MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

June 10, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-10166

Subject: MHI's Responses to US-APWR DCD RAI No.574-4633

Reference: 1) "Request for Additional Information No. 574-4633 Revision 2, SRP Section: 10.02.03 – Turbine Rotor Integrity, Application section Tier 2 FSAR Section 10.2.3," dated February 9, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Responses to Request for Additional Information No. 574-4633 Revision 2"

Enclosed are the responses to 4 RAIs contained within Reference 1.

As indicated in the enclosed materials, this document contains information that MHI considers proprietary, and therefore should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential. A non-proprietary version of the document is also being submitted with the information identified as proprietary redacted and replaced by the designation "[ ]".

This letter includes a copy of the proprietary version (Enclosure 2), a copy of the non-proprietary version (Enclosure 3), and the Affidavit of Yoshiki Ogata (Enclosure 1) which identifies the reasons MHI respectfully requests that all materials designated as "Proprietary" in Enclosure 2 be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Y. Ogata

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

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NRO

Enclosure:

1. Affidavit of Yoshiki Ogata

2. Responses to Request for Additional Information No. 574-4633 Revision 2 (proprietary version)

3. Responses to Request for Additional Information No. 574-4633 Revision 2 (non-proprietary version)

CC: J. A. Ciocco
C. K. Paulson

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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-10166

MITSUBISHI HEAVY INDUSTRIES, LTD.

AFFIDAVIT

I, Yoshiki Ogata, state as follows:

1. I am General Manager, APWR Promoting Department, of Mitsubishi Heavy Industries, LTD ("MHI"), and have been delegated the function of reviewing MHI's US-APWR documentation to determine whether it contains information that should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4) as trade secrets and commercial or financial information which is privileged or confidential.

2. In accordance with my responsibilities, I have reviewed the enclosed document entitled "Responses to Request for Additional Information No. 574-4633 Revision 2" dated April 2010, and have determined that portions of the document contain proprietary information that should be withheld from public disclosure. Those pages containing proprietary information are identified with the label "Proprietary" on the top of the page and the proprietary information has been bracketed with an open and closed bracket as shown here "[ ]". The first page of the document indicates that all information identified as "Proprietary" should be withheld from public disclosure pursuant to 10 C.F.R. § 2.390 (a)(4).

3. The information identified as proprietary in the enclosed document has in the past been, and will continue to be, held in confidence by MHI and its disclosure outside the company is limited to regulatory bodies, customers and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and is always subject to suitable measures to protect it from unauthorized use or disclosure.

4. The basis for holding the referenced information confidential is that it describes the unique design by MHI for performing the turbine rotors design of the US-APWR.

5. The referenced information is being furnished to the Nuclear Regulatory Commission ("NRC") in confidence and solely for the purpose of information to the NRC staff.

6. The referenced information is not available in public sources and could not be gathered readily from other publicly available information. Other than through the provisions in paragraph 3 above, MHI knows of no way the information could be lawfully acquired by organizations or individuals outside of MHI.

7. Public disclosure of the referenced information would assist competitors of MHI in their design of new nuclear power plants without incurring the costs or risks associated with the design of the subject systems. Therefore, disclosure of the information contained in the referenced document would have the following negative impacts on the competitive position of MHI in the U.S. nuclear plant market:

A. Loss of competitive advantage due to the costs associated with development of turbine rotor materials.

B. Loss of competitive advantage of the US-APWR created by benefits of information of turbine rotor materials specification.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Executed on this 10th day of June, 2010.

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

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Enclosure 3

UAP-HF-10166
Docket Number 52-021

Responses to Request for Additional Information
No. 574-4633 Revision 2

June 2010
(Non Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/10/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 574-4633**
SRP SECTION:	**10.02.03 – Turbine Rotor Integrity**
APPLICATION SECTION:	**Application Section: Tier 2 FSAR Section 10.2.3**
DATE OF RAI ISSUE:	**4/20/2010**

QUESTION NO.: 10.02.03-8, RAI 10.2.3-8

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.

ANSWER:

MHI deleted the reference to grade C (Classes 5, 6 and 7) in Revision 2 of US-APWR FSAR Section 10.2.3.1 in accordance with NRC requirement of letter dated May 20 2009, a response to RAI No. 324-1997, Question 03.05.01.03-1.

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

QRESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/10/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 574-4633**
SRP SECTION:	**10.02.03 – Turbine Rotor Integrity**
APPLICATION SECTION:	**Application Section: Tier 2 FSAR Section 10.2.3**
DATE OF RAI ISSUE:	**4/20/2010**

QUESTION NO.: 10.02.03-9, RAI 10.2.3-9

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.

