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December 9, 2011

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-11424

Subject: MHI's Response to US-APWR DCD RAI No. 758-5680 Revision 0 (SRP 03.05.03)

Reference: 1) "Request for Additional Information No. 758-5680 Revision 0, SRP Section: 03.05.03 – Barrier Design Procedures," dated 5/16/2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") a document entitled "Response to Request for Additional Information No. 758-5680, Revision 0."

Enclosed is the response to the RAI contained within Reference 1. This transmittal completes the response to this RAI.

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. Response to Request for Additional Information No. 758-5680, Revision 0

D081
NRO

CC: J. A. Ciocco
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Docket No. 52-021
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Enclosure 1

UAP-HF-11424
Docket No. 52-021

Response to Request for Additional Information No. 758-5680,
Revision 0

December, 2011

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12/09/2011

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 758-5680 REVISION 0**
SRP SECTION:	**03.05.03 – Barrier Design Procedures**
APPLICATION SECTION:	**3.5.3**
DATE OF RAI ISSUE:	**05/16/2011**

QUESTION NO. RAI 03.05.03-10:

In the response to RAI 686-4557, the applicant stated the following:

"With respect to item (2) global damage in the RAI question: Design for building "tipover" and foundation sliding failure are dominated by the seismic design load combinations, not by load combinations involving tornado missiles. For example, the heaviest missile, which is the 4000 lb automobile missile, is about 0.013% of the weight of a Power Source Building, which weighs roughly 30,000,000 lb (Reference MHI Technical Report MUAP-10001, "Seismic Design Bases of the US-APWR Standard Plant", Revision 2, Table 5.4.2-1). Due to this small ratio, lateral building load due to transfer of the automobile missile kinetic energy will have negligible impact on "tip-over" and sliding. This ratio is even less for the PCCV, which weighs roughly 70,000,000 lb (shell cylinder and dome portions only)"

Based on the above information, the building "tip-over" and foundation sliding failure are indeed bounded by the design-basis seismic loadings. However, the impact loading by the automobile missile (> 500 Hz, high pulse) imposes a different structural response from seismic loading (<33 Hz, inertia force induced, quasi-static). Thus, the seismic analysis methodology may not apply directly in this case. One of the major differences is the applied load distribution wherein the impact force induced by the auto missile at the impact site is much bigger than the inertia force induced at that location locally by the SSE, even though the overall seismic loads are higher. Accordingly, the local effects induced by the localized dynamic impact load can still affect the structural integrity at or near the impact location of the building.

DCD Rev. 2 Tier 2, Section 3.5.1.4 on Page 3.5-11 states that "all seismic category I structures are capable of withstanding the impact of each identified tornado missile at any elevation, including the potential impact of a 4,000 pound automobile greater than 30 feet above grade." Thus, the staff requests investigations of local impact effects to assure structural integrity of all seismic category I structures under a automobile missile striking at any elevation. The analyses should include local shear response of the building at the critical elevation level near the auto missile impact site as well as the possibility of the auto missile penetrations at the weakest locations wherever the missile can strike. It should be noted that the case of auto missile impact at elevations higher than 30 ft. above grade is not covered by RG 1.76, thus not addressed in Item (1) of the response to RAI 686-4557.

ANSWER:

Local Impact Loading Due to Automobile Missile

The Reactor Building, East Power Source and West Power Source Buildings walls and roof slabs are evaluated for the effect of the automobile missiles (as well as other design-basis tornado-generated missiles described in DCD Subsection 3.5.1.4). Detail design calculations, which are available for NRC audit, investigate the weakest walls and slabs having minimum thicknesses (20", 21" and 15"). The calculations are performed in accordance with the US-APWR DCD tornado missile design requirements. The minimum thicknesses of the Reactor Building and Power Source Building walls and roof slabs are shown to be larger than the calculated values for penetration, perforation and scabbing due to any design basis tornado missiles, and higher than the minimum thicknesses provided in Table 1 of SRP 3.5.3.

The effect of automobile impact on the walls and slabs is evaluated with two methods: one method using formulation based on "no penetration" as described in Williamson and Alvy, "Impact Effect of Fragments Striking Structural Elements" (DCD Reference 3.3-6), and a time history method, assuming an almost constant impact force based on the crashing load of the missile with no penetration. The calculated ductility values conform to the requirements in DCD Subsection 3.5.3.2. The ultimate load capacities of the walls and slab panels in direct shear are shown to be larger than the impact load or the flexural capacity (whichever is less) increased by a factor of 1.2 (DCD References 3.5-16 and 3.5-9).

Please note that for clarity, a cross-reference to the tornado loading requirements discussed in DCD Subsections 3.3.2 and 3.8.4 will be added to DCD Subsection 3.5.1.4 as indicated below in "Impact on DCD".

