MITSUBISHI HEAVY INDUSTRIES, LTD.
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TOKYO, JAPAN

March 30, 2009

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-09120

Subject: MHI's Responses to US-APWR DCD RAI No.257-1613

References: 1) "Request for Additional Information No. 257-1613 Revision 0, SRP Section: 04.03 – Nuclear Design, Application Section: MUAP-07021-P – "US-APWR Incore Power Distribution Evaluation Methodology," dated March 3, 2009.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document as listed in Enclosures.

Enclosed are the responses to twenty-eight RAIs contained within Reference 1, which includes two NON-PUBLIC PROPRIETARY RAIs.

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 "[ ]" but does not include responses on NON-PUBLIC PROPRIETARY RAIs.

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.

Enclosures:

D081
NRO

1. Affidavit of Yoshiki Ogata

2. Responses to Request for Additional Information No. 257-1613 Revision 0 (proprietary version)

3. Responses to Request for Additional Information No. 257-1613 Revision 0 (non-proprietary version)

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

Contact Information
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Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-09120

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. 257-1613 Revision 0 dated March 30, 2009, 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 and methodology developed by MHI for performing the nuclear design of the US-APWR reactor.

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 methodology related to the analysis.

B. Loss of competitive advantage of the US-APWR created by benefits of modeling information.

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 30th day of March, 2009.

Y. Ogata

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

Enclosure 3

UAP-HF-09120
Docket Number 52-021

Responses to Request for Additional Information No. 257-1613
Revision 0

March 2009
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-20

Page 2 – How many incore fission detectors are available for concurrent measurements of the flux. How many will be used during a concurrent measurement? This question is asked to satisfy GDC10 requirements.

ANSWER:

[ ]

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-21

Page 3 – Specify the planes that define each quadrant of Figure 2-2. This question is asked to satisfy GDC10 requirements.

ANSWER:

The instrumentation thimble and rod control cluster assembly (RCCA) locations for the US-APWR core are shown in Figure 04.03-21-1. The dotted lines along the vertical and horizontal axes (major axes) are the planes that define each quadrant.

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.

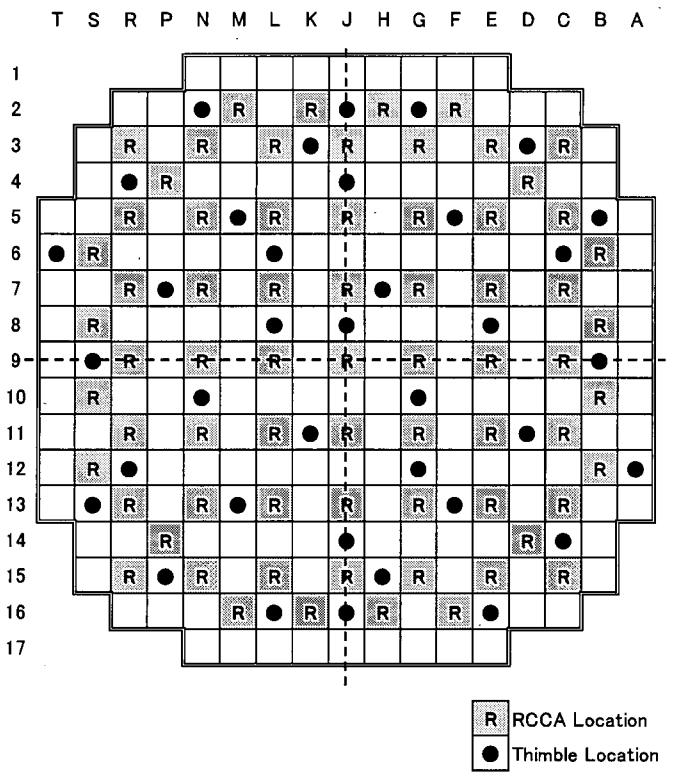

Figure 04.03-21-1 US-APWR INSTRUMENTATION THIMBLE AND RCCA LOCATIONS

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Mitsubishi Heavy Industries

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-22

Page 3 – Clarify the statement that the thimbles are "distributed nearly uniformly in the core" and that the distribution in each quadrant is nearly identical. This question is asked to satisfy GDC10 requirements.

