**MITSUBISHI HEAVY INDUSTRIES, LTD.**
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TOKYO, JAPAN

April 9, 2009

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

Attention: Mr. Jeffery A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-09145

**Subject:** MHI's Response to US-APWR DCD RAI No. 215-1906

**Reference:** 1) "Request for Additional Information No. 215-1906 Revision 0, SRP Section: 03.03.01 – Wind Loadings, Application Section: 03.03.01," dated 2/25/2009.

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. 215-1906, Revision 0."

Enclosed are the responses to 6 RAIs contained within Reference 1, including RAI 3.3.1-06 which has a 60-day response time.

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

Sincerely,

Y. Ogata

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

Enclosure:

1. Responses to Request for Additional Information No. 215-1906, Revision 0

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

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Docket No. 52-021
MHI Ref: UAP-HF-09145

Enclosure 1

UAP-HF-09145
Docket No. 52-021

# Responses to Request for Additional Information No. 215-1906, Revision 0

April, 2009

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**4/9/2009**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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|---|---|
| **RAI NO.:** | **NO. 215-1906 REVISION 0** |
| **SRP SECTION:** | **03.03.01 – Wind Loadings** |
| **APPLICATION SECTION:** | **03.03.01** |
| **DATE OF RAI ISSUE:** | **02/25/09** |

**QUESTION NO. RAI 3.3.1-01:**

1. RAI Text

Wind loads on the Power Supply Buildings (PS/Bs) are determined by the applicant using Method 1 described in ASCE/SEI 7-05, Section 6.4. In order for the NRC staff to evaluate the applicability of this method for the analysis of the PS/Bs wind loadings, the applicant is requested to provide additional information pertaining to the following subject areas.

The PS/Bs have large openings in the exterior shear walls. Provide an analysis that explains:

- how the PS/Bs are classified as enclosed buildings rather than partially enclosed buildings based on definitions in ASCE/SEI 7-05, Section 6.2.
- whether or not these openings have closures and whether or not the glazing, if any, complies with requirements in ASCE/SEI 7-05, Section 6.5.9.3.

2. Concern

Design wind loads for buildings and other structures, including the Main Wind-Force Resisting Systems (MWFRS) and components, may be determined using one of three procedures defined in ASCE/SEI 7-05, Section 6.1.2. The applicant selected Method 1 – Simplified Procedure described in ASCE/SEI 7-05, Section 6.4 to determine design wind loads for the PS/Bs. According to this procedure, Method 1 can only be used to design the MWFRS for buildings that satisfy all eight conditions defined in ASCE/SEI 7- 05, Section 6.4.1.1. Condition 3 for Method 1 states that the buildings must be enclosed and conform to the wind-borne debris provisions of ASCE/SEI 7-05, Section 6.5.9.3. The definition in ASCE/SEI 7-05, Section 6.2 for an enclosed building is a building that does not comply with requirements for open or partially enclosed buildings. To qualify as a partially enclosed building, the building is required to comply with both of the following two conditions.

(1) The total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10 percent.

(2) The total area of openings in a wall that receives positive external pressure exceeds 4 square feet or 1 percent of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20 percent.

Wind-borne debris provisions in ASCE/SEI 7-05, Section 6.5.9.3 require that glazing in buildings located in wind-borne debris regions be protected with an impact-resistant covering or be impact-resistant glazing according to the requirements specified in ASTM E 1886 and ASTM E 1996 or other approved test methods and performance criteria.

In order for the NRC staff to determine whether Method 1 can be used to determine the design wind loads for the PS/Bs in accordance with ASCE/SEI 7-05, Section 6.4 requirements, additional information about the size, location, and construction of the large openings in the exterior walls of the PS/Bs is required to demonstrate compliance with GDC-2 in Appendix A to 10 CFR Part 50.

3. Applicant References

DCD Tier 2, Revision 1, Section 3.3.1.2 and Section 3.8.4.4.2.2.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of Title 10 of CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

