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July 19, 2012

Mr. Mark D. Lombard
Director
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
United States Nuclear Regulatory Commission
Mail Stop E-3-D-2M
Washington, DC 20555-0001

Reference: Docket Number 72-1014; HI-STORM 100 System
Holtec Project # H-5014

Subject: ISFSI Pad Qualification - Request for Guidance

Dear Mr. Lombard:

We thank SFST for the opportunity to present our regulatory understanding in the matter of the ISFSI pad design qualification in the July 12, 2012 meeting at NRC's offices. We also appreciate the insightful observations by the Staff and the ensuing technical dialogue in the meeting that shed much light on the subject matter. Having exchanged the necessary technical and regulatory information, we now request your favor to officially comment on the substance of our presentation on ISFSI pad qualification, which we summarize below, such that the design compliance status of previously designed pads at our Holtec Users Group (HUG) sites is clarified. Our request for NRC's clarification and guidance in this subject matter is intended to remove the regulatory uncertainty with respect to pad qualification which arose some two years ago and which is continuing to impact ISFSI configuration management at certain HUG sites. Specifically, our request for NRC's regulatory input pertains to the provisions in the HI-STORM 100 FSAR (the "FSAR") in the areas of pad design and analysis, including its safety category and the applicable ACI Code for its strength qualification. We summarize the key points in the following:

1. Provisions in the HI-STORM 100 FSAR:

The FSAR designates the ISFSI pad for storing freestanding casks as Not-Important-to-Safety (NITS). Reinforcing the NITS designation of the pad, the FSAR permits the use of ACI-318 for the pad's structural qualification.

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By way of underlining the historical background of the above regulatory position established in the HI-STORM 100 FSAR, we should note that the FSAR does not instruct the designer to incorporate the long-term differential settlement (which is a major "load" contributor) in the pad's strength analysis because the focus of safety assurance is directed towards ensuring that the MPC will continue to keep the fuel in a reactivity and confinement-compliant state in the event the storage cask were to tip over (the so-called "non- mechanistic tip-over" requirement). As can be surmised from physical reasoning, the impact from tip-over is maximized if the pad is assumed to have undergone no reduction in the equivalent sub-grade stiffness due to long-term differential settlement effects. The focus of the FSAR, in a nutshell, is to require a conservative tip-over analysis and thus implicitly guide the design towards as soft a pad (termed "the target" in the tip-over event) as possible.

Aside from specifying the safety category (NITS), naming acceptable ACI codes (viz., ACI-318), and pointedly leaving out differential settlement as a consideration in the pad's strength analysis, the FSAR provides no additional guidance.

2. Holtec's Pad Design Practice:

Holtec International has followed the provisions of the FSAR in all pad design/qualification work performed by the Company to date. As our design practice evolved, the 30-year old guidance documents on time-history generation (1980 issue of NUREG-0800), which required a single synthetic time-history, has been replaced with ASCE 4-98, which calls for multiple time-histories. Learning from experience, we have determined that differential settlement could be added to the dead-plus-live-load combination without making the pad excessively stiff (which would run counter to our goal of maximizing the margin under the *safety significant* tip-over event). The design approach for pads for several sites accordingly has utilized a conservative input value for differential settlement in the dead-plus-live load combination (where it is suggested to be incorporated in ACI-318), making this load combination even more severe than the one that includes the Design Basis Earthquake. The strength analysis of every pad that we have analyzed thus far has shown that the *DBE load combination does not govern,* even though the dynamic load from earthquake has been calculated using a non-linear model and multiple time-histories (in contrast to the linear SASSI model that yields generally smaller reaction forces and has been widely used in the industry) and the peak impact load is over 300% of the cask's weight.

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In this context, we should clarify that we have always adhered to the practice of using only NRC-reviewed computer codes and performing appropriate parametric studies to ensure a converged solution.

We respectfully submit that the above approach, based on national consensus standards, is sufficiently conservative to compute the dynamic load from seismic excitation which, in the ultimate analysis, has not been found to control the pad's design in all of the cases that we have thus far analyzed. In our view, exacerbating computational complexity through adoption of the latest issue of SRP 3.7.1 (which calls for 5 natural earthquake derived time-histories with several additional restrictions) which most operating plants have not yet adopted in their FSARs for *safety related* non- linear structures (as proposed in the meeting) may not be justifiable for a structure or ancillary which is Not-Important-to-Safety.

In fact, it should be clarified that the pad strength analysis seeks to satisfy the limits of ACI-318 only because it is required by the FSAR. We believe that, because exceeding the ACI strength limits would not have an adverse safety consequence, the requirement to meet ACI strength limits, from a safety perspective, lacks an identifiable imperative. Nevertheless, we must comply with the FSAR and abide by its provisions without exception. We accordingly intend to continue the practice of demonstrating compliance with ACI-318 strength limits in the manner of the above.

3. New Staff Guidance on Cask Kinematics under DBE:

In the meeting, the Staff suggested using NUREG/CR-6865 (including its nomograms) to assess the potential of inter-cask impact under the DBE event under the lower bound interface friction scenario. We have determined that implementing this recommendation would provide added assurance with respect to the adequacy of the inter-cask spacings and would be in full accord (i.e., not in any conflict) with the FSAR. We therefore plan to include such evaluation in all future pad qualification analyses.

