TRANSNUCLEAR
AN AREVA COMPANY

June 10, 2013
E-35274

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Subject: Revision 8 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (Docket No. 72-1029; TAC No. L24607)

References: (1) "Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (Docket No.: 72-1029, TAC No.: L24607)," (E-33290, September 7, 2012)

(2) TN-NRC Teleconference, March 26, 2013, regarding TN's Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, TN Response to Request for Additional Information, Question 3-1

Pursuant to Reference 2, this submittal provides TN's revised response to question 3-1 of the response to the NRC's request for additional information (RAI), forwarded by Reference 1. Enclosure 1 herein provides RAI 3-1 followed by the revised TN response. Please disregard the original response, provided in Reference 2.

Enclosure 2 provides two changed UFSAR pages, Pages B.3.1-17 and B.3.6-38. Those same two pages were revised based on the original response, provided in Reference 2, where they were annotated as Revision 3. Please disregard the Revision 3 versions of those pages. Those pages are herein annotated as Revision 8, with changes associated with the new response indicated by italicized text, revision bars, and shading.

Should the NRC staff require additional information to support review of this application, please do not hesitate to contact Mr. Don Shaw at 410-910-6878 or me at 410-910-6820.

Sincerely,

Paul A Triska

Paul Triska
Vice President, Operations

cc: Steve Ruffin (NRC SFST) as follows:

- Two paper copies of this cover letter and Enclosures 1 and 2
- Two computer disks, each containing this cover letter and Enclosures 1 and 2

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Enclosures:

1. RAI and Revised Response
2. CoC 1029 Amendment 3, Revision 8 Changed UFSAR Pages B.3.1-17 and B.3.6-38

CHAPTER 3 – STRUCTURAL EVALUATION

3-1 Provide information regarding plastic analysis for the 32PTH2.

Elastic-plastic stress criteria is generally not acceptable for the closure region (outer top cover plate to shell weld); however, they can be applicable to other regions in a spent fuel canister.

Provide the load cases and plastic stress results (w/design limits) in tabular format for all instances where Appendix F of ASME Code was used for elastic-plastic stress evaluation of the 32PTH2.

Also consider the effects of using elastic-plastic analysis and ASME Code Section XI in the same general location(s).

This information is required to demonstrate compliance with 10 CFR 72.236(d).

REVISED RESPONSE TO RAI 3-1

The assessments methods and requirements for the stresses used in the weld flaw evaluations are addressed in response to RAI 3-9.

The 32PTH2 DSC is designed to meet the ASME Code Subsection NB requirements except as noted in the code alternatives (UFSAR Section B.3.1.2.3). For the accident loads (Service Level D), Subsection NB allows the rules contained in Appendix F to be used to evaluate the Level D loads. Appendix F includes elastic-plastic analysis method and criteria. Furthermore, elastic-plastic analyses have been used for 24PT1 and 24PT4 DSC shells (UFSAR Chapter 2 and A.2).

The UFSAR methodology permits the use of the elastic-plastic approach of Appendix F of ASME Code Section III in case the elastic stress limits cannot be met for a load combination. In the case when the load combination, classified as Service Level D, includes a load that is analyzed by means of the elastic-plastic method, the elastic-plastic analysis criteria are applied to such a load combination. The 32PTH2 DSC load combinations and service levels are listed in UFSAR Table B.3.1.5 (Chapter B.3). Five load combinations, listed in UFSAR Table B.3.1.5, include analyses that used an elastic-plastic bilinear model of steel materials: RF-1, UL-8, AHSM-HS-6, TR10, and TR11. An identification of analysis cases that used an elastic-plastic bilinear model of steel materials and an identification of resultant load combination along with stress results are provided in Table 1 and Table 2 herein.

The cylindrical shell, inner top cover plate (ITCP), inner bottom cover plate (IBCP), siphon and vent block, siphon and vent port cover plates, and the associated welds form the pressure retaining confinement boundary for the spent fuel. The outer top cover plate (OTCP) and associated weld function as a redundant welded barrier for confining radioactive material within the 32PTH2 DSC.

IBCP welds are full penetration welds and are qualified via qualification of connected components, IBCP and cylindrical shell.

The ITCP weld (3/16" groove weld) is modeled as a line weld due to its small size. The maximum stress for this weld is derived from the maximum resultant nodal forces $\sqrt{F_x^2 + F_y^2 + F_z^2}$.

Maximum stress is reported in the UFSAR. Per the ASME Code, Appendix F, the method is classified as an elastic analysis method used in an elastic-plastic system. The elastic analysis criteria of Article F-1341.1 are used. The OTCP weld (0.5" groove weld) is modeled using an ANSYS PLANE42 element in a 2D finite element model and SOLID45 element in a 3D finite element model. For Service Level D, stresses in the weld are assessed by means of a plastic analysis method, in the same way as for the other structural components of the 32PTH2 DSC. The plastic analysis criteria of Article F-1341.2 are used. Maximum total stress intensities are reported in the UFSAR. The stress results for the ITCP and OTCP welds are summarized in Table 1 and Table 2, respectively.

