REQUEST FOR ADDITIONAL INFORMATION 574-4633 REVISION 2

4/20/2010

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)

10.02.03-8

Revision 2 to the US-APWR FSAR revised Section 10.2.3.1 to delete the reference to Grade C (Classes 5, 6 and 7). Therefore the FSAR no longer specifies the type of material (Grade or Classification) from ASTM A470. Since there are different Grades and Classifications in ASTM A470 that have different chemical compositions and mechanical properties, the NRC staff cannot assess the acceptability of the material concerning the turbine rotor integrity as described in SRP 10.2.3, and whether the turbine rotor material is bounded by the turbine missile analysis. Therefore, the specific Grade and Classification of ASTM A470 material or reference to the specific material ordering requirements should be included in the US-APWR FSAR that is bounded by the turbine missile analysis.

10.02.03-9

In a letter dated March 10, 2009, the response to RAI No. 199-2073, Question 10.02.03-2 provided acceptance criteria for the 50% FATT and Charpy V-notch energy which do not meet the acceptance criteria of -18°C (0°F) and 8.3 kg-m (60 ft-lbs), respectively, as provided in SRP Sections 10.2.3 (paragraphs II.1b and II.1c). Therefore, provide a discussion on why the material properties for the 50% FATT and Charpy V-notch energy provided in the response to RAI No. 199-2073, Question 10.02.03-2 ensures that the turbine rotor has adequate fracture toughness during startup and normal operating temperatures.

10.02.03-10

In a letter dated March 10, 2009, MHI provided a response to RAI No. 199-2073, Question 10.02.03-2, stated that the tensile and charpy testing will be performed on five specimens from the outer periphery of the turbine rotor. For a bored rotor, additional tensile and Charpy testing will be performed from three specimens on the interior bore periphery of the turbine rotor. However, the staff notes that Revision 2 of the US-APWR FSAR did not include the number of specimens to be tested as provided in the response to RAI No. 199-2073, Question 10.2.3-2. In addition, the staff notes that neither MHI's response to RAI No. 199-2073, Question 10.02.03-2 provided in a letter dated March 10, 2009, nor Section 10.2.3.2 of the US-APWR FSAR, Revision 2, Tier 2 provides the

method of calculating the fracture toughness value for the turbine rotor material. SRP Section 10.2.3 (paragraph II.2) lists four acceptable methods for obtaining the fracture toughness properties. Therefore, the staff requests that the US-APWR FSAR be revised to:

a. Include the number of test specimens as stated in its response to RAI No. 199-2073, Question 10.02.03-2
b. Include the test method and fracture toughness acceptance criteria that will be used for the turbine rotor design.

10.02.03-11

In a letter dated March 10, 2009, MHI provided responses to RAI No. 199-2073, Questions 10.02.03-2 and 10.02.03-5 concerning the integrity of a non-bored (solid) turbine rotor.

> MHI response to RAI No. 199-2073, Questions 10.02.03-2 provided some material test result comparisons between the rotor outer periphery and the rotor center core so that the mechanical properties at the rotor center core can be evaluated using the material at the outer periphery of the turbine rotor. Based on this comparison, chemical composition and mechanical testing of the core for non-bored rotors would not be performed. The NRC staff notes that the comparative material test results provided shows that the material at the center core of the turbine rotor has material properties that are less conservative (lower reduction of area, lower impact energy and higher 50 percent FATT temperature) than at the outer periphery, which is due to the different solidification rates of this large component. Therefore, the material properties cannot be accurately and consistently determined using only test specimens from the outer periphery of the turbine rotor.
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> In its response to RAI No. 199-2073, Question 10.02.03-05, MHI stated that ultrasonic inspection of the turbine rotor will be performed prior to gashing (final outside periphery machining) so that 100% ultrasonic inspection can be performed on the turbine rotor due to its drum shape. However, it also states that as ultrasonic testing technology advances, potential defects at the center core region will be detected. Therefore, this implies that currently, ultrasonic inspection is not capable of ensuring the integrity of non-bored turbine rotors at the center region.

Therefore, the integrity of non-bored turbine rotors cannot be verified, since the non-destructive examinations (pre-service and in-service volumetric inspections) are not capable of detecting defects at the center core region, and destructive testing cannot be performed on non-bored rotors to confirm the material properties. Therefore, the non-bored rotor design should be deleted from the US-APWR FSAR, or provide the following:

- Specific destructive testing that can confirm the material properties at the core region, and/or more extensive test results.
- Specific non-destructive testing that can detect defects at the center core region, or provide specific in-service non-destructive examinations, including inspection types, inspection interval,

acceptance criteria, etc. taking into consideration that material properties and the presence of internal defects of the as-built turbine rotor cannot be confirmed.

- Appropriate operating experience which justifies the integrity of the turbine rotor can be maintained.