MITSUBISHI HEAVY INDUSTRIES, LTD.
16-5, KONAN 2-CHOME, MINATO-KU
TOKYO, JAPAN

March 27, 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-09095

Subject: MHI's Responses to US-APWR DCD RAI No.202-1846

References: 1) "Request for Additional Information No. 202-1846 Revision 0, SRP Section: 04.03 – Nuclear Design, Application Section: MUAP-07019-P(R0), US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC." dated February 25, 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 seventeen RAIs contained within Reference 1, which includes three NON-PUBLIC PROPRIETARY RAI.

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.

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Enclosures:

1. Affidavit of Yoshiki Ogata

2. Responses to Request for Additional Information No. 202-1846 Revision 0 (proprietary version)

3. Responses to Request for Additional Information No. 202-1846 Revision 0 (non-proprietary version)

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

Contact Information
C. Keith Paulson, Senior Technical Manager
Mitsubishi Nuclear Energy Systems, Inc.
300 Oxford Drive, Suite 301
Monroeville, PA 15146
E-mail: ck_paulson@mnes-us.com
Telephone: (412) 373-6466

Enclosure 1

Docket No. 52-021
MHI Ref: UAP-HF-09095

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. 202-1846 Revision 0 dated 27 March 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 27th day of March, 2009.

Y. Ogata

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

Enclosure 3

UAP-HF-09095
Docket Number 52-021

Responses to Request for Additional Information No. 202-1846
Revision 0

March 2009
(Non-Proprietary)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

3/27/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-1

Page 1 – Reference is made at several locations within the document to a "--- previously approved by the US NRC" code package. Has the PARAGON code package and other codes referenced in this document have been changed or modified in any manner relative to that approved by the US NRC? Provide approval references of all the codes referenced in this technical report. This question is asked to satisfy GDC10 requirements.

ANSWER:

The methodology of the PARAGON/ANC code package has not been changed or modified in any manner relative to that approved by the US NRC.

Approval references:

References 1 through 3 of MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC" are applicable for all codes referenced in this technical report, and the approval references are contained in the approved versions.

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

3/27/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-2

Page 3 – A 70 energy group library is referred to. How many of these groups are thermal (below ~ 0.625 eV), how many are in the resonance range (resolved and unresolved), how many in the high energy range? This question is asked to satisfy GDC10 requirements.

ANSWER:

The 70 energy group PARAGON library has the following group structure:

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.

3/27/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-3

How are the resonance cross sections treated in this code (PARAGON)? This question is asked to satisfy GDC10 requirements.

ANSWER:

In Uranium and MOX fuel, the same self-shielding method of the resonance cross sections as PHOENIX-P is used with a 1 pellet region model. The self-shielding of resonance cross sections in Gadolinia fuel is accounted for using a spatially dependent Dancoff method, which correctly accounts for the radial flux distribution within fuel pellets using a multi-ring model.

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-4

Page 3 – Since, there is no modal shape in the reflector how are few group cross sections determined for the reflector regions? This question is asked to satisfy GDC10 requirements.

ANSWER:

The few group cross sections for the steel neutron reflector are generated using a one-dimensional PARAGON model. The few group cross sections for ANC are generated by collapsing the PARAGON 70 energy group cross sections and applying flux discontinuity factors at the fuel/reflector interface.

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

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RAI NO.: **NO.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-5

Page 3 – The ANC core simulator calculates a variety of parameters. What is meant by "--- core stability and other nuclear parameters"? This question is asked to satisfy GDC10 requirements.

ANSWER:

Core stability and other nuclear parameters include:

- Power distributions
- Fuel and burnable absorber depletion
- Reactivity coefficients and defects (Doppler temperature/power, moderator temperature/density, total power)
- Boron worth, Xenon/Samarium worth and control rod worth
- Xenon stability (axial/horizontal)

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-6

Page 4 – How are the few group cross sections arrived at, particularly since the steel has a significant resonance structure (both positive resonance's, and negative resonance's, particularly iron)? This question is asked to satisfy GDC10 requirements.

ANSWER:

The few group cross sections for the steel neutron reflector are generated using a one-dimensional PARAGON model. The few group cross sections for ANC are generated by collapsing the PARAGON 70 energy group cross sections and applying flux discontinuity factors at the fuel/reflector interface. In addition, the PARAGON cross section library has a specific set of resonance cross sections for steel based on thicknesses of [
] to account for geometry effects on the self-shielding. [

]

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-7

Page 5 – Summarize the critical experiment results referred to in Reference 1. This question is asked to satisfy GDC10 requirements.