ANSWER:

Please refer to the Figure 04.03-21-1 in RAI Question No. 04.03-21. The following table shows the distribution of instrumentation thimble locations by quadrant. Note that out of 37 total instrumentation thimble locations, 7 are on the major axes of the core and are counted in two quadrants. Each quadrant has a similar number of instrumentation thimble locations available. Also, each instrumentation thimble is located adjacent to a control rod and the control rod pattern is symmetric and therefore the instrumentation thimbles have a nearly uniform distribution.

QUADRANT	NON-AXIS LOCATIONS	AXIS LOCATIONS	TOTAL IN QUADRANT
1 (NW)	8	4	12
2 (NE)	7	4	11
3 (SW)	7	3	10
4 (SE)	8	3	11
TOTAL IN CORE	30	7	

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.

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-23

Page 3 – Reference to figure 2-2 on page 5 - Provide the basis for choosing the thimble locations. This question is asked to satisfy GDC10 requirements.

ANSWER:

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-24

Page 6 – Paragraph 1. It is stated that "The same methodology used in the conventional PWRs, ..." Describe the statement "conventional PWRs". This question is asked to satisfy GDC10 requirements.

ANSWER:

For the purposes of MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology", the term "conventional PWR" means currently operating pressurized water reactors using square-lattice fuel assemblies and movable fission chamber detectors (MDs) that are remotely positioned in the core through guide thimbles; examples include Japanese domestic "Westinghouse-type" PWRs. Current operating plants of this type include 121, 157 or 193 assemblies (for 2-loop, 3-loop, and 4-loop plants, respectively) and fuel assembly lattices with 14x14, 15x15, and 17x17 arrays.

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.

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US-APWR Design Certification

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Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-25

Page 6 – Paragraph 1. Justify the statement, "The same methodology used in the conventional PWR, therefore, can be applied to the US-APWR". This question is asked to satisfy GDC10 requirements.

ANSWER:

The US-APWR uses fuel that is almost identical to that used in currently operating Japanese 4-loop plants: fuel assemblies with a 17x17 fuel lattice and a central instrumentation thimble. The movable fission chamber detectors (MDs) and the flux mapping principles are almost identical to those used in currently operating Japanese plants. Therefore, the incore power distribution determination method used for the US-APWR is the same as that used in other Japanese PWRs.

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.

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US-APWR Design Certification

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-26

Page 6 – 3.1 MD Data Processing. – Specify dimensions and quantity of axial locations. Is the voltage measured in the center of the equally spaced axial locations, or is a continuous voltage measured and then averaged? This question is asked to satisfy GDC10 requirements.

ANSWER:

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-27

Page 6, Equation 3-1. Provide units for all terms in equation 3-1. This question is asked to satisfy GDC10 requirements.

ANSWER:

The following are the units for the terms in equation 3-1:

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.

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-28

Page 6, bottom – It is stated that "Normally, several detectors are used for flux mapping". State how many detectors are normally used, and provide a range (from minimum to maximum) for the number of detectors that can be used. This question is asked to satisfy GDC10 requirements.

ANSWER:

[ ]

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.

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Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-29

Page 6, bottom – It is stated that "To correct the difference of sensitivity between detectors, each detector is routed separately in a common calibration thimble at least once." – Provide the number of times a detector is routed through a calibration thimble and the criteria that is used to require further routing through a calibration thimble. This question is asked to satisfy GDC10 requirements.

ANSWER:

To correct the difference of sensitivity between detectors, each detector needs to be routed once through a common calibration thimble during a power distribution measurement (flux map). A detector may be routed through a common calibration thimble twice when detector drift check is required.

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.

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-30

Page 7, Equation (3-2) – The equation uses a reaction rate from a "reference detector", but the "reference detector" is not defined. Provide definition of the "reference detector". This question is asked to satisfy GDC10 requirements.

ANSWER:

Designation of the "reference detector" is purely arbitrary and may be either one of the detectors for a given flux map.

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.

