RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

03/29/2013

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

RAI NO.:	**NO. 960-6709 REVISION 0**
SRP SECTION:	**03.07.02 – Seismic System Analysis**
APPLICATION SECTION:	**3.7.2**
DATE OF RAI ISSUE:	**09/24/2012**

QUESTION NO. 03.07.02-215:

Section 3.0 of MHI's TR MUAP-12002 (R0), "Sliding Evaluation and Results," states that one of the objectives of this report is to, "Demonstrate acceptable seismic sliding of the Reactor Building (R/B) Complex and the Turbine Building (T/B) structures." It also states that possible sliding will be calculated during the safe-shutdown earthquake (SSE) using nonlinear time history analyses which will demonstrate that the amount of sliding, if any, is too small to cause any physical damage to the R/B Complex and T/B structures or to the structural connections. Currently, the criterion in SRP 3.8.5 indicates that there should be a factor of safety of 1.1 against sliding, rather than an evaluation of the effects of sliding on physical damage to structures and structural connections. The guidance in the SRP is intended to show that there is no sliding, including the consideration of the factor of safety. Therefore, the applicant is requested to provide the technical basis and justification for allowing some small displacement. The staff notes that the report does not include acceptance criteria for sliding. The staff requests the applicant to define the acceptance criteria it will use to evaluate sliding, and to provide the technical basis and justification for the acceptance criteria.

ANSWER:

This answer revises and replaces the previous MHI answer that was transmitted by Letter UAP-HF-12292 (ML12356A069).

In order to better describe the objective of the Technical Report MUAP-12002, Rev. 1, the sentence, "Demonstrate acceptable seismic sliding of the Reactor Building (R/B) Complex and the Turbine Building (T/B) structures" in Section 3.0 is replaced by: "The objective of this Technical Report is to estimate conservative upper bounds for seismic sliding displacements for the R/B complex and the T/B subjected to CSDRS compatible acceleration time histories. The upper bounds for sliding values calculated here are used to satisfy the requirements of SRP 3.8.5, Rev. 3, and are applied in the detailed design of the Standard Plant."

The need to perform seismic sliding evaluation by means of nonlinear time history analysis is briefly discussed in Section 1.0 of Technical Report MUAP-12002, Rev.1. As stated in Reference 2 of the Technical Report:

"In DC applications, however, it has been difficult to demonstrate seismic stability using simple calculations. The reason for this difficulty seems to be that, for the reasons mentioned in the introductory section, the seismic demands tend to be overestimated while the seismic resistance tends to be conservatively underestimated. To overcome this difficulty, DC applicants have had to perform more realistic time-history seismic analyses that, in some instances, explicitly incorporated the nonlinearities caused by sliding, uplift and lateral soil pressure at the perimeter of embedded structures. The results of these analyses often indicate that small amounts of sliding or uplift may occur during a seismic ground motion. To meet the intent of the SRP, the safety review needs to determine, on a case-by-case basis, whether the small amounts of sliding or uplift are acceptable."

Specifically, the equivalent-static factor of safety for sliding may be less than the minimum accepted value for very short time intervals. It is the industry practice (e.g., References 2, 22, 26, 27, and 28 of the Technical Report) to demonstrate acceptable sliding stability by estimating the structure movement during small time intervals and demonstrating that the structure safety and functionality is not affected by these displacements. Technically, this approach is no different from the approaches described in the Standard Review Plan (SRP) Acceptance Criteria of SRP 3.8.5.II.4 B (Second Section B) where the consideration of passive pressure implies a displacement of the structure. The wall displacement necessary to mobilize passive pressure is generally taken to be 0.005 to 0.01 H, where H is the height of concrete surface where the passive pressure occurs (Reference 1). For a 42 ft basement wall, this translates into a displacement of approximately 2½ to 5 in. The dynamic analysis methodology currently being applied is based on a more accurate calculation of lateral displacements of the structures analyzed here. It is more accurate than the ones implied by passive pressure theories that are based upon observations of existing structures.

The method used for sliding stability analysis calculates seismic induced sliding by direct integration time history analysis and: (1) uses compression only sliding friction elements at the interface of basemat and soil, (2) considers basemat uplift in addition to sliding, (3) applies a seismic input increased by 10 percent in all directions to demonstrate an adequate factor of safety against sliding, and (4) does not account for the beneficial effect of passive soil reaction. Furthermore: (5) the sliding analysis model used is a three dimensional model, including horizontal accelerations in two orthogonal directions in addition to the vertical acceleration, and (6) the friction coefficient considered at the basemat-subgrade interface is 0.5 for both sliding and no-sliding conditions. Other conservative assumptions used are listed in Section 4.5.1 of Technical Report MUAP-12002, Rev.1.

Regarding new NRC guidance (Memorandum of February 19, 2013 regarding “Technical Rationale for Proposed Enhancements to Seismic and Structural Review Guidance”), the MHI methodology complies with all proposed revisions to SRP Section 3.8.5 II 4 for the case where the stability evaluation is performed using a nonlinear time history analysis.

Technical Report MUAP-12002, Rev. 1, provides the maximum expected values of sliding for the reactor building (R/B) complex and the turbine building (T/B). As specified in the Design Control Document (DCD), the design of all aspects related to interaction between adjacent structures and components (structural gaps, structural connections, such as buried tunnels and other umbilicals, buried commodities) will accommodate the displacements corresponding to the maximum expected sliding.

Additional Reference:

1. Das, B.M., Principles of Geotechnical Engineering, 7th edition, Cengage Learning, 2010.

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.