The evaluation criteria set forth in ASCE/SEI 7-05 Section 6.2 for determination of the classification of a building as enclosed, partially enclosed, or open were reviewed with regard to the RAI question. The "large openings in the shear walls" which are cited in the question are openings to the R/B, as shown on the drawings in MHI Document "General Arrangement of Power Block (for Standard Plant)", 4CS-UAP-20070026 Rev.4. Those openings do not receive positive external wind pressure. Therefore, the PS/Bs do not comply with condition 1 of the definition of a partially enclosed building in ASCE/SEI 7-05 Section 6.2. The PS/Bs would need to comply with both conditions 1 and 2 of ASCE/SEI 7-05 as cited above in order to qualify as partially enclosed buildings. Since they do not comply with condition 1, the PS/Bs are not partially enclosed buildings as defined by ASCE/SEI 7-05. Neither PS/B has exterior walls that are at least 80 percent open, and therefore the PS/Bs also do not comply with the requirement for open buildings as defined in ASCE /SEI 7-05 Section 6.2. Since enclosed buildings are defined by ASCE/SEI 7-05 as buildings that do not comply with the requirements for open or partially enclosed buildings, the PS/Bs are classified as enclosed buildings. The PS/Bs do not utilize glazing and therefore the wind-borne provisions of ASCE/SEI 7-05 Section 6.5.9.3 do not apply.

Therefore, the PS/Bs meet the requirements of condition 3 of ASCE/SEI 7-05 Section 6.4.1.1 and are qualified to be designed for wind loading using Method 1 in Section 6.4 of ASCE/SEI 7-05.

**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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## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**4/9/2009**

**US-APWR Design Certification**

**Mitsubishi Heavy Industries**

**Docket No. 52-021**

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| **RAI NO.:** | **NO. 215-1906 REVISION 0** |
| **SRP SECTION:** | **03.03.01 – Wind Loadings** |
| **APPLICATION SECTION:** | **03.03.01** |
| **DATE OF RAI ISSUE:** | **02/25/09** |

**QUESTION NO. RAI 3.3.1-02:**

1. RAI Text

The Power Supply Buildings (PS/Bs) have translational and rotational displacements. Provide a dynamic model analysis showing that the PS/Bs are not classified as slender buildings with fundamental natural frequencies less than 1 Hz.

2. Concern

Design wind loads for buildings and other structures, including the Main Wind-Force Resisting Systems (MWFRS) and components, may be determined using one of three procedures defined in ASCE/SEI 7-05, Section 6.1.2. The applicant selected Method 1 – Simplified Procedure described in ASCE/SEI 7-05, Section 6.4 to determine design wind loads for the PS/Bs. According to this procedure, Method 1 can only be used to design the MWFRS for buildings that satisfy all eight conditions defined in ASCE/SEI 7- 05, Section 6.4.1.1. Condition 5 for Method 1 states that the buildings must not be classified as slender buildings based on the definition in ASCE/SEI 7-05, Section 6.2. According to this definition, a slender building has a fundamental natural frequency that is less than 1 Hz.

In order for the NRC staff to determine whether Method 1 can be used to determine the design wind loads for the PS/Bs in accordance with ASCE/SEI 7-05, Section 6.4 requirements, additional information about the fundamental natural frequency of the PS/Bs is requested to demonstrate compliance with GDC-2 in 10 CFR 50, Appendix A.

3. Applicant References:

DCD Tier 2, Revision 1, Section 3.7.2.8.6.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of 10 CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

DCD Section 3.7, Reference 3.7-33, MUAP-08002 "Enhanced Information for PS/B Design," contains information on the fundamental natural frequencies of the PS/Bs. This document outlines and presents the results of the seismic analysis of the PS/Bs. In Table 2.2-2(1) of MUAP-08002, Summary of Natural Frequencies for PS/B (Soft Soil), the lowest fundamental natural frequency is 3.03 Hz for Mode 1 in the NS direction. This is the lowest natural frequency in any orthogonal direction for any of the four standard plant soil conditions considered in the design of the PS/B. Based on this result, the PS/Bs are classified as rigid buildings per the rigid building definition contained in ASCE/SEI 7-05 Section 6.2, and condition 5 of ASCE/SEI 7-05 Section 6.4.1.1 is satisfied.

**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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| **SRP SECTION:** | **03.03.01 – Wind Loadings** |
| **APPLICATION SECTION:** | **03.03.01** |
| **DATE OF RAI ISSUE:** | **02/25/09** |

**QUESTION NO. RAI 3.3.1-03:**

1. RAI Text

The Power Supply Buildings (PS/Bs) have both translational and rotational displacements. Provide an analysis showing that the torsional load cases defined in ASCE/SEI 7-05, Figure 6-10, Note 5 do not control the design of any of the MWFRSs of the PS/Bs.

