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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: USNRC Docket No. 72-1014, TAC L23524
HI-STORM 100 Certificate of Compliance 1014
One-Time Alternative to Codes and Standards - Response to Request for Additional Information

References:
1. Holtec Projects 5014, 1108, and 71188
2. NRC Letter to Holtec dated January 8, 2003

Dear Sir:

We have reviewed the questions contained in the Reference 2 Request for Additional Information and provide herewith the responses to those questions. The attachment to this letter provides the questions and responses for your review.

If you have any questions or require additional information, please contact the undersigned at (856) 797-0900, extension 668.

Sincerely,

Brian Gutherman, P.E.
Licensing Manager

Approved:

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

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Concurrence:

Manufacturing

Structural Evaluation

Thermal Evaluation

emcc: Mr. Christopher Regan, USNRC
Mr. Ken Ainger, Exelon Nuclear
Mr. Terry Sides, Southern Nuclear
Mr. Bernard Gilligan, Holtec

Document ID: 5014478

Attachment: RAI Questions and Responses

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
ASME CODE ALTERNATIVE REQUEST

Question 1

Provide an analysis demonstrating the confinement/structural capability of the MPC closure ring to perform its intended function(s), assuming that the welds for which it is providing a redundant function were to fail (singly or in combination).

This first paragraph of the confinement discussion argues that the closure ring provides a redundant welded closure for the primary confinement boundary, but is not normally pressure retaining. The analysis must demonstrate that the MPC closure ring and welds would maintain confinement and meet Code stress allowables under normal, abnormal and accident conditions. Stating that the MPC closure ring does not normally perform this function is insufficient for demonstrating confinement/structural integrity under postulated conditions. Consideration of the effect(s) of postulated worst-case laminations upon the closure ring attachment welds should be included. For example, an analysis assuming two half thickness plates, simply stacked and otherwise unattached to each other except at the edge welds, may provide the bounding assumption.

Response to Question 1

The stress analysis for the MPC closure ring is reported in Appendix 3.E, Section 3.E.8.5 of the HI-STAR 100 Final Safety Analysis Report (Docket 72-1008), and incorporated by reference into the HI-STORM 100 FSAR. The analysis was performed assuming a non-mechanistic leak of the confinement boundary through the MPC lid-to-shell weld that allows a helium pressure of 100 psig (normal and off-normal MPC internal design pressure per Table 2.2.1 of the HI-STORM FSAR) to act under the closure ring.

It is noted that the stress analysis of the closure ring presented in HI-STAR FSAR Appendix 3.E is performed only for the case of design pressure (100 psig) and design temperature (400°F). The stress intensity limits for all service conditions were determined to be bounded by the design condition. Specifically, the MPC internal design pressure of 100 psig is set to bound the normal storage (Level A) condition of approximately 70 psig and the closure ring design temperature of 400°F is set to bound the closure ring's metal temperature during normal operation (which, because of its direct contact with the environment external to the MPC is only modestly elevated above the local air temperature). Likewise, the increased pressure accident condition reflects a pressure rise corresponding to an assumed scenario where all of the fuel rod plenum gas in 100% of the fuel rods is released. Because the increase in the MPC internal pressure for this event (which is bounded by the 200 psig accident design pressure) also increases the circulating gas mass within the MPC, the resultant temperature of the MPC as a result of the increased internal pressure event will be lower than that experienced under normal storage conditions due to increased convection heat transfer. Therefore, the 400°F design temperature also bounds the reference metal temperature for the increased pressure accident event (the ASME Code designation for this event is Level D).

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In addition to the increased pressure accident event, the FSAR also defines a stress limit for the off-normal condition (HI-STORM FSAR Table 2.2.10). The pressures, temperatures, and applicable stress intensity limits for the loading conditions that pertain to the closure ring are summarized in Table A below along with reference locations in the HI-STORM FSAR.

