72-1014

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March 20, 2001

Mr. E. William Brach
Director, Spent Fuel Project Office, NMSS
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Reference: Docket No. 72-1014, HI-STORM 100

Subject: HI-STORM Deployment Under CoC 72-1014
Manufacturing and Deployment Issue (MDI) No. 1
Holtec Project 90428

Dear Mr. Brach:

The deployment of our HI-STAR 100 System (Docket No. 72-1008) at the Dresden and Plant Hatch sites last year led to several issues pertaining to the manufacturing and loading of HI-STAR 100 Systems, which were addressed by our company through the vehicle of the *clarification letter* to the Spent Fuel Project Office. The clarification letter served to answer a utility's question on a system deployment issue that, in the view of the ISFSI owner, may not have been sufficiently well articulated in our FSAR, NRC's SER, or the CoC. As agreed in our March 15, 2000 meeting, we submit clarification letters on only those items where our client requests that we document our response, and the response is warranted for reasons of quality assurance or regulatory compliance. Now that the deployment of HI-STORMs under our CoC No. 72-1014 at several sites is scheduled to occur this year, we need to submit a clarification letter on the HI-STORM docket to the SFPO dealing with a topic raised by one of our clients. As before, we do not require a written communication from the SFPO unless the NRC finds our response to the utility's question to be non-compliant to the HI-STORM system CoC.

Question 1: What is the precise meaning of G_H and G_V in the inequality under Section 3.4 of Appendix B, "Approved Contents and Design Features"?

Answer 1:

G_H is the vectorial sum of the two horizontal accelerations and G_V is the vertical acceleration. All accelerations are referred to the HI-STORM/pad interface, i.e., at the top surface of the pad.

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Basis:

Appendix B to the HI-STORM 100 CoC, Section 3.4.3, specifies the design basis seismic accelerations for the cask system in terms of G_H (the equivalent vectorial sum of two horizontal ZPAs) and G_V (the corresponding vertical ZPA). FSAR 3.1.2.1.1.6 clearly specifies that the design basis earthquake is assumed to be at the top surface of the pad. This assumption is used to perform a stability analysis (tipping and sliding) in Subsection 3.4.7.1 of the FSAR. The NRC's SER on this subject (at the unnumbered table in Section 3.4.2) clearly identifies these accelerations as "horizontal g-level vector sum" and "corresponding vertical g-level (upward)" on the top surface of the pad. The acceleration inequality in Section 3.4.3 of Appendix B to the CoC is derived from purely static equilibrium considerations, i.e., it is not based on a dynamic analysis.

Question 2: Development of model element properties to simulate soil elasticity and damping using the equivalent elastic half-space method described in ASCE 4-86 is a common and acceptable method used to quantify the effects of soil structure interaction for cask and support pad systems. Is the use of averaged stiffness soil properties (primarily the shear modulus) for evaluation of soil springs per Table 3300-1 of ASCE 4-86) acceptable?

Answer 2:

Yes. To establish the effective accelerations on the top of the ISFSI pad founded on a deep soil stratum, the equivalent elastic half-space method described in ASCE 4-86 may be used to evaluate frequency independent soil-structure impedance functions. The loaded HI-STORM overpacks are modeled as free-standing rigid cylindrical components with the pad modeled as a rigid plate. The structural attributes of the soil half-space underlying the ISFSI pad may be simulated by equivalent linear spring constants and viscous damping coefficients developed from the shear modulus estimate obtained as an average for the soil strata located beneath the pad down to the depth of the input seismic excitation (commonly bedrock). Averaging of the of the soil shear modulus through the depth of the subterranean soil is acceptable provided that the properties are available from appropriate physical measurements and the shear modulus based on the geostatic pressure alone is corrected to account for the overburden from the ISFSI and the magnitude of the shear strains anticipated during the design earthquake. The methodology described in EERC Report 70-10 [Soil Moduli and Damping Factors for Dynamic Response Analyses by H.B. Seed and I.M. Idriss] and the guidance provided in NRC Generic Letter 80-

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109 are considered robust sources that can be used for the evaluation of the lower bound, best estimate, and upper bound estimate of the soil shear modulus. Three discrete soil-structure interaction analyses are performed by Holtec using the lower bound estimate, best estimate, and upper bound estimate of the soil shear modulus, respectively, to account for the uncertainties in the characterization of the soil properties.

In summary, as is typical at many sites with deep soil beds, the mechanical properties of the subsoil may vary significantly with depth forming distinctive layers of softer and harder soil. For simplicity of analysis, the shear modulus of the soil may be averaged through depth to obtain appropriate stiffness properties of an equivalent elastic half-space. As prescribed in ASCE 4-86, a set of six linear soil springs and dampers then can be used to model the frequency independent soil-structure impedance functions. For a shallow soil stratum site, the half-space model will be inapplicable.

Basis:

Incorporating the effect of the soil substrate using the ASCE 4-86 procedure will usually produce a greater value of G_H and G_V than their respective free field values. Therefore, incorporating the effect of the soil structure interaction in the pad dynamic model is conservative. Development of soil properties based on the composite of all soil strata between the pad base and the input seismic excitation is appropriate for the class of problems in which free-standing rigid bodies (casks) are situated on a relatively thick (over 18") concrete pad. Lower bound, best estimate, and upper bound values of the averaged thru-depth shear modulus used to perform three discrete dynamic analyses constitute an acceptable approach to account for the potential uncertainty in the modeling of the stiffness properties of an equivalent elastic half-space.

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We trust that the above responses to the questions raised by one of our clients in the context of a planned deployment of the HI-STORM 100 System at their plant are consistent with the conservative approach espoused by the NRC and with the provisions of the system's CoC.

We thank you for your review of this communication.

Sincerely,

Brian Gutherman, P.E.
Licensing Manager

Approval:

Dr. K.P. Singh, Ph.D., P.E.
President and CEO

Emcc: Mr. Steve Scammon, Energy Northwest
Mr. Charles Davis, TVA
Mr. Steve Nichols, Portland General Electric
Mr. Bruce Patton, Pacific Gas & Electric: Diablo Canyon
Mr. Roy Willis, Pacific Gas & Electric: Humboldt Bay
Mr. Mark Smith, Pacific Gas & Electric, Humboldt Bay
Mr. Darrell Williams, Entergy
Mr. Ken Phy, Entergy Nuclear Northeast
Mr. Rick Redmond, Entergy, River Bend
Ms. Jodi Furr, Entergy, River Bend
Mr. Stanley Miller, Vermont Yankee
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Technical Concurrence

Dr. Alan I. Soler (Structural Mechanics): ______________

Dr. Luben Todorovski (Soil Mechanics): ______________

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