HOLTEC INTERNATIONAL

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July 10, 2003

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Reply to a Notice of Violation

Reference: NRC Inspection Report 72-1014/2003-201, dated June 13, 2003

Dear Sir:

We acknowledge receipt of the above-referenced inspection report containing the notice of a Level IV violation. We herewith provide the required response to the violation, which summarizes the cause, corrective actions, and actions to prevent recurrence.

Summary of Violation

Design measures for the HI-STORM 100 dry storage cask systems were not adequate to ensure compatibility of materials. During dry runs and spent fuel cask loading at Columbia Generating Station, significant amounts of hydrogen were generated indicating significant aluminum-water reaction. The pre-passivation of the Boral plates had been done at nominal water depth, whereas the Boral plates were subjected to substantially greater water depth during cask loading in the spent fuel pool. The pre-passivation process had not been qualified under the most adverse conditions, i.e., the water depth associated with cask loading.

Reason for Violation

The root cause of the violation is the over-reliance on experience and a pre-disposition to accept materials that are considered "proven" without an in-depth, objective and critical assessment of the material's performance under all applicable service conditions.

The combination of Boral and stainless steel had been successfully used in wet storage applications for over twenty-five years, and in dry storage applications since the 1980s (first introduced in the NUHOMS System in the late 1980's). Indeed, as the use of polymer-based neutron poisons faded in the 1980s, the brand name 'Boral' began to be used synonymously for neutron absorber in the industry. Decades of in-pool experience had shown that Boral did not shrink, develop internal gaps, or degrade in any manner that would reduce its neutron attenuation capacity. In rare instances upon extended submergence in pool water, Boral had developed blisters (although none in the hundreds of racks supplied by Holtec to over 60 plants in the country). Even where the blisters occurred, they did not reduce its neutron absorber capability or

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lead to leaching out of boron carbide from the sintered core of the ceramic-metal (cermet). Hundreds of Boral-equipped high-density fuel racks, designed by Holtec as well as others, have been installed around the world since the late 1970s. In the 1990s, Boral's market share in wet and dry storage applications stood at virtually 100 percent.

It was against this backdrop of product experience that the Holtec dry storage cask design team evaluated the compatibility of Boral installed in the all-stainless steel MPC basket. The depth of inquiry, heavily influenced by the industry's long reliance on the material for reactivity control in the identical material combination (stainless steel and Boral) was not adequate. The design team specified pre-passivation of Boral in a shallow tank to arrest hydrogen generation in the pool, guided by the prevailing scientific opinion that exposing the raw edges of the Al/B_4C cermet to water would seal them against further incursion of water, and thus prevent the generation of hydrogen when the MPC is filled with water for fuel loading. The manufacturing of MPCs in the factory over the past five years and the extensive exposure of the basket to water during this time failed to reveal any significant hydrogen generation. In summary, there was nothing in the ongoing experience to portend the CGS observation.

Since the observation of hydrogen generation at the CGS plant during dry run activities, Holtec has been investigating the source of hydrogen when the MPC is submerged in the spent fuel pool. Under the hydrostatic pressure present when the MPC fuel basket is under water, spent fuel pool water is forced into the Boral "core" region where the aluminum and boron carbide reside. This can expose additional aluminum (beyond that on the outer panel surfaces) to water, resulting in additional hydrogen generation. Our research has revealed that the rate of hydrogen production and total amount generated due to Boral core exposure is based on a number of variables, some of which cannot be controlled in practical application, viz:

- Aluminum particle size: The aluminum particle size in the Boral core, and associated porosity, affects the amount of aluminum available for reaction with water. Larger aluminum particles yield less surface area for reaction, but higher porosity for aluminum-water interaction; smaller aluminum particles yield more surface area for reaction, but lower porosity for aluminum-water reaction.

- Presence of trace impurities: The presence of trace impurities in the Boral core due to the manufacturing process (i.e., sodium hydroxide, boron oxide, and iron-oxide) can affect the rate of hydrogen production, both increasing and suppressing the reaction. Sodium dissolved in the water increases the pH and tends to increase the rate of hydrogen production. This is counteracted by the boron oxide, which hydrolyzes to boric acid (H_3BO_3) and reduces the rate of hydrogen production. Trace impurities do not affect the total amount of hydrogen generated.