Table A

STRESS INTENSITY LIMITS APPLICABLE TO THE CLOSURE RING ANALYSIS*

CONDITION	**PRESSURE (psig)**	**TEMPERATURE (^oF)**	**Code Stress Intensity, S_m (psi) (3.1.13)**	**Local Membrane + Primary Bending Stress Intensity, $P_L + P_b$ (psi)**	**Secondary Stress, Q (psi)**
Design (as defined in the ASME Code)	100 (2.2.1)	400 (2.2.3)	18.7	28.1 (3.1.13)	56.1 (3.1.13)
Level A (normal storage)	100 (2.2.1)	400 (2.2.3)	18.7	28.1 (3.1.13)	56.1 (3.1.13)
Level B (off-normal)	100 (2.2.1)	775 (2.2.3)	15.05	N/A (2.2.10)	45.15 (2.2.10)
Level D (faulted)	200 (2.2.1)	400 (bounded by design temp.)	18.7	67.4 (3.1.14)	N/A

* Double-decimal numbers in parentheses provide the reference table in the HI-STORM FSAR

In the above table, the limits on $P_L + P_b$ and Q are listed. However, because the closure ring is a simple plate-type structure (i.e., it possesses no gross structural discontinuities that give rise to secondary stresses and it resists pressure principally by flexural action), the limit on $P_L + P_b$ is the defacto acceptance criterion for the closure ring stress analysis.

Further, it is noted that the allowable stress intensity permitted under accident pressure is more than twice the allowable stress intensity under normal pressure. Because the stress level is proportional to pressure in the linear elastic model used for the closure ring analysis, it follows that the normal condition bounds the accident condition. Therefore, demonstrating that the normal condition stress intensity limits are satisfied guarantees that the off-normal and accident condition limits will be satisfied with greater margins. The current margin of safety for the Level A service condition is 1.24 (for the peripheral welds) and 0.405 for closure ring bending under the internal pressure as reported in HI-STAR FSAR Appendix 3.E.

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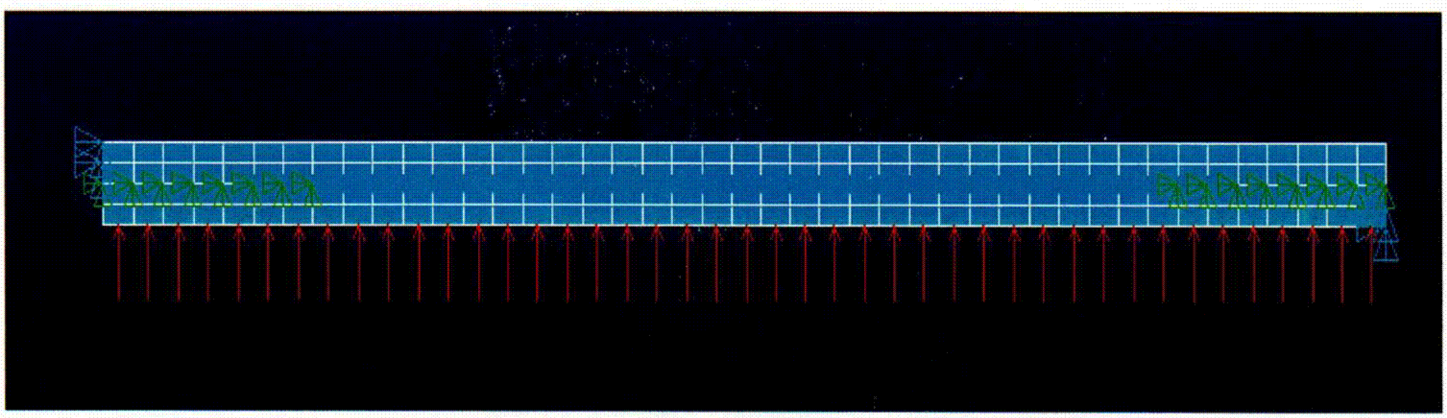
Strictly speaking, an internal flaw in the closure ring would produce a localized incremental stress, known as a "peak stress" in the ASME Code. Peak stresses do not have a stress limit, per se. They are significant only in establishing the cyclic fatigue life of a pressure vessel part (Ref. NB-3213.11). However, if the flaw were assumed to be body extensive, such that the flexural capacity of the closure ring is reduced, then the corresponding margin of safety will decrease. To quantify the reduction in the safety margin due to a body extensive flaw, a stress analysis of the closure ring has been performed to determine the effect of an undetected horizontal lamination at the mid-surface of the closure ring. The design pressure of 100 psig is assumed to act underneath the closure ring. The same finite element methodology as is described in HI-STAR FSAR Appendix 3.E was utilized in this analysis. The non-linear finite element model employed to simulate a postulated mid-surface internal flaw that produces a delamination that extends around the entire circumference of the closure ring is summarized below.