Response Summary

The ITCP and OTCP welds form a redundant weld barrier for confining radioactive material within the 32PTH2 DSC and need to be fully compliant with Subsection NB of the ASME Code and need to comply with the guidance of ISG-15. A joint efficiency factor of 0.8 is applied to these two welds. Base metal properties (materials type 304 or 316) are used conservatively for weld stress limit determination. The applicable stress criteria for these two welds are documented in UFSAR Table B.3.1-3 (b).

The only primary stress for closure welds required to be analyzed per ASME Code requirements is pure shear stress. The qualification of ITCP and OTCP welds for pure shear are provided in the section of this response titled "Primary Shear Stress for 32PTH2 DSC Closure Boundary Welds." Note that the 32PTH2 DSC is designed such that the bending stresses of all 32PTH2 welds can be classified as secondary stresses and their assessments for Service Level D are not required. The basis for qualification of ITCP and OTCP welds are provided in the section of this response titled "Bending Stresses for 32PTH2 DSC Closure Boundary Welds."

The side drop event generates local compressive stresses concentrated at the impact vicinity that do not deteriorate the functionality of the weld connection, and in consequence do not lead to weld failure. Therefore, closure weld qualification based on the pure shear criterion is deemed the most adequate for the 32PTH2 DSC design to assess weld capacities and adequacy. The approach presented in Table 1 and Table 2 provides the conservative envelope of weld stresses and as the conservative assessment standard is reported in the UFSAR.

The modifications related to this response include correction of weld stress value in UFSAR Table B.3.6-8 and modification of weld stress criteria in UFSAR Table B.3.1-3 (b).

Primary Shear Stress for 32PTH2 DSC Closure Boundary Welds

An average shear stress, τ, in the groove weld of thickness "t" fastening circular plate at its outer radius "r", and the plate loaded with lateral pressure "q", can be calculated as:

$$\tau(q, r, t) = \frac{q \cdot \pi \cdot r^2}{2 \cdot \pi \cdot r \cdot t}$$

For ITCP weld $$\tau\left(140\,\text{psi}, 35\,\text{in}, \frac{3}{16}\,\text{in}\right) = 13.1\ \text{ksi}$$

For OTCP weld $$\tau\left(140\,\text{psi}, 35\,\text{in}, 0.5\,\text{in} - \frac{1}{16}\,\text{in}\right) = 5.6\ \text{ksi}$$

The pure shear stress limit for Service Level D, $0.8\times0.42*S_u$, (weld joint efficiency factor 0.8 used, per ISG-15) is 0.8 × 0.42 × 63.4 ksi = 21.3 ksi for ITCP weld, and 0.8 × 0.42 × 71.8 ksi = 24.1 ksi for OTCP weld.

Finally, for Service Level D pressure loads, the ITCP weld connection is qualified with stress ratio 13.1/21.3 = 0.62, while the OTCP weld connection is qualified with stress ratio 5.6/24.1 = 0.23.

Bending Stresses for 32PTH2 DSC Closure Boundary Welds

Per the ASME Code provision in Table NB-3217-1, Note 1, if bending stresses in the center of the simply supported plate are within the acceptable limits of the ASME Code, then the bending stresses at the edge of the plate can be classified as the secondary stresses.

Using closed form formula to calculate maximum stress due to pressure load, it is proved that ITCP and OTCP are sized to satisfy the ASME Code provision discussed above. Such qualification of bending stresses for ITCP and OTCP welds is provided below.

Per Reference [1], Table 11.2, Case 10a, for the simply supported plate of thickness "t" and radius "r", with uniformly distributed lateral pressure "q" and Poisson's coefficient "ν", the maximum bending stress in the plate can be assessed from formula:

$$\sigma_{max}(q,t,r,\nu) = \frac{3q\cdot r^2\cdot(3+\nu)}{8t^2}$$

For Service Level A, B, C or test conditions, the limiting pressure load is 23 psig. For Service Level D, the limiting pressure is 140 psig. Therefore, the maximum stresses for ITCP and OTCP can be assessed conservatively as:

ITPC:

$$\sigma_{max}(23psi, 2in, 35in, 0.3) = 8.7ksi$$

for Service Level A, B, C or test conditions - stress limit is 26.3 ksi

$$\sigma_{max}(140psi, 2in, 35in, 0.3) = 53.1ksi$$

for Service Level D - stress limit is 63.0 ksi

OTCP

$$\sigma_{max}\left(23psi, 2in - \frac{1}{16}in, 35in, 0.3\right) = 9.3ksi$$

for Service Level A, B, C or test conditions - stress limit is 27 ksi

$$\sigma_{max}\left(140psi, 2in - \frac{1}{16}in, 35in, 0.3\right) = 56.5ksi$$

for Service Level D conditions - stress limit is 64.8 ksi

Allowable stress limits are taken from stress criteria of UFSAR Table B.3.1-2.