Elevation of Automobile Missile

In response to the NRC comment in the last sentence of the RAI question, please note that RG 1.76 states:

> "The automobile missile is considered to impact at all altitudes less than 30 feet (9.14 meters) above all grade levels within 0.5 mile (0.8 kilometer) of the plant structures."

Site-specific conditions may exist where grades within 0.5 mile of plant structures may be elevations higher than grades immediately adjacent to standard plant structures, therefore the automobile missile may potentially impact SSCs at elevations more than 30 feet above standard plant grade.

Therefore, the potential for automobile missiles to impact at elevations higher than 30 feet above grade is an implied requirement in RG 1.76, and this requirement is addressed in the response to RAI 686-4557 (ML110620099), in DCD Subsection 3.5.1.4, and in the missile calculations discussed above.

Impact on DCD

See the Attachment 1 mark-up of DCD Tier 2, Subsection 3.5, changes to be incorporated. The last paragraph in DCD Subsection 3.5.1.4 will be revised to read as follows:

> "Openings through the exterior walls of the seismic category I structures, and the location of equipment in the vicinity of such openings, are arranged so that a missile passing through the opening would not prevent the safe shutdown of the

plant and would not result in an offsite release exceeding the limits defined in 10 CFR 100 (Reference 3.5-2). Otherwise, structural barriers are designed to resist tornado missiles in accordance with the design procedures discussed in Subsection 3.5.3. Tornado missiles are not postulated to ricochet or strike more than once at a target location. Tornado missile protection is provided to resist the normal component of force delivered by the missile striking in any direction. Additional tornado loading design requirements are addressed in Subsections 3.3.2 and 3.8.4. Due to the robustness of the exterior wall design, all seismic category I structures are capable of withstanding the impact of each identified tornado missile at any elevation, including the potential impact of a 4,000 pound automobile greater than 30 feet above grade."

Impact on R-COLA

There is no impact on the R-COLA.

Impact on S-COLA

There is no impact on the S-COLA.

Impact on PRA

There is no impact on the PRA.

Impact on Technical/Topical Report

There is no impact on a Technical/Topical Report.

This completes MHI response to the NRC question.

protection is provided to resist the normal component of force delivered by the missile striking in any direction. Additional tornado loading design requirements are addressed in Subsections 3.3.2 and 3.8.4. Due to the robustness of the exterior wall design, all seismic category I structures are capable of withstanding the impact of each identified tornado missile at any elevation, including the potential impact of a 4,000 pound automobile greater than 30 feet above grade. DCD_03.05.03-10

3.5.1.5 Site Proximity Missiles (Except Aircraft)

Externally initiated missiles considered for the US-APWR standard design are based on tornado missiles as described in Subsection 3.5.1.4. As described in DCD, Section 2.2, the COL Applicant is to establish the presence of potential hazards, except aircraft, which is reviewed in Subsection 3.5.1.6, and the effects of potential accidents in the vicinity of the site. The RG followed is identified, and any deviations from this guidance or any alternative methods that are used are explained or justified. The information also describes the data collected, analyses performed, results obtained, and any previous analyses and results cited to justify any of the conclusions. Additional analyses may be required to evaluate other potential site-specific missiles.

3.5.1.6 Aircraft Hazards

The US-APWR standard plant design basis is that the plant is located such that an aircraft crash and air transportation accidents are not required to be considered as part of the design basis. It is the responsibility of the COL Applicant to verify the site interface parameters with respect to aircraft crashes and air transportation accidents as described in Section 2.2. Additional analyses may be required to evaluate potential aircraft missiles.

3.5.2 Structures, Systems, and Components to be Protected from Externally Generated Missiles

Safety-related SSCs are identified in Section 3.2 and Section 3.11. Protection of these systems from external missiles is provided by the external walls and roof of the safety-related R/B and PS/B. The external walls and roofs are reinforced concrete. The structural design requirements for the R/B and PS/B are outlined in Subsection 3.8.4.

Openings through exterior walls of the seismic category I structures are evaluated as described in Subsection 3.5.1.4 to provide confidence that a missile passing through the opening would not prevent safe shutdown and would not result in an offsite release exceeding the limits defined in 10 CFR 100 (Reference 3.5-2). The COL Applicant is responsible to evaluate site-specific hazards for external events that may produce missiles more energetic than tornado missiles, and assure that the design of seismic category I and II structures meet these loads.

3.5.3 Barrier Design Procedures

If required, components, protective shields, and missile barriers are designed to prevent damage to safety-related components by absorbing and withstanding missile impact loads. The target SSCs, shields, and barriers are evaluated for both local effects and overall structural effects due to missile impacts. The local effects in the impacted area are evaluated to predict the minimum thickness required for steel structures and for concrete