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-31

Page 7, Source Deck – Provide the axial zone length used in the 3D core model. This question is asked to satisfy GDC10 requirements.

ANSWER:

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.

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-32

Page 9, bottom – Define the term, "engineering heat flux hot channel factor" used in this page. This question is asked to satisfy GDC10 requirements.

ANSWER:

As described in US-APWR DCD Subsection 4.3.2.2.1, the engineering heat flux hot channel factor F_Q^E accounts for increases in heat flux due to the effects of manufacturing tolerances. Local variations in pellet density and diameter and enrichment are considered for the fuel. The fuel rod surface area is considered for the cladding.

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.

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-33

Page 10, top - Has the "INCORE" code (Reference 1) been approved for use by NRC? This question is asked to satisfy GDC10 requirements.

ANSWER:

The topical report WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties" describes the use of the INCORE code as part of the derivation of the uncertainties applied to the maximum local heat flux F_Q and the nuclear enthalpy rise hot channel factor $F_{\Delta H}^N$, and Reference 1 of MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology" is Reference 3 of WCAP-7308-L-P-A.

Therefore Reference 1 of MUAP-07021-P was explicitly included as part of the approval of WCAP-7308-L-P-A rather than approved on a 'stand-alone' basis.

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-34

Page 10; Specify all the modifications to the INCORE code that were made in creating the INCORE-M code. This question is asked to satisfy GDC10 requirements.

ANSWER:

The following items describe the modifications to the INCORE code to produce INCORE-M:

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-35

Page 10 and Page 32; Provide a copy of Reference 1. This question is asked to satisfy GDC10 requirements.

ANSWER:

A copy of Reference 1 of MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology" was provided to US NRC by MHI letter UAP-HF-07189 as part of "Document # 1" of Enclosure 2, "Referenced Materials".

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-36

Page 10 – 4.2 Input data – Provide the nodalization that is used in the specification of the input data. This question is asked to satisfy GDC10 requirements.

ANSWER:

Nodalization is performed on an assembly and axial-zone basis. Information is provided in the source deck as follows:

[ ]

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-37

Page 14, Figure 4-3, "Example of INCORE-M Output (Radial Power Distribution)." Provide sample data from one of the perturbed cases used in Appendix A, and/or any case other than the 0.0 percent differences case. This question is asked to satisfy GDC10 requirements.

ANSWER:

Figure 04.03-37-1 shows an example of data for simulation case No.8 described in Table A-1 of MUAP-07021-P, "US-APWR Incore Power Distribution Evaluation Methodology."

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.

Figure 04.03-37-1 Example of INCORE-M Output (Radial Power Distribution) Simulation Case No.8

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RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-38

Page 18 – This uncertainty analysis relies on Reference 2. Provide Reference 2. Is Reference 2 approved by the NRC. This question is asked to satisfy GDC10 requirements.

ANSWER:

A copy of Reference 2 of MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology" was provided to US NRC by MHI letter UAP-HF-07189 as part of "Document # 1" of Enclosure 2, "Referenced Materials".

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-39

Page 18 – 2nd paragraph – Provide reference for the US-APWR instrumental uncertainty analysis. This question is asked to satisfy GDC10 requirements.

ANSWER:

The following description supports the use of Reference 2 of MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology" as the primary basis for the US-APWR uncertainties.

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-40

Page 19 – Provide units for all terms in equation (5-1) and (5-2). This question is asked to satisfy GDC10 requirements.

ANSWER:

Equations 5-1 and 5-2 are used to determine relative rod power or relative local power against core average. A unit for each term in these equations is canceled out in the process of determining these relative powers.
The following are the units for the terms in equations 5-1 and 5-2:

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-41

All pages - Provide an alphabetical list of all symbols used in this report along with units of the symbols. This question is asked to satisfy GDC10 requirements.