ANSWER:

The critical experiments used to qualify PARAGON include:

- The Strawbridge and Barry 101 Criticals: Reactivity experiments for a set of 101 uniform, uranium oxide/metal fuelled, cold light water configurations for a wide range of lattice parameters. The mean k_{eff} for all experiments was [ ] with a standard deviation of [ ].
- KRITZ High Temperature Criticals: Twelve experiments to verify predictions of reactivity changes with uranium-fuelled, high temperature water-moderated lattices to approximate typical operating conditions. The mean k_{eff} for all experiments was [ ] with a standard deviation of [ ] which demonstrates that PARAGON consistently predicts reactivity effects over a large temperature range, without significant trends.
- Babcock and Wilcox Spatial Criticals: Twenty-nine cold experiments to obtain reactivity and power distribution measurements for typical PWR lattices using various fuel rod, guide thimble, and burnable absorber configurations. The mean k_{eff} for all experiments was [ ] with a standard deviation of [ ], and

the average difference between measured and predicted power distributions for six experiments of particular interest (without burnable absorbers, with integral burnable absorbers, and various assembly lattices) was [ ] with an average standard deviation of [ ]. Results for other experiments with non-integral burnable absorbers show similar results.

- Monte Carlo Assembly Benchmarks: Reactivity and power distribution comparisons between PARAGON and a "higher-order" code to confirm performance for a wide range of lattices, integral burnable absorber types, enrichments, and fuel compositions (uranium vs. MOX). The mean difference in k-infinities between the codes was [ ] and average rod power differences were less than [ ].
- Saxton and Yankee Isotopics Data: Comparisons of PARAGON-predicted isotopics to measured (spectro-graphed) data from operating cores. The data includes a variety of fuel compositions (uranium vs. MOX), cycles (first cores vs. reloads), and cladding materials (stainless steel vs. zircaloy) for burnups up to approximately [ ] MWD/MTU. As described in the response to 04.03-8 of RAI No. 202-1846, the isotopic comparisons demonstrate excellent agreement between measurement and PARAGON for all isotopes over the entire range of burnups.

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-8

Page 6 – What are the Saxton and Yankee results? Summarize the data presented in Reference 1. This question is asked to satisfy GDC10 requirements.

ANSWER:

The Saxton and Yankee isotopics measurements were used for comparisons of PARAGON-predicted isotopics to measured (spectro-graphed) data from operating cores. The data includes a variety of fuel compositions (uranium vs. MOX), cycles (first cores vs. reloads), and cladding materials (stainless steel vs. zircaloy) for burnups up to approximately [ ] MWD/MTU.

For each of the major isotopes of uranium and plutonium, the measured data and PARAGON predictions for a specific isotope were presented in two ways:

[ ]

The data was provided in graphical form using the ratio vs. fuel burnup for each combination described above.

The isotopic comparisons demonstrate excellent agreement between measurement and PARAGON for all isotopes over the entire range of burnups, which confirms the ability of PARAGON to accurately predict the depletion characteristics of both uranium and MOX fuel.

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-9

Page 7 and Figs. 3.1-8, 3.1-9 – What is the magnitude of the error bars on the results? Is there a reason for the systematic error associated with the plutonium isotopes (Fig 3.1-9 MOX fuel)? This question is asked to satisfy GDC10 requirements.

ANSWER:

For all uranium isotopes in uranium fuel, the maximum measurement error is [ ] and is less than [ ] for almost all samples. For plutonium isotopes in uranium fuel, the measurement error is less than [ ] for all samples.

For all uranium isotopes in MOX fuel, the measurement error is [ ] or less, except for one data point for U^{236}, which was [ ]. Although this percentage uncertainty is larger than for the uranium fuel, the absolute content of uranium isotopes in the MOX fuel is much smaller than in uranium fuel. For plutonium isotopes in MOX fuel, the measurement uncertainty is less than [ ] for all samples, which is consistent with the uncertainty for uranium isotopes in uranium fuel.

MHI does not observe a significant overall trend in the behavior of the plutonium isotopes in Figure 3.1-9 for MOX fuel. For example, over the approximate burnup interval of [ ] MWD/MTU, the measured-to-predicted difference for Pu^{239} was consistently in the [ ] range, Pu^{241} was in the [ ] range, and Pu^{240} was in the [ ] range. Only Pu^{242} had a noticeably larger difference, in the [ ] range.

However, it is also important to note that all isotopes showed very stable behavior for the approximate burnup interval of [ ] MWD/MTU.

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03- 10

Page 7, the calculations and measurements shown on Fig. 3.1-10 and 3.1-11 show good agreement. Provide a detailed description how the space and energy dependent burnup is modeled in PARAGON for these experiments. How does this experience translate into accurately predicting the behavior of gadolinia burnup in the actual US-APWR, which might have its gadolinia in a different arrangement from that in the test reactor experiment? This question is asked to satisfy GDC10 requirements.