To simulate the internal delamination, the mid-surface of the model is defined with a double set of nodes so that the lower two layers and the upper two layers of elements are unconnected. At the inner and outer edges of the closure ring, beyond the flaw, the two sets of nodes are coupled to prevent interpenetration/separation and simulate virgin material. The node sets at the mid-surface within the postulated flaw region are defined to be associated with compression-only contact elements; thus, separation in the middle region of the closure ring is permitted and the lower and upper sets of elements are independent except that normal stress can be transmitted across the interface. The flaw is assumed to extend around the entire 360-degree ring. The radial length of the flaw is varied and the maximum primary stress intensity computed. After iterations on radial flaw length, the maximum flaw radial length (to meet the Level A stress intensity limits) extends from r = 27.795 inches to r = 32.642 inches; the ratio of flaw span to total span is 4.847/7.188 = 0.674. The presence of the lamination does not affect the shear capacity of the closure ring, which means that the safety margin of 1.24 reported in the FSAR is unaffected. The figure below shows the model.



| coupled nodes--|----------------contact elements at mid-surface-------------------| coupled nodes|

Finite Element Model (100 psig pressure)

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The significant conservatisms used in this analysis are:

(1) Minimum material strengths cited in the ASME Code are assumed. Actual material strengths for the heat of closure rings affected by this Code alternative have yield and ultimate strengths that are 48% and 20% greater than the ASME values, respectively. These higher strengths for the actual material used would increase the safety margins beyond those reported herein.

(2) Allowable stress intensities are computed at the design temperature, which is deliberately set to bound all expected in-service temperatures for design basis contents, and applicable event conditions. Therefore, actual safety margins would be greater.

(3) The design pressure of 100 psig is a value deliberately set to bound expected in-service pressures under normal and off-normal storage conditions. The computed normal condition pressure in the HI-STORM FSAR is less than 70 psig. Therefore, actual safety margins would be greater.

The results from the finite element analysis establish that the maximum extent of the all-around flaw permitted without exceeding ASME Code allowable limits is 4.847" out of the total 7.1875" width. In other words, the mid-plane flaw can extend to two-thirds of the total closure ring width around the entire circumference of the closure ring before the computed stress intensity begins to approach the allowable value. This represents a postulated extent of flaw that is wholly inconsistent with industry experience with ASME Section II-certified thin austenitic stainless steel plates

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Question 2

How much area of the material from heat number 893771 has failed UT? The third paragraph of the confinement discussion mentions that 10,000 square inches of material from this heat have passed the Code required UT examination. Describe the nature of any defects discovered during examinations of other plates, lots, or heats of this material?

Response to Question 2

No material tested by Holtec from heat number 893771 has failed the ASME Code Subsection NB-2532 UT examination and we have tested well over 10,000 square inches of material from that heat number.

We have discussed the typical ability of 3/8" thick stainless steel to pass the Code required UT examination with our material suppliers. They have informed us that when they melt and roll the plate, they typically do not know what the end use of the plate is to be. Therefore, they choose to manufacture all plate to the same quality standards to ensure that the plate can be used in all applications. The same material supplier of heat number 893771 has provided at least two other heats of 3/8" stainless steel that met all UT inspection criteria.

Typically, the raw material is supplied with the UT examination having already been performed with satisfactory results. This is a requirement of our purchase order to the material supplier. As such, if any plate was to fail the UT inspection, the plate would not meet our purchase order requirements and would not be provided to Holtec or its fabricator. Consequently, all plate from other heats has been supplied to Holtec with satisfactory UT examination results.

The acceptance criteria for the Code mandated UT examination is as follows:

> "(1) Any area where one or more imperfections produce a continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed within a circle whose diameter is 3 in. (76 mm) or one-half of the plate thickness, whichever is greater, is acceptable.
>
> (2) In addition, two or more imperfections smaller than described in (1) above shall be unacceptable unless separated by a minimum distance equal to the greatest diameter of the larger imperfection, or unless they may be collectively encompassed by the circle described in (1) above."

The plate thickness is only 3/8". Therefore, the acceptance criteria for a continuous indication is no larger than a 3" diameter. Small imperfections, if any, are not required to be recorded and have not been recorded. Therefore, no data is available for defects (if any existed) smaller than the ASME Code acceptance criteria.