We herewith make the unusual request of SFST to provide us its official position on the NITS classification of the pad and the use of ACI-318 as the reference code as sanctioned by the FSAR. We would also appreciate if the Commission were to reaffirm its long standing practice of devolving the authority and responsibility to select the analysis methodology for analyzing NITS systems, structures, and components (SSC), *which is not covered in the FSAR*, to the

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certificate holder. In our humble opinion, it is necessary to instill such clarity to enable us to carry out our responsibilities with full regulatory accountability, to enable the inspectors to focus on the safety significant SSCs and to avert the kind of uncertainty that our industry has suffered after Region 3 issued the TAR two years ago on LaSalle's pad analysis. To this day our pad analysis for LaSalle remains in limbo even though it is in full compliance with the FSAR and the codes referenced therein. In a broader context, the pad analysis remains an unresolved generic matter for us that handicaps our present and future pad design work. To dispel the confusion that surrounds this topic and thus to foster improved regulatory efficiency, we believe that SFST's review of and concurrence with the attached appendix, which lays out the essential requirements for pad analysis consistent with its NITS designation and provisions in the FSAR, would be most helpful.

We believe that your affirmative response to this letter and its appendix would help eliminate the ambiguity that surrounds our pad design and analysis effort. Because ambiguity is antithetical to regulatory certainty, we request your expeditious action on our request.

Sincerely,

Stefan Anton

Stefan Anton , Dr.-Ing.
Vice President of Engineering
Nuclear Power Division
Holtec International

cc: HUG Membership
Holtec Executive Committee
Mr. Douglas Weaver, USNRC
Mr. Eric J. Benner, USNRC
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Dr. Kris Singh, Holtec International
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Appendix to Holtec Letter 5014471

Essentials of the ISFSI Pad Qualification Requirements per the FSAR

This appendix outlines the key elements of the Holtec methodology used to analyze and qualify reinforced concrete ISFSI pads for freestanding HI-STORM casks consistent with the HI-STORM FSAR and our July 12th, 2012 presentation to the NRC. The key elements are:

1. The candidate ISFSI pad design shall be subjected to the "non-mechanistic" tip over analysis on LS-DYNA as set forth in the FSAR and the acceptance criteria in the FSAR shall be shown to be met.

2. In the next step, the pad shall be analyzed for the governing load combinations set forth in the FSAR. For the HI-STORM 100, the governing load combinations are (as specified in Section 2.0.4.1 of the HI-STORM 100 FSAR):

    a. Load Combination # 1: $U_c > 1.4D + 1.7L$
    b. Load Combination # 2: $U_c > 1.05D + 1.275(L + F)$
    c. Load Combination # 3: $U_c > D + L + E$ (or W_t)

    where U_c = Ultimate strength, D = Dead load, L = Live load, F = Hydrological (Flood) load, E = Earthquake load, and W_t = Tornado load.

3. The above load combinations shall be used to evaluate the pad's compliance with ACI-318 provisions. In accordance with ACI-318, the effects of long term differential settlement shall be included in Load Combination #1 only. As permitted in the FSAR, the ISFSI pad owner may elect to invoke ACI 349 (which requires the effects of long term differential settlement to be considered in conjunction with seismic loading).

4. The SSI analysis shall be performed using the time history analysis method implemented in LS-DYNA. A minimum of three sets of time histories, which are compliant with ASCE 4-98, shall be used to carry out the SSI analysis. Per ASCE 4-98, the time histories may be real recorded, modified recorded, or synthetic.

5. The strain compatible soil properties to be used as input to the SSI analysis model shall be determined using the computer code SHAKE2000. The strain compatible properties shall be computed for the Best Estimate, Lower Bound, and Upper Bound soil profiles.

6. The LS-DYNA coupled model shall include the soil foundation, the ISFSI pad, and a single freestanding cask. The size and depth of the soil foundation shall follow the guidance in ASCE 4-98 and NUREG/CR-6865. The ISFSI pad shall be modeled as a flexible plate (or shell) based upon the minimum design concrete compressive strength.

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The cask shall be positioned on the pad at a perimeter storage location. The coupled model shall permit uplift and sliding of the cask relative to the ISFSI pad.

7. The SSI analysis shall consider an upper bound coefficient of friction (COF) of 0.8 at the cask/pad interface to maximize rocking behavior. A COF value of 1.0 shall be specified at the pad/soil interface based on the guidance in NUREG/CR-6865.

8. The boundary conditions for the LS-DYNA model shall be the same as those employed in NUREG/CR-6865 (i.e., each ring of perimeter soil nodes shall be rigidly constrained to move together).

9. The average of the maximum cask-to-pad impact loads from the SSI analysis for the limiting soil profile (i.e., Best Estimate, Lower Bound, or Upper Bound) shall be used as input to the ACI strength evaluation of the ISFSI pad. Impact load shall be applied at all cask locations simultaneously for the following cask loading patterns:

   a. First loading campaign
   b. Quarter loaded pad (25% of storage locations occupied)
   c. Half loaded pad (50% of storage locations occupied)
   d. Fully loaded pad (100% of storage locations occupied)

10. The effects of long term differential settlement shall be incorporated in the ACI strength evaluation of the pad using a method that has been used in a NRC reviewed Holtec FSAR.

11. If the candidate pad design does not satisfy both tip- over and ACI strength checks, then the design shall be modified and re- analyzed.

All future ISFSI pad analyses performed by Holtec (as well as those already performed for the LaSalle ISFSI pad) shall conform with the key elements described above.