

REQUEST FOR ADDITIONAL INFORMATION NO. 199-2073 REVISION 1

2/9/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 10.02.03 - Turbine Rotor Integrity

Application Section: 10.2.3

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects)
(CIB1)

10.02.03-1

The US APWR DCD, Tier 2, FSAR Section 10.2.3.1 specifies that the turbine rotor material complies with the chemical properties of ASTM A470, Classes 5, 6, and 7, but the specification for the rotor has lower limitations for phosphorous, sulfur, aluminum, antimony, tin, argon and copper than ASTM A470. In addition the US APWR DCD, Tier 2, FSAR Section 10.2.3.2 states that the impact energy and transition temperature requirements are more rigorous than those given in ASTM A470 Class 6 or 7. The above does not provide sufficient information concerning the material used for the LP and HP turbine rotors in accordance with SRP Section 10.2.3 to assess its acceptability on the turbine rotor integrity. Therefore, the NRC staff requests the following information be provided in the US APWR DCD FSAR:

- a) The chemical composition ranges, including maximum levels of trace elements, and the corresponding mechanical properties (yield strength, impact energy, transition temperature, etc.) of the materials that differ from the ASTM A470 specification.
- b) Discuss how these material properties relate to those used in the turbine missile analysis (Mitsubishi Report MUAP-07028, Revision 0).

10.02.03-2

The US APWR DCD, Tier 2, FSAR Section 10.2.3.1 specifies that Charpy tests and tensile tests in accordance with ASTM A370 and /or the equivalent are required from the forging supplier. This does not provide specifics about the tests in order for the staff to review it with. The guidelines of SRP Section 10.2.3 has specific guidelines for the staff to use in reviewing the acceptability of the material selection and fracture toughness of the rotor. Therefore, the NRC staff requests that the following information be provided:

- a) Provide the specific tests (i.e., chemical analysis, Charpy V-notch - including fracture appearance temperature (FATT), tensile) to be performed, the acceptance criteria and the number of tests to be performed on the fabricated rotor. Also, specify the equivalent standards and provide the criteria used to determine that these standards are equivalent to ASTM A370 in order to ensure that the material properties are tested appropriately and consistently to prevent

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failure of the turbine rotor assemblies and the generation of potential missiles in accordance with GDC 4 of Appendix A to 10 CFR Part 50.

- b) The US APWR DCD, Tier 2, FSAR Section 10.2.3.1 also implies that the rotor may or may not have a bored area. Discuss where the tests locations will be on the rotor, including the bore region. In addition, discuss how the material properties for the fabricated rotor will be homogeneous for the internal regions if the rotor is not bored.

10.02.03-3

Table 2.7.1.1-1 in US APWR DCD, Revision 1, Tier 1, Section 2.7.1.1, provides an ITAAC (commitment 2) for the inspections and tests of the as-built turbine rotors. The acceptance criteria for the ITAAC states, "the as-built LP rotor material conforms to the specified requirements as described in Subsection 2.7.1.1.1." However, the NRC staff notes that FSAR Section 2.7.1.1.1 does not provide requirements for the turbine rotor. Therefore, the ITAAC should specify acceptance criteria, which determines that the as-built turbine material properties, turbine rotor and blade designs, pre-service inspection and testing results, and in-service inspection and testing plans meet the requirements of the turbine missile probability analysis-(Mitsubishi Technical Reports MUAP-07028, and MUAP-07029).

It should be noted that USAPWR DCD, Revision 0, Tier 2, FSAR Section 10.2.5 discussed this issue by stating the following:

"The program ISI be consistent with the maintenance and inspection program plan activities and inspection intervals identified in Subsection 10.2.3.5. The Combined License holder has available plant-specific turbine rotor test data and calculated toughness curves that support the material properties assumptions in the turbine rotor analysis. Plant start-up procedure including warm-up time is to be verified based on the specific material property."

However, this statement was removed from COL information item 10.2(1). Confirm that this information was to be addressed in the ITAAC (commitment 2) to verify that the actual material properties (once the turbine is fabricated) are within the bounding turbine missile probability analysis, which determines the inspections and testing intervals of the turbine generator and overspeed protection systems for meeting the requirements of GDC 4 of 10 CFR Part 50 in protecting safety-related equipment from turbine missiles. In addition, the applicable ITAAC should be revised to include this information.

10.02.03-4

Confirm that terminology "subsurface sonic indications" should be "subsurface ultrasonic indications" in the US APWR DCD, Tier 2, FSAR Section 10.2.3.3.

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10.02.03-5

The US APWR DCD, Tier 2, FSAR Section 10.2.3.4 specifies that the non-bored design of the high-pressure and low-pressure turbine rotor provide the necessary design margin by virtue of its inherently lower centerline stress. Also the use of solid rotor forgings was verified by an evaluation of the material removed from center-bored rotors for fossil power plants, and this evaluation demonstrated that the material at the center of the rotors satisfied the rotor material specification requirements. The NRC staff requests the following:

- a) Discuss how the non-bored rotor will be 100% ultrasonically inspected in accordance with the US APWR DCD, Tier 2, FSAR Section 10.2.3.3 since there is no bore to gain access to perform the ultrasonic inspection.
- b) Other sections in the US APWR DCD, Tier 2, including FSAR Section 10.2.3.3, state "in bores (if present)." This implies that there is an option for the rotor to either have a bore or not. Clarify whether the rotor will have a bore or not.
- c) Typically each fabricated rotor has destructive testing performed at various locations to ensure homogeneity and acceptable material properties. Discuss how the material properties for each rotor fabricated will have the required material properties and homogeneity throughout the forged rotor, including the interior, which is normally bored out. Also, provide any supporting evaluations or tests.

10.02.03-6

The US APWR DCD, Tier 2, FSAR Section 10.2.3.5 states the ultrasonic inspection is performed on both the high and low-pressure turbine rotors "at intervals of about 10 years." Clarify the inspection interval of "about 10 years," to a more specific value or range, such as "every 10 years" or "10 year intervals," etc..

10.02.03-7

Provide a sketch of the christmas tree side entry type root attachment referenced in US APWR DCD, Tier 2, FSAR Section 10.2.3.4 for connecting the turbine blades to the rotor. Discuss how ultrasonic inspection performed during inservice inspection in accordance with US APWR DCD, Tier 2, FSAR Section 10.2.3.5 will be performed and whether 100% coverage of the area can be achieved for the christmas tree side entry type root attachment.