REQUEST FOR ADDITIONAL INFORMATION 215-1906 REVISION 0

2/25/2009

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 03.03.01 - Wind Loading
Application Section: 03.03.01- Wind Loadings

QUESTIONS for Structural Engineering Branch 1 (AP1000/EPR Projects) (SEB1)

03.03.01-1

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.

03.03.01-2

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.

03.03.01-3

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.

03.03.01-4

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

λ = 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.

03.03.01-5

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.

03.03.01-6

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.