ANSWER:

Gadolinia is a strong absorber of thermal neutrons. PARAGON performs depletion calculations considering the thermal neutron distribution within the fuel pellets using a multi ring model and accurately evaluates nuclide concentration changes in each ring region. The self-shielding of resonance cross sections within each ring is accounted for using a spatially dependent Dancoff method, which correctly accounts for the radial flux distribution within pellets using a multi ring model. Detailed power distribution and depletion data are especially important for accurate modeling of fuel integral absorbers such as Gadolinia.

A comparison of key nuclear parameters for the BR3 and US-APWR reactors was evaluated. The parameters included:

- Reactor conditions such as linear power, system pressure, coolant temperate and flow
- Fuel rod dimensions, fuel assembly geometry, rod pitch, and information on non-fuel elements (guide thimbles, water holes, etc.)
- Fuel pellet enrichments, dimensions, material, Gadolinia loading, and density
- The environment of the Gadolinia rods (adjacent fuel and non-fuel elements).

Based on this evaluation, it was determined that the parameters were sufficiently similar to conclude that the depletion experience from the BR3 reactor was appropriate to use for the PARAGON/ANC qualification and application to PWRs such as 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

3/27/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No.52-021

RAI NO.: **NO.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-11

Provide history of MHI experience using PARAGON to high burnup? What documentation is available to validate that this code package can accurately predict the burnup behavior to the high burnup levels expected in the US-APWR? This question is asked to satisfy GDC10 requirements.

ANSWER:

The qualification of the code package described in Reference 1 of MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC" includes data for plant/cycles with assembly average discharge burnups exceeding [ ] MWD/MTU.

MHI's capability to use the code package is equivalent to that described in Reference 1. As described in Section 3.2, MHI performed evaluations for several plant/cycles as part of the qualification of the code package. Based on the cycle lengths and fuel management, typical assembly average discharge burnups for several plant/cycles were approximately [ ] MWD/MTU, with a subset of assemblies achieving higher burnups.

Based on the combination of experience databases for both Reference 1 and the MHI qualification report, it is concluded that MHI can appropriately use the code package for high burnup applications.

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.202-1846 REVISION 0**

SRP SECTION: **04.03 – Nuclear Design**

APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-12

Page 8 – What is the configuration of the TCA critical experiment? Discuss the analysis technique used to arrive at answers. Page 25 and Figs. 3.2-1 – 3.2-3 – identify the different plants and cycle number on these plots. This question is asked to satisfy GDC10 requirements.

ANSWER:

A figure of the PARAGON model configuration of the TCA critical experiment is shown below, using a top-view perspective.

[ ]

The data points for Figures 3.2-1 through 3.2-3 of MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC" were obtained from the plants and cycles described in Table 3.2.-1.

Top View of TCA Configuration

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.202-1846 REVISION 0**

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APPLICATION SECTION: MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC"

DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-13

Page 25 and Fig. 3.2-4 – Provide definition of "stability index". This question is asked to satisfy GDC10 requirements.

ANSWER:

Xenon induced power distribution oscillations for the US-APWR are analyzed using the modal perturbation method, which allows the determination of the degree stability for a particular oscillation mode. The stability of a reactor can be characterized by the stability index. The power distribution perturbation can be written as a function of time as:

$$\delta\phi(t) = a \cdot e^{b \cdot t} \cdot \cos\left(\frac{2 \cdot \pi \cdot t}{T}\right) + c$$

where a and c are constants, T is the period of the oscillation and b is called the stability index.

At a first approximation, T can be obtained as the time difference between successive maxima flux peaks and the stability index b as

$$b = \frac{2}{T} \ln\left(-\frac{a_2 - a_3}{a_1 - a_2}\right)$$

Where a_1, a_2 and a_3 are successive maxima and minima in the perturbed flux at times t, $t+T/2$ and $t+T$. A negative stability index b indicates stability for the oscillatory mode being investigated.

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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DATE OF RAI ISSUE: **2/25/2009**

QUESTION NO. : 04.03-14

Page 26 – Are any of the few group cross sections adjusted based on level of agreement with critical experiments or are the ENDF/B data used without adjustment? This question is asked to satisfy GDC10 requirements.

ANSWER:

Few group cross sections for use in ANC are not modified from those generated by PARAGON. As described in Reference 1 of MUAP-07019-P (R0), "US-APWR Qualification of Nuclear Design Methodology using PARAGON/ANC", PARAGON uses an ENDF/B VI – based 70 energy group library. The library includes an adjustment [ ] to the U-238 resonance integral as described in the following paper:

Huria H., Ouisloumen M., "An optimized ultra-fine energy group structure for neutron transport calculations", International Conference on the Physics of Reactors "Nuclear Power: A Sustainable Resource", Interlachen, Switzerland, 2008.

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.