2. Concern

Design wind loads for buildings and other structures, including the Main Wind-Force Resisting Systems (MWFRS) and components, may be determined using one of three procedures defined in ASCE/SEI 7-05, Section 6.1.2. The applicant selected Method 1 – Simplified Procedure described in ASCE/SEI 7-05, Section 6.4 to determine design wind loads for the PS/Bs. According to this procedure, Method 1 can only be used to design the MWFRS for buildings that satisfy all eight conditions defined in ASCE/SEI 7- 05, Section 6.4.1.1. Condition 8 for Method 1 states that the building is exempted from torsional load cases as indicated in Note 5 of Figure 6-10, or the torsional load cases defined in Note 5 do not control the design of any of the MWFRSs of the building.

In order for the NRC staff to determine whether Method 1 can be used to determine the design wind loads for the PS/Bs in accordance with ASCE/SEI 7-05, Section 6.4 requirements, additional information about the response of the PS/Bs to torsional load cases described in ASCE/SEI 7-05, Figure 6-10, Note 5 is requested to demonstrate compliance with GDC-2 in 10 CFR 50, Appendix A.

3. Applicant References

DCD Tier 2, Revision 1, Section 3.7.2.8.6.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of 10 CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

US-APWR DCD Section 3.3.1.2 states that east and west PS/Bs are low-rise, simple rigid diaphragm buildings. ASCE/SEI 7-05 Commentary, Section C6.4, page 283, states that buildings with a MWFRS in each principal direction and meeting the requirement that "Rigid roof and floor diaphragms distributing lateral force to two shear walls, braced frames, or moment frames of approximately equal stiffness that are spaced apart a distance not less than 50 percent of the width of the building normal to the principal axis" would not be torsionally sensitive. MHI Document 4CS-UAP-20070026 Rev.4, "General Arrangement of Power Block (for Standard Plant)", shows the layout of the PS/Bs as having the exterior walls designed as continuous shear walls for the MWFRS and meeting this requirement. Therefore, the PS/Bs are not considered to be torsionally sensitive, condition 8 in ASCE/SEI 7-05 Section 6.4.1.1 is considered to be met, and the analysis of the PS/Bs using Method 1 is considered to be acceptable.

**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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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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US-APWR Design Certification
Mitsubishi Heavy Industries
Docket No. 52-021

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| **RAI NO.:** | **NO. 215-1906 REVISION 0** |
| **SRP SECTION:** | **03.03.01 – Wind Loadings** |
| **APPLICATION SECTION:** | **03.03.01** |
| **DATE OF RAI ISSUE:** | **02/25/09** |

**QUESTION NO. RAI 3.3.1-04:**

1. RAI Text

The equation used by the applicant to determine the simplified design wind pressure, $p_s$, for the Power Supply Building (PS/Bs) and the accompanying text that describes the basic formula for effective wind velocity pressure are not consistent with the requirements presented in ASCE/SEI 7-05, Section 6.4.2.1 for Method 1. Provide revised text for the description of Method 1 used by the applicant to determine the simplified design wind pressure, $p_s$, for the PS/Bs so that the revised text is consistent with the text in ASCE/SEI 7-05, Section 6.4.2.1.

2. Concern

The applicant provided the following text describing Method 1 which is used by the applicant to determine design wind loads for the Main Wind-Force Resisting Systems (MWFRS) for the PS/Bs.

"For method 1 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1 of the DCD), and substituting 1.0 for the topographic factor, the basic formula for effective wind velocity used for building main wind-force resisting systems is:

$$p_s = 1.15\ \lambda\ p_{basic}$$

where

$p_s$ = effective wind velocity pressure, psf

$\lambda$ = adjustment factor for exposure category C from ASCE/SEI 7-05, Figure 6-2

$p_{basic}$ = wind pressure value in psf, from ASCE/SEI 7-05, Figure 6-2 corresponding to a basic wind speed of 155 mph"

This text describes the basic formula for effective wind velocity, but presents an equation for effective wind velocity pressure, $p_s$.

In order for the NRC staff to understand how Method 1 is used to determine the design wind loads for the PS/Bs in accordance with ASCE/SEI 7-05, Section 6.4 requirements, the text that describes Method 1 needs to be revised to eliminate the wind velocity versus wind velocity pressure inconsistency. Additional information about the description of Method 1 is requested to demonstrate compliance with GDC-2 in 10 CFR 50, Appendix A.

3. Applicant References

DCD Tier 2, Revision 1, Section 3.3.1.2.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of 10 CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

The text of the second paragraph of DCD Section 3.3.1.2 will be corrected to "velocity pressure" to be consistent with the wind velocity pressure formula that is being described.

