as it relates to the CRDS, requires that the CRDS be designed with appropriate margin to assure its functionality under accident conditions. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.3, Appendix A, Table 1 (page 3.9.3-23) includes DBPB in both Emergency and Faulted System Operating Conditions (ASME Code Service Stress Limits C and D, respectively). Similar guidance is also found in USNRC Standard Review Plan (SRP), Section 3.9.3, Appendix A, Paragraph 4.B(iii)(1) (page 3.9.3-20). However, in US-APWR DCD Tier 2, Section 3.9.3, Table 3.9.3 (page 3.9-91), DBPB is listed in the ASME Code Service Level D Design Load Combinations, but not in the ASME Code Service Level C Design Load Combinations.

RAI 1293-05

Provide for review a description in more detail of the quality classification of the non-pressurized safety components of the CRDS (e.g., latch mechanism).

General Design Criterion (GDC) 1 and 10CFR50.55a, as they relate to the CRDS, require that the CRDS be designed to quality stands commensurate with the importance of the safety functions to be performed. US-APWR DCD Tier 2, Section 3.9.4.2.3 (page 3.9-61) states that, "The design, fabrication, inspection, and testing of the safety-related latch mechanism comes under the quality assurance requirement regarding safety components in 10CFR 50.55a..." However, non-pressurized safety component portions of the CRDM are not listed in US-APWR DCD Tier 2, Table 3.2.2 (pages 3.2-16 to 3.2-65), nor is a specific paragraph of 10CFR50.55a referenced, and the quality standards (e.g., such as NQA-1 or 10 CFR 50 Appendix B) to be applied need to be clarified.

RAI 1293-06

Provide for review the basis of the 1.18-inch allowable rod travel housing deflection during the seismic event in US-APWR DCD Tier 2, Section 3.9.4.3 (page 3.9-62), and how it has been quantified by analysis that the rod control cluster assembly (RCCA) will be inserted into the core at this deflection.

General Design Criterion (GDC) 2, as it relates to the CRDS, requires that the CRDS be designed to withstand the effects of an earthquake. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part I **AREAS OF REVIEW,** Item 1 (page 3.9.4-2) states that, "The descriptive information, including design criteria...is reviewed to permit an evaluation of the adequacy of the system to perform its mechanical function properly."

RAI 1293-07

Include the criteria used for CRDM operational capability, including the margin, following exposure to the combined effects of a LOCA and an SSE.

General Design Criteria (GDC) 2 and 27, as they relate to the CRDS, require that the CRDS be designed to withstand the effects of an earthquake, and be designed with appropriate margin to assure its functionality under conditions of postulated accident conditions. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part I **AREAS OF REVIEW,** Item 1 (page 3.9.4-2) states that, "The descriptive information, including design criteria, testing programs,...is reviewed to permit an evaluation of the adequacy of the system to perform its mechanical function properly."

RAI 1293-08

Include a reference(s) that the CRDM design conforms to its design criteria and limits. If the design verification includes loading combination analysis in conjunction with testing, then include a reference(s).

General Design Criteria (GDC) 2 and 27, as they relate to the CRDS, require that the CRDS be designed to withstand the effects of an earthquake, and be designed with appropriate margin to assure its functionality under conditions of postulated accident conditions. The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part I **AREAS OF REVIEW,** Item 1 (page 3.9.4-2) states that, "The descriptive information, including design criteria, testing programs,...is reviewed to permit an evaluation of the adequacy of the system to perform its mechanical function properly."

RAI 1293-09

Verify that the insertion and withdrawal times in the stepping mode, and the drop times, meet the design requirements. Provide the design requirements for these functions, their bases (for example, the safety analysis), and the margins between the CRDS functional requirement times and the times required by the safety analysis.

General Design Criteria (GDC) 26, 27, and 29, as they relate to the CRDS, require that the CRDS be designed with appropriate margin to assure its functionality under conditions of normal operation, postulated accident conditions, and anticipated operational occurrences (AOO). The guidance in USNRC Standard Review Plan (SRP), Section 3.9.4, Part I **AREAS OF REVIEW,** Item 1 (page 3.9.4-2) states that, "The descriptive information, including design criteria, testing programs,...is reviewed to permit an evaluation of the adequacy of the system to perform its mechanical function properly." Section 3.9.4.2.1 of US-APWR DCD Tier 2 (page 3.9-61), states that, "The rod drop time…is evaluated by analysis." However, no analysis is referenced and the type of analysis needs to be clarified.

RAI 1293-10

Clarify if all CRDMs go through the functional verification tests, and at what stage (including post-refueling). Provide for review the test abstract for the Control Rod Drive System referred to in US-APWR DCD Tier 2 Section 14.3.4.7.

General Design Criteria (GDC) 26, 27, and 29, as they relate to the CRDS, require that the CRDS be designed with appropriate margin to assure its functionality under conditions of normal operation, postulated accident conditions, and anticipated operational occurrences. Section 4.6.3 in US-APWR DCD Tier 2 (page 4.6-2) lists four stages of tests: prototype tests of components, production tests of components following manufacture in shop, preoperational tests on site, and periodic in-service tests, which are stated to be in Section 3.9.4.4 and Section 14.2. These Sections give some information on preshipment and preoperational testing, but none on periodic in-service or post-refueling startup tests. The tests included in each stage need to be clarified, and whether each CRDM must be tested. Section 14.3.4.7 in US-APWR DCD Tier 2 (page 14-16) refers to Section 14.2.9.1.8 for a test abstract on Control Rod Drive Systems, but this section is not included in the Tier 2 information.