ANSWER:

It is confirmed in the rotor design that the rotor has adequate fracture toughness.

The fracture analysis done in the design includes determining the stresses in the rotor resulting from rotation, steady-state thermal loads and transient thermal loads from startup and stop. Fracture toughness K_{IC} used in the fracture analysis is introduced by specified mechanical properties of the rotor material, [ ], with [ ].

[

]

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

QRESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/10/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 574-4633**
SRP SECTION:	**10.02.03 – Turbine Rotor Integrity**
APPLICATION SECTION:	**Application Section: Tier 2 FSAR Section 10.2.3**
DATE OF RAI ISSUE:	**4/20/2010**

QUESTION NO.: 10.02.03-10, RAI 10.2.3-10

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 USAPWR 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.

ANSWER:

a. The numbers of test specimens will be added to FSAR section 10.2.3.
The location of test specimens is shown as Figure 10-1.
b. The impact test criteria will be added to FSAR section 10.2.3.
The Acceptance criteria for the impact test are shown as Table 10-1.

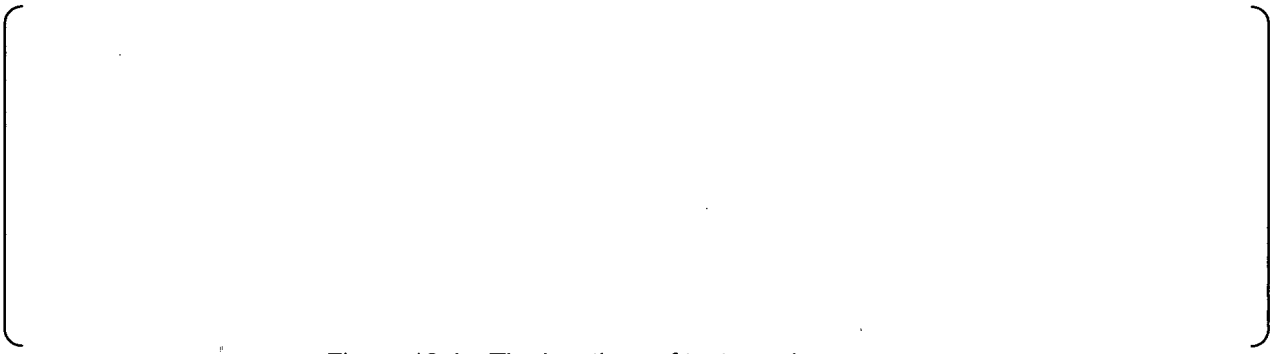

Figure 10-1 The locations of test specimens

Table 10-1 Acceptance criteria of the impact test

Impact on DCD

The 1st paragraph of the US-APWR, Tier 2, Section 10.2.3 will be revised as follows.

10.2.3.1 Materials Selection

Fully integral turbine rotors are made from ladle refined, vacuum deoxidized Ni-Cr-Mo-V alloy steel by processes that maximize the cleanliness and toughness of the steel. The lowest practical concentrations of residual elements are obtained through the melting process. The turbine rotor material complies with the chemical property limits of ASTM A470 (Reference 10.2-5). The specification for the rotor steel has lower limitations than indicated in the ASTM standard (Reference 10.2-5) for phosphorous, sulphur, aluminum and antimony. This material has the lowest fracture appearance transit temperatures (FATT) and the highest Charpy V-notch energies obtainable on a consistent basis from water-quenched Ni-Cr-Mo-V material at the sizes and strength levels used. Charpy tests and tensile tests are in accordance with ASTM, A370 (Reference 10.2-6). A minimum of three Charpy test specimens are tested using the impact test criteria that satisfy ASTM A470 Grade C (Class 6).

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.

QRESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

06/10/2010

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 574-4633**
SRP SECTION:	**10.02.03 – Turbine Rotor Integrity**
APPLICATION SECTION:	**Application Section: Tier 2 FSAR Section 10.2.3**
DATE OF RAI ISSUE:	**4/20/2010**

QUESTION NO.: 10.02.03-11, RAI 10.2.3-11

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.
>
> 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.

ANSWER:

Through the progress of steel making technology, the content of S (Sulfur) and P (Phosphorous) that have adverse effects on inclusion and segmentation have been significantly reduced. Figure 11-1 shows the history of reduction in the content of S and P. Figure 11-2 also shows the material test record sample for rotors manufactured over the last 20 years. The test result shows that the mechanical properties at the center core of the rotor are stable enough to satisfy the specification requirements.