Additional information about the use of Method 1, with respect to the requirements of ASCE/SEI 7-05 Section 6.4.1.1 in determining design wind loading, is provided in the responses to questions 3.3.1-1, 3.3.1-2, and 3.3.3-3 of this RAI.

**Impact on DCD**

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.3, Revision 2, changes to be incorporated.

- Change the first sentence in the second paragraph of Subsection 3.3.1.2 to: "For method 1 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1), and substituting 1.0 for the topographic factor, the basic formula for effective wind velocity pressure used for building main wind-force resisting systems is:"

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/9/2009

US-APWR Design Certification

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| **SRP SECTION:** | **03.03.01 – Wind Loadings** |
| **APPLICATION SECTION:** | **03.03.01** |
| **DATE OF RAI ISSUE:** | **02/25/09** |

**QUESTION NO. RAI 3.3.1-05:**

1. RAI Text

The equation used by the applicant to determine the velocity pressure, *P*, for the Prestressed Concrete Containment Vessel (PCCV) and the Reactor Building (R/B) and the accompanying text that describes the basic formula for effective wind velocity pressure are not consistent with the requirements presented in ASCE/SEI 7-05, Section 6.5 for Method 2. Provide revised text for the description of Method 2 used by the applicant to determine the velocity pressure, *p*, for the PCCV and the R/B and include an explanation for the +/- signs that appear in the equation so that the text is consistent with the requirements in ASCE/SEI 7-05, Section 6.5.12.2.1.

2. Concern

The applicant provided the following text describing Method 2 that is used by the applicant to determine design wind loads for the Main Wind-Force Resisting Systems (MWFRS) for the PCCV and the R/B.

"For method 2 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1 of the DCD), equation 6-15 from Subsection 6.5.10 of ASCE/SEI 7-05 is used where the topographic and directionality factors $K_{zt}$ and $K_d$ are each 1.0, and substituting into equation 6-17 of ASCE/SEI 7-05, Subsection 6.5.12 for enclosed and partially enclosed buildings, the basic formula for effective wind velocity used for building main wind-force resisting systems is:

$$P = 0.00256\, K_z\, V^2\, 1.15\, (GC_p +/- GC_{pi})$$

Where

$p$ = effective wind velocity pressure, psf

$K_z$ = velocity pressure coefficient varying with height, taken from Table 6-3 of ASCE/SEI 7-05 for exposure category C; however, not less than 0.87 as recommended by SRP 3.3.1 (Reference 3.3-2)

$V$ = basic wind speed of 155 mph per Subsection 3.3.1.1

$G$ = gust effect factor = 0.85 or as determined per ASCE/SEI 7-05, Subsection 6.5.8 (where a combined gust effect and pressure coefficient factor is used from a figure(s) in ASCE/SEI 7-05, an individual gust effect factor is not applied)

$C_p$ = external pressure coefficient from ASCE/SEI 7-05 Subsection 6.5.11

$C_{pi}$ = internal pressure coefficient from ASCE/SEI 7-05 Subsection 6.5.11

This text describes the basic formula for effective wind velocity, but presents an equation for effective wind velocity pressure.

In order for the staff to understand how Method 2 will be used to determine the design wind loads for the PCCV and the R/B in accordance with ASCE/SEI 7-05, Section 6.5 requirements, the text in this paragraph needs to be revised to eliminate the effective wind velocity versus effective wind velocity pressure inconsistency. In addition, the variables used in the equation need to be revised so the variables, $P$, and, $p$, are used consistently. Also text that describes the use of the equation needs to be revised so that application of the +/- signs can be evaluated for appropriateness and consistency. Additional information about the description of Method 2 is requested to demonstrate compliance with GDC-2 in 10 CFR 50, Appendix A.

3. Applicant References

DCD Tier 2, Revision 1, Section 3.3.1.2.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of 10 CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

The text of the third paragraph of DCD Section 3.3.1.2 will be corrected to "velocity pressure" to be consistent with the wind velocity pressure formula that is being described. The variable $P$ (upper case) used in the equation in DCD Subsection 3.3.1.2 for Method 2 will be changed to lower case $p$ to be consistent with the lower case variable $p$ used in the variable definitions.

