RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

03/29/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 643-4967 REVISION 1**
SRP SECTION:	**03.07.01 – Seismic Design Parameters**
APPLICATION SECTION:	**3.7.1**
DATE OF RAI ISSUE:	**10/04/2010**

QUESTION NO. 03.07.01-06 (03.07.01-12):

In Section 3.7.1.3, "Supporting Media for Seismic Category I Structures," of Revision 1 of the DCD, a value of 15 ksf is specified as the required allowable static bearing capacity for seismic Category I building structure basemats. In RAI 1946 Question 3.7.1-7, the applicant was asked to provide the justification and technical basis for the value of 15 ksf as well as the justification of the minimum factor of safety of 2 that was proposed for the ultimate bearing capacity versus the allowable dynamic bearing capacity. The applicant responded to the RAI in a letter, MHI ref: UAP-HF-09187, dated April 23, 2009. The staff reviewed the applicant response and concluded that the response did not adequately address the issue and as a result, a follow-up RAI (RAI 3978, Question 3.7.1-9) was issued requesting that the applicant describe how the proposed value of 15 ksf is significant to the plant design and how the static and dynamic bearing pressures and corresponding soil capacities will be used in the plant design. The applicant responded to the follow-up RAI in a letter, MHI Ref: UAP-HF-10022, dated January 29, 2010. The staff evaluated the applicant response and considered the response to be inadequate because, the responses did not answer such questions as the difference between demand and capacity, the difference between static and dynamic values for bearing pressure, the technical basis for safety factors, and whether the 15 ksf value is intended to apply to the soil or to the building foundation.

In order to evaluate the Supporting Media for Seismic Category I Structures, per SRP Acceptance Criteria 3.7.1.II.3, the staff request MHI to provide response to the following specific questions:

1. Provide an analysis of the effect of the maximum groundwater level that is 1 ft below plant grade is considered on the analysis of static and dynamic bearing capacities of saturated soil and associated design safety factor.

2. Discuss what is the static bearing pressure demand value for the soil; the design value used for the static bearing pressure; the safety factor applied to the static bearing pressure; the justification for the minimum bearing pressure capacity; what is the dynamic bearing pressure demand value for the soil?

3. Provide a technical basis and justification for justification to support the minimum required dynamic bearing pressure capacity and state how it is governed, whether by the soil or the building foundation?

Reference: RAI Response 494-3978, UAP-HF-10022; dated January 29, 2010; ML100330617.

ANSWER:

This answer revises and replaces the previous answer that was transmitted by MHI letter UAP-HF-10308 (ML103200405).

The following quantities are calculated at the Standard Plant level: (1) the maximum static and dynamic bearing pressures are calculated as explained in the answer to RAI 94-1491, Rev. 1, Question 02.05.04-01, and (2) the minimum *allowable* static and dynamic bearing capacities are established to be equal or larger than the corresponding maximum static and dynamic bearing pressures. The *ultimate* bearing capacities are site specific and are calculated by the Combined License (COL) Applicant based on local subgrade conditions.

1. The effect of groundwater level is considered in calculation of the maximum bearing pressure demands for both static and dynamic cases, as explained in the response to RAI 94-1491, Question 02.05.04-01. The minimum allowable bearing capacities are determined by rounding up the maximum demands. The safety factors specified in Design Control Document (DCD) Section 3.7.1.3 are for the ratio between the *ultimate* bearing capacities calculated by the Applicants for site specific conditions and the minimum *allowable* bearing capacities specified for the Standard Plant, as described in the response to RAI 211-1946, Question 3.7.1-7.

2. The static bearing pressure demand for the US-APWR is 13.1 ksf computed for the reactor building (R/B) complex based upon the weight and footprint of the structure. The DCD establishes a design value, identified as the minimum allowable static bearing capacity, of 15 ksf in Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1. This value is obtained by rounding up the static bearing pressure demand. DCD Section 3.7.1.3 recommends a safety factor of 2.5 for static bearing capacity. Therefore, if using this factor of safety, each applicant must ensure their site has an ultimate bearing capacity (q_u) for the R/B complex under static loads of 37.5 ksf (15 ksf x 2.5) or greater.

   The ultimate bearing capacity (q_u) is the maximum bearing pressure that can be applied to the soil without general failure of the structure. It is estimated by the COL applicant using the bearing capacity equation and depends on site specific soil properties. The recommended minimum factor of safety for static bearing capacity, FS_S = 2.5, was selected based on upper ranges of published values (e.g., Reference 1, Table 4-9).

   The maximum dynamic bearing pressure demand is 21.9 ksf based upon the 2032-100 soil case. The DCD notes the minimum dynamic bearing capacity of 35 ksf for all subgrades in Tier 1, Table 2.1-1 and Tier 2, Table 2.0-1. These values are obtained by rounding up the dynamic bearing pressure demand. DCD Section 3.7.1.3 recommends a safety factor of 2.0 for dynamic bearing capacity. Therefore, if using this factor of safety, each applicant must ensure their site has a dynamic ultimate bearing capacity (q_u) for the R/B complex of 70 ksf (35 ksf x 2.0) or greater

3. As described above, the minimum allowable dynamic bearing capacity is based on the results of the seismic analysis. The ultimate dynamic bearing capacity is developed based on the soil and site specific conditions, and the COL Applicant must determine the ultimate dynamic bearing capacity at their site and ensure an adequate factor of safety. The ultimate dynamic bearing capacity depends on subgrade properties, foundation size, shape and depth, and intensity of earthquake acceleration.

References

1. Bowles, J.E. (1996), Foundation Analysis and Design, Fifth Edition, McGraw-Hill.

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.