Figure 11-1 Reduction history of the content of S and P

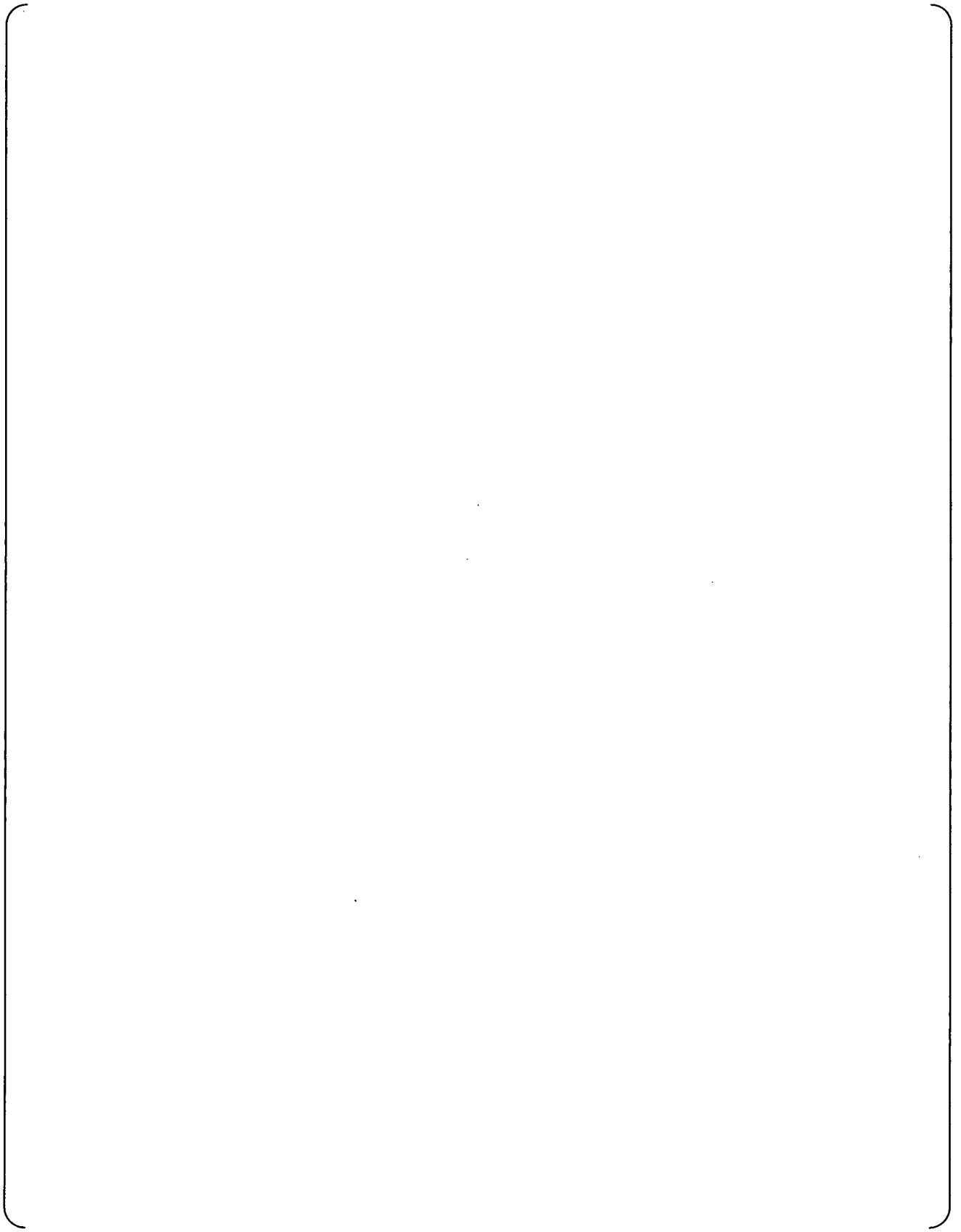

Figure 11-2 Example of the material test result from last 20 years record

Through past improvement in ultrasonic testing technology, it is possible to detect small defects at the center of the rotor from the rotor periphery. As indicated in Figure 11-3, it is verified that ultrasonic inspection from the rotor periphery can reliably detect flaws [ ] in length.

Figure 11-3 Minimum detectable flaw size at the center of the rotor by the ultrasonic inspection

Table 11-1 shows example of bore inspection record after long term operation. From this record, it is confirmed that integrity of the turbine rotor has been maintained for more than [ ].

Table 11-1 Examples of bore inspection after operation (with-bored rotor)

Impact on DCD

There is no impact on the DCD.

Impact on COLA

There is no impact on the COLA.

Impact on PRA

There is no impact on the PRA.