The use of the +/- signs in the equation for Method 2 in DCD Subsection 3.3.1.2 is consistent with ASCE/SEI 7-05 Section 6.5.11.1, Figure 6-5, Note 3 which states:

> Two cases shall be considered to determine the critical load requirements for the appropriate condition:

(i) a positive value of $GC_{pi}$ applied to all internal surfaces
(ii) a negative value of $GC_{pi}$ applied to all internal surfaces

The text in DCD Subsection 3.3.1.2 is to be revised to provide additional description of Method 2, by adding the above statement to the definition for the internal pressure coefficient $C_{pi}$.

**Impact on DCD**

See Attachment 1 for a mark-up of DCD Tier 2, Section 3.3, Revision 2, changes to be incorporated.

- Change the first sentence in the third paragraph of Subsection 3.3.1.2 to: "For method 2 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1), equation 6-15 from Subsection 6.5.10 of ASCE/SEI 7-05 is used where the topographic and directionality factors $K_{zt}$ and $K_d$ are each 1.0, and substituting into equation 6-17 of ASCE/SEI 7-05, Subsection 6.5.12 for enclosed and partially enclosed buildings, the basic formula for effective wind velocity pressure used for building main wind-force resisting systems is:"

- Change the formula in the third paragraph of Subsection 3.3.1.2 to:

  "$p = 0.00256\ K_z\ V^2\ 1.15\ (GC_p +/- GC_{pi})$"

- Change the definition of $C_{pi}$ in Subsection 3.3.1.2 to:

  "$C_{pi}$ = internal pressure coefficient from ASCE/SEI 7-05 Subsection 6.5.11 where two cases shall be considered to determine the critical load requirements for the appropriate conditions:

  (i) a positive value of $GC_{pi}$ applied to all internal surfaces
  (ii) a negative value of $GC_{pi}$ applied to all internal surfaces"

**Impact on COLA**

There is no impact on the COLA.

**Impact on PRA**

There is no impact on the PRA.

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

4/9/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

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| RAI NO.: | NO. 215-1906 REVISION 0 |
| SRP SECTION: | 03.03.01 – Wind Loadings |
| APPLICATION SECTION: | 03.03.01 |
| DATE OF RAI ISSUE: | 02/25/09 |

**QUESTION NO. RAI 3.3.1-06:**

1. RAI Text

The Reactor Building (R/B) has translational and rotational displacements. Provide an analysis showing that the R/B does not have response characteristics making it subject to across wind loading, vortex shedding, instability due to galloping or flutter; and does not have a site location from which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.

2. Concern

Design wind loads for buildings and other structures, including the Main Wind-Force Resisting Systems (MWFRS) and components, may be determined using one of three procedures defined in ASCE/SEI 7-05, Section 6.1.2. The applicant selected Method 2 – Analytical Procedure described in ASCE/SEI 7-05, Section 6.5 to determine design wind loads for the R/B. According to this procedure, Method 2 can only be used to design the MWFRS for buildings that satisfy the two conditions defined in ASCE/SEI 7- 05, Section 6.5.1. Condition 2 for Method 2 states that the building does not have response characteristics making it subject to across wind loading, vortex shedding, instability due to galloping or flutter; and does not have a site location from which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.

In order for the NRC staff to determine whether Method 2 can be used to determine the design wind loads for the R/B in accordance with ASCE/SEI 7-05, Section 6.5 requirements, additional information about the response characteristics of the R/B to wind effects is needed to demonstrate compliance with GDC-2 in 10 CFR 50, Appendix A.

3. Applicant References

DCD Tier 2, Revision 1, Section 3.7.2.8.5.

4. Context

Structural integrity of Seismic Category I structures, which assures that SSCs important to safety are protected, and not compromised according to GDC-2 in the Appendix A to Part 50 of 10 CFR.

5. Priority/Impact

Medium – information is essential to completing a technical review and resolving a safety issue. The review can continue, but cannot be completed without the requested additional information.

6. Dependencies

Internal – There are interfaces with SRP Chapter 3.0, Section 3.3.2.

External – There are no external dependencies.

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**ANSWER:**

ASCE/SEI 7-05 Commentary, Section C6.5.2, page 284, states:

"The provisions given under Section 6.5.2 apply to the majority of site locations and buildings and structures, but for some locations, these provisions may be inadequate. Examples of site locations and buildings and structures (or portions thereof) that require the use of recognized literature for documentation pertaining to wind effects, or the use of the wind tunnel procedure of Section 6.6 include:

1. Site locations that have channeling effects from up-wind obstructions. Channeling effects can be caused by topographic features (e.g., mountain gorge) or buildings (e.g., a cluster of tall buildings). Wakes can be caused by hills or by buildings or other structures.