ANSWER:

An alphabetical list of all symbols and corresponding units for MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology" is provided below:

Symbol	Units
a	dimensionless
b	dimensionless
$BG_{n,m}$	ampere
C	dimensionless
E^{ext}	%
$F_{\Delta H}^{MU}$	dimensionless (normalized)
$F_{\Delta H}^{N}$	dimensionless (normalized)
$(F_{\Delta H}^{N})_n$	dimensionless (normalized)
F_Q^E	dimensionless (normalized)
F_Q^{MU}	dimensionless (normalized)
F_Q^N	dimensionless (normalized)
$(F_Q^N)_n$	dimensionless (normalized)
$FS_{n,m}$	ampere
$(F_z)_n$	dimensionless (normalized)
κ	dimensionless

Symbol	Units
$MP_{k,i}$	dimensionless (normalized)
$MP_{k,n}$	dimensionless (normalized)
MP_n	dimensionless (normalized)
MP(x,y)	dimensionless (normalized)
MP(x,y,z)	dimensionless (normalized)
$MR_{k,j}$	ampere or dimensionless (normalized)
$MR_{k,j,n,m}$	ampere or dimensionless (normalized)
$MR_{k,j,n,m}$	ampere or dimensionless (normalized)
$\overline{MR}_{cal,ref}$	ampere or dimensionless (normalized)
$\overline{MR}_{cal,n}$	ampere or dimensionless (normalized)
MR(x',y')	ampere or dimensionless (normalized)
MR(x',y',z)	ampere or dimensionless (normalized)
N	dimensionless (normalized)
P^{ext}	dimensionless (normalized)
P^{ref}	dimensionless (normalized)
$PP_{k,i}$	dimensionless (normalized)
$PP_{k,j}$	dimensionless (normalized)
$PP^{assembly}(x,y)$	dimensionless (normalized)
$PP^{rod}(x,y)$	dimensionless (normalized)
$PP^{rod}(x,y,z)$	dimensionless (normalized)
PR	sec^{-1} or dimensionless (normalized)
$PR_{k,j}$	sec^{-1} or dimensionless (normalized)
PR (x'y')	sec^{-1} or dimensionless (normalized)
PR (x',y',z)	sec^{-1} or dimensionless (normalized)
$r_{i,j}$	dimensionless
RP_m	dimensionless (normalized)
RP_{ref}	dimensionless (normalized)
s	%
s_{total}	%
$V_{k,j,n,m}$	dimensionless (normalized voltage)
$W_{i,j}$	dimensionless (normalized)
W(x,y,x',y')	dimensionless (normalized)

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-42

Page 21 to 24 – Provide extrapolation uncertainty scale to the US-APWR. This question is asked to satisfy GDC10 requirements.

ANSWER:

Please refer to the response to RAI QUESTION NO.04.03-39. No extrapolation uncertainty scale is needed for the US-APWR.

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

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APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-43

Page 33, 2nd paragraph – Provide justification for the source of data used for the uncertainties on power peaking factors. This question is asked to satisfy GDC10 requirements.

ANSWER:

Please refer to the response to RAI QUESTION NO.04.03-39.

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

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APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-44

Page 34, bottom – Provide information on the perturbations steps used during misalignment of the control rods. This is asked to satisfy GDC10 requirements.

ANSWER:

At Hot Full Power conditions, the lead control bank (Bank D) is typically inserted to the "bite position", to provide a reactivity control without a large perturbation in the power distribution.

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.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/30/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO. 257-1613 REVISION 0**

SRP SECTION: **4.3 – Nuclear Design**

APPLICATION SECTION: MUAP-07021-P "US-APWR Incore Power Distribution Evaluation Methodology"

DATE OF RAI ISSUE: **3/3/2009**

QUESTION NO. : 04.03-45

Page 33 - Does the simulated data for the US-APWR represent a more conservative case than measured data for a PWR? Specify which of the perturbation types, A, B, C, and D, represent a more conservative estimate than actual PWR data. This question is asked to satisfy GDC10 requirements.

ANSWER:

The simulated data used for the thimble failure analysis represents both normal and abnormal cases. Types A and B were chosen to provide plant conditions that are expected to occur during normal operation. Types C and D represent abnormal conditions, where Type C provides a severe local power distribution perturbation while Type D provides severe global (core-wide) perturbations which would not be permitted during normal operation. Therefore Types C and D are more conservative estimate than actual PWR data during normal operation.

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.