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boric acid (H_3BO_3) and reduces the rate of hydrogen production. Trace impurities do not affect the total amount of hydrogen generated.

- Pool water chemistry: Chemicals in the plant spent fuel pool water (e.g., copper, boron) can affect the rate of hydrogen production, both increasing (copper) and suppressing (boron) the reaction.

- MPC loading operations: Operating needs or preferences by individual utilities as to when, and for how long, the MPC is kept at varying water depths in the spent fuel pool, and how long the MPC is kept filled with water outside the spent fuel pool can affect the amount of aluminum in the Boral core that may be exposed to water.

Corrective Actions and Results Achieved

1. Operating Procedure Changes

The variables affecting hydrogen generation, as discussed above, reveal that it is impossible to accurately predict the rate or total amount of hydrogen to be produced by any one MPC in a particular spent fuel pool. Therefore, the appropriate, conservative corrective action is to recognize that hydrogen will be generated and certain actions are required to be taken by the cask users during loading and loading operations to assure hydrogen combustion under the MPC lid is precluded. Specifically, prior to, and during applicable loading and unloading operations, the space beneath the MPC lid where combustible gas can accumulate is required to be exhausted or purged. This action is in addition to an existing FSAR requirement to monitor the area for combustible gases during these same activities.

Holtec's users were informed of this change to the operating requirements in May, 2003 via a revision to the associated Holtec International Bulletin (HIB) pertaining to this issue. On June 3, 2003 the HI-STAR and HI-STORM FSARs were formally modified under 10 CR 72.48 to add this new requirement. The users of our dry storage technology have been provided with the affected FSAR sections reflecting these modified operating procedures.

2. Additional Laboratory Testing

Laboratory testing of Boral to fully characterize its behavior during dry storage implementation (which, unlike wet storage, involves not only short-term exposure to water, but also a thermal ramping and dehydration of the Boral panels) has been ongoing in our Florida laboratories since the Fall of 2002. This testing involves using two specially-designed test chambers to simulate the hydrostatic head of pool water and other aspects of MPC loading. One of the early results of the

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test program indicates that pre-passivation of the Boral panel surfaces in water provides no additional protection against hydrogen generation. Therefore, we have requested NRC approval to eliminate this step from the Boral procurement process via CoC amendment request (Docket 71-9261).

As part of the ongoing laboratory work, Boral is also being tested for physical integrity under the conditions to which it is exposed during MPC drying. Although Boral has never been found to release boron carbide in our industrial experience, we must examine this aspect of material performance. The Boral procurement specification, unaltered since the early 1990s version developed for wet storage, and used without modification in dry storage, is being modified to make it focused for dry storage application and, particularly, to incorporate a "physical integrity" test.

The test program to evaluate Boral for dry storage applications is being modified accordingly to implement the following:

- A one-time test to mimic the MPC field preparation process (i.e., deep water submersion and drying) to re-confirm its suitability for use and identify any other unforeseen issues to be addressed, and

- Develop a test to use thereafter on a representative sample Boral coupons during production to confirm that there is reasonable assurance that the material was manufactured properly.

If the results of this testing reveal additional corrective actions to address hydrogen generation from Boral or risk to the physical integrity of Boral while in-service should be taken, they will be implemented in a timely manner, consistent with their safety significance.

Corrective Actions to Avoid Further Violations

Holtec's design control procedures are being revised to address this issue and associated training will be provided to appropriate personnel to discuss the lessons learned and expectation for future activities.

Date When Full Compliance will be Achieved

The corrective actions to require users to purge or exhaust the space under the MPC lid during certain parts of loading and unloading operations are complete.

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The corrective action to modify Holtec's design control procedures and provide training will be completed by August 31, 2003.

The Boral testing program and associated report will be completed by September 30, 2003. Any additional corrective actions identified as a result of the testing will be scheduled after the test program is complete.

Should the NRC require any additional information concerning this response, please contact our Licensing Manager, Brian Gutherman at (856) 797-0900, extension 668.

Sincerely,

Mark Soler
QA Manager

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