2. Buildings with unusual or irregular geometric shape, including barrel vaults, and other buildings whose shape (in plan or profile) differs significantly from a uniform of series of superimposed prisms similar to those indicated in Figs. 6-6 through 6-17. Unusual or irregular geometric shapes include buildings with multiple setbacks, curved facades, irregular plan resulting from significant indentations or projections, openings through the building, or multitower buildings connected by bridges.

3. Buildings with unusual response characteristics that result in across-wind and/or dynamic torsional loads, loads caused by vortex shedding, or loads resulting from instabilities, such as fluttering or galloping. Examples of buildings and structures that may have unusual response characteristics include flexible buildings with natural frequencies normally below 1 Hz, tall slender buildings (building height-to-width ratio exceeds 4), and cylindrical buildings or structures. Note: Vortex shedding occurs when wind blows across a slender prismatic or cylindrical body. Vortices are alternately shed from one side of the body and then the other side, which results in a fluctuating force acting at right angles to the wind direction (across-wind) along the length of the body.

4. Bridges, cranes, electrical transmission lines, guyed masts, telecommunication towers, and flagpoles."

As shown in US-APWR General Arrangement of Power Block, 4CS-UAP-20070026 Rev. 4, and as described in DCD Tier 2 Subsection 3.8.4.1, the R/B is a rigid (with respect to wind loading), relatively low-rise, nearly square structure (height-to-width ratio less than one) that does not include any unusual or irregular geometric shapes and is constructed of reinforced concrete walls, floors, and roofs. Based on the configuration and properties of the R/B complex as presented on the general arrangement drawings and in the DCD, the R/B does not fall within the limitations of Section C6.5.2 of the ASCE/SEI 7-05 Commentary cited above. Therefore, the R/B is not

considered to have response characteristics that make it subject to unusual wind effects such as across wind loading, vortex shedding, or instability due to galloping or flutter, and condition 2 of Section 6.5.1 is satisfied. Note that as stated in DCD Section 2.3, the COL Applicant is to verify that the site-specific regional climatology and local meteorology are bounded by the site parameters for the standard US-APWR design. Therefore, any unusual wind loading effects not bounded by the parameters outlined in Chapter 2 must be considered by COL applicants on a project-specific basis when confirming the wind loading parameters for a particular site.

**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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This completes MHI's responses to the NRC's questions.

For method 1 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1), and substituting 1.0 for the topographic factor, the basic formula for effective wind velocity pressure used for building main wind-force resisting systems is:

$p_s = 1.15 \lambda p_{basic}$

where

$p_s$ = effective wind velocity pressure, psf

$\lambda$ = adjustment factor for exposure category C from ASCE/SEI 7-05, Figure 6-2

$p_{basic}$ = wind pressure value in psf, from ASCE/SEI 7-05, Figure 6-2 corresponding to a basic wind speed of 155 mph

For method 2 with an importance factor of 1.15 (as discussed in Subsection 3.3.1.1), equation 6-15 from Subsection 6.5.10 of ASCE/SEI 7-05 is used where the topographic and directionality factors $K_{zt}$ and $K_d$ are each 1.0, and substituting into equation 6-17 of ASCE/SEI 7-05, Subsection 6.5.12 for enclosed and partially enclosed buildings, the basic formula for effective wind velocity pressure used for building main wind-force resisting systems is:

~~P~~ $p = 0.00256 K_z V^2 1.15 (GC_p +/- GC_{pi})$

where

$p$ = effective wind velocity pressure, psf

$K_z$ = velocity pressure coefficient varying with height, taken from Table 6-3 of ASCE/SEI 7-05 for exposure category C; however, not less than 0.87 as recommended by SRP 3.3.1 (Reference 3.3-2)

$V$ = basic wind speed of 155 mph per Subsection 3.3.1.1

$G$ = gust effect factor = 0.85 or as determined per ASCE/SEI 7-05, Subsection 6.5.8 (where a combined gust effect and pressure coefficient factor is used from a figure(s) in ASCE/SEI 7-05, an individual gust effect factor is not applied)

$C_p$ = external pressure coefficient from ASCE/SEI 7-05 Subsection 6.5.11

$C_{pi}$ = internal pressure coefficient from ASCE/SEI 7-05 Subsection 6.5.11 where two cases shall be considered to determine the critical load requirements for the appropriate conditions:

(i) a positive value of $GC_{pi}$ applied to all internal surfaces
(ii) a negative value of $GC_{pi}$ applied to all internal surfaces