RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1/31/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 852-6003 REVISION 3**
SRP SECTION:	**03.07.02 – Seismic System Analysis**
APPLICATION SECTION:	**3.7.2**
DATE OF RAI ISSUE:	**10/24/11**

QUESTION NO. RAI 03.07.02-117:

In Subsection 4.3.1.4 of MUAP-10001(R3), "Modeling of Mass," the last paragraph (Page 4-24) states, "Liquid masses contained in the Spent Fuel Pit, Emergency Feed Water Pits, and Refueling Water Storage Pit are applied as impulsive mass to walls and slabs. The direction of the mass is perpendicular to the surface of the walls or slabs as shown in Figure 4.3.1.4-1."

The applicant did not provide sufficient details for the staff to evaluate the modeling of the fluid mass. The applicant is requested to provide the following additional information:

- Provide technical information that shows how the impulsive mass is calculated.
- Provide information for the locations of Nodes i and j.
- Is the convective effect (including the surface sloshing wave height) considered for these liquid masses? If not, provide the rationale for not including the convective effects.
- Does the mass used for the new fuel and spent fuel storage pits include the mass of the fuel and the fuel storage racks contained within the pool? If not, provide the rationale for not including these masses.
- Provide a breakdown of masses considered in the 3D seismic SSI model for the new and spent fuel, fuel storage racks, pool water, and the fuel storage pool structure including the pool liner plate.

Also, the fuel storage pool will experience a rocking motion at its base in addition to the horizontal excitation due to SSI. Thus, the applicant is requested to describe how this rocking effect is considered in the analyses, or to provide numerical data to show that this rocking effect is negligible.

ANSWER:

Technical Report MUAP-10001, Rev. 3 has been superseded and its relevant information has been incorporated into Technical Report MUAP-10006, Rev. 3. Section 4.3.1.4 of MUAP-10001

Rev. 3 is Section 02.4.1.1.4 in MUAP-10006 Rev. 3. The last paragraph in this section provides discussion about the modeling of liquids.

The following is additional information for the bulleted items:

- Provide technical information that shows how the impulsive mass is calculated:

  The liquid is separated into regions in which fluid motions can develop under horizontal seismic excitation. Within each region the behavior of the liquid is characterized by the motion of the rigid (impulsive) mass and the sloshing (convective) mass using the Housner Method that conforms to the provisions of SRP 3.7.3 Acceptance Criteria 14, and guidance of ASCE 4-98, Subsection 3.5.4. To account for this behavior, the total liquid mass is divided into the sloshing (convective) and the rigid (impulsive) mass. For each region the magnitude of these masses is a function of the liquid depth and the depth-to-length ratio in the direction of seismic excitation. Section 02.4.1.1.4 of Technical Report MUAP-10006 describes this approach to calculate impulsive mass.

- Provide information for the locations of Nodes i and j:

  The full weight (mass) of the water contained in the respective pit (spent fuel pit, emergency feedwater pit and refueling water storage pit) is applied perpendicular to each wall and slab of the pit, and moves with each surface along its entire width and height. The weight is applied by distributing the mass appropriately among the finite elements in the pit/pool wall/slab areas as shown in the example of Figure 02.4.1.1.4-1 of MUAP-10006.

- Inclusion of convective effects:

  To consider convective effects, upper convective masses were attached to walls in the dynamic model similar to the lower impulsive mass of the fluid. Section 02.4.1.1.4 of Technical Report MUAP-10006 describes the inclusion of convective effects with masses as shown in Figure 02.4.1.1.4-1. This practice is conservative for SSI analyses due to the low seismic accelerations associated with the low frequencies of the convective spring mass system, calculated using a simplified assumption of a rigid tank shell in accordance with guidance provided in ASCE 4-98, Subsection 3.8.3.4.8. The surface sloshing wave height with respect to the potential of creating flooding is not the subject of Technical Report MUAP-10006, which addresses soil-structure interaction (SSI). Surface sloshing wave height or maximum vertical displacement of the fluid surface with respect to the potential of creating flooding is the subject of separate calculations.

- Mass of fuel and fuel storage racks:

  The mass used for the new fuel and spent fuel storage pits does include the mass of the fuel and the fuel storage racks. This is accomplished by adding the masses as additional density to the concrete slabs of the pits. The dynamic characteristics of the racks are not modeled or coupled with the structure. Section 02.4.1.1.4 of Technical Report MUAP-10006 describes the modeling of mass of the new fuel and spent fuel storage pits.

- Breakdown of masses considered in the 3D seismic SSI model:

  The updated closure plan for the US-APWR seismic and structural analyses (ML12290A009094A342) references Calculation NIC-13-05-113-001, which contains an extensive breakdown to the weights of equipment and liquids in the various pools. Section 02.4.1.1.4 of Technical Report MUAP-10006 describes the masses considered in the 3D seismic SSI model for the new and spent fuel, fuel storage racks, pool water, and

the fuel storage pool structure except for the pool liner plate, which is considered negligible compared to the weight of the massive concrete structure.

The fuel storage pool will experience a rocking motion at its base. Describe how this rocking effect is considered in the analyses, or to provide numerical data to show that this rocking effect is negligible.

The dynamic finite element models account for seismic rocking effects through the SSI SASSI analyses. Rotational effects including rocking and torsion are captured in the analyses through the detailed modeling of the building structures.

Impact on DCD

There is no impact on the DCD.

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 the Technical/Topical Report.

This completes MHI's response to the NRC's question.