The weld stresses are obtained after selecting only the "weld" layer of element and the layer of adjacent elements. The resultant stress, which includes peak stresses, remains below stress limits for all load cases, except for side drop load case (TR-10). Post processing of TR-10 load case is performed manually by excluding local peak stresses at the discontinuity area. Furthermore, the evaluation conservatively takes the maximum bending stresses, which are qualified as secondary stresses, and compares it to the membrane plus bending allowable resulting in a stress ratio of 0.91.

Reference:

1. Warren C. Young, Richard G. Budynas, "Roark's Formulas for Stress and Strain," Seventh Edition.

Table 1 Stress Results for ITCP Weld

Load Combination ID, (UFSAR Table B.3.1.5)	Loads Description	Maximum Stress [ksi]	Stress Limits [ksi]	Stress Ratio
RF-1	Internal Pressure of 140 psi + 22 psi External Hydrostatic Pressure	11.7	50.4	0.23
AHSM-HS-6, UL-8	140 psi Internal Pressure	13.3	50.4	0.26
TR10	75 g Side Drop (Top End, Load on One Rail) + 20 psi Internal Pressure	21.3	50.4	0.42
TR11	75 g Top End Drop + 20 psi Internal Pressure	1.5	50.4	0.03
TR11	75 g Bottom End Drop + 20 psi Internal Pressure	5.7	50.4	0.11

Table 2 Stress Results for OTCP Weld

Load Combination ID, (UFSAR Table B.3.1.5)	Loads Description	Maximum Stress [ksi]	Stress Limits [ksi]	Stress Ratio
RF-1	Internal Pressure of 140psi + 22 psi External Hydrostatic Pressure	28.1	51.6	0.54
AHSM-HS-6, UL-8	140 psi Internal Pressure	31.0	51.6	0.60
TR10	75 g Side Drop (Top End, Load on One Rail) + 20 psi Internal Pressure	46.7[(1)]	51.6	0.91
TR11	75 g Top End Drop + 20 psi Internal Pressure	7.9	51.6	0.15
TR11	75 g Bottom End Drop + 20 psi Internal Pressure	8.6	51.6	0.17

Note:
(1) The reported stresses exclude local peak stress due to the geometric discontinuity at the weld root location and are obtained by linearization.

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Enclosure 2

CoC 1029 Amendment 3, Revision 8
Changed UFSAR Pages B.3.1-17 and B.3.6-38

Table B.3.1-3 (a)
Allowable Weld Stresses for Non Pressure Boundary Partial Penetration and Fillet Welds

Service Level	Allowable Stress	Basis
Level A	Fw=0.30S_u (weld metal) Fw=0.40S_y (base metal)	Table NF-3324.5(a)-1
Level B	Fw=0.40S_u (weld metal) Fw=0.53S_y (base metal)	Table NF-3324.5(a)-1 and Table NF-3522(b)-1 (K = 1.33)
Level C	Fw=0.45S_u (weld metal) Fw=0.60S_y (base metal)	Table NF-3324.5(a)-1 and Table NF-3522(b)-1
Level D	Fw=0.60S_u (weld metal) Fw=0.80S_y (base metal)	Table NF-3324.5(a)-1 and F-1334

Note: Level D allowables are determined as two times bigger than Level A allowables per Reference [B3.5], F-1334 for Type 304 base material.

Table B.3.1-3 (b)
Allowable Weld Stresses for Pressure Boundary Partial Penetration Welds

Service Level	Stress Region / Category	Stress Criteria
Level A / Level B	Primary Membrane + Bending Stress, Pm + Pb	$P_m + P_b$= 0.8 [1.5 S_m]
	Primary + Secondary Stress, P+Q	$P_m + P_b + Q$ = 0.8 [3.0 S_m]
Level C	*Primary Membrane Stress, P_m or Primary Local Stress, P_L*	0.8 [Max (1.8S_m, 1.5S_y)]
Level D (Elastic)	*Primary/Local Membrane + Bending Stress, P_m/P_L + P_b*	0.8 [Min (3.6 S_m, S_u)]
Level D (Elastic / Plastic)	*Primary Stress Intensity, P*	0.8 [0.9 S_u]

Note: A joint efficiency factor of 0.8 for pressure boundary welds is used per [B3.5].

Table B.3.6-8
Partial Penetration Welds - Stress Summary

Weld Location	Controlling Load Case	Weld Stress (ksi)	Allowable Stress (ksi)	Weld Stress Ratio
Outer Top Cover Plate to DSC Shell Weld	TR10	*46.7* [(1)]	51.6	*0.91*
Inner Top Cover Plate to DSC Shell Weld	TR10	21.3	*50.4*	*0.42*
Support Ring to DSC Shell Weld	TR10	*14.8*	*15.5*	*0.96*
Outer Bottom Cover Plate to DSC Shell Weld	UL-8	37.5	43.1	0.87

Note: 1. The reported stress excludes local peak stress due to geometric discontinuity at the weld root locations and is obtained by linearization.