July 27, 2010

L-PI-10-075
10 CFR 72.56

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001

Prairie Island Independent Spent Fuel Storage Installation
Docket No. 72-10
Materials License No. SNM-2506

Supplement to License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)

References:
1. Nuclear Management Company, LLC (NMC) letter to US Nuclear Regulatory Commission (NRC), L-PI-08-020, "License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT)", dated March 28, 2008 (ML081190039).
2. NMC letter to NRC, L-PI-08-059, "License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)", dated June 26, 2008.
3. NMC letter to NRC, L-PI-08-073, "Supplement to License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)", dated August 29, 2008.
4. Northern States Power Company, a Minnesota corporation (NSPM), letter to NRC, L-PI-09-071, "Supplement to License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)", dated June 26, 2009.
5. NRC letter to NMC, "Second Request For Additional Information TN-40HT License Amendment Request (LAR) To Modify The TN-40 Cask Design for Use At The Prairie Island Independent Spent Fuel Storage Installation (ISFSI)", dated November 25, 2009 (ML093310293).
6. NSPM Letter to NRC, L-PI-09-121, "Supplement to License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)", dated January 18, 2010, (ML100210197).

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Telephone: 651.388.1121

7. NSPM Letter to NRC, L-PI-10-021, “Supplement to License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT) (TAC No. L24203)”, dated May 4, 2010.
8. NSPM Letter to NRC, L-PI-09-094, “Support for License Amendment Request (LAR) to Modify TN-40 Cask Design (Designated as TN-40HT)(TAC No. L24203),” dated September 28, 2009.

In Reference 1, NMC* submitted an LAR to revise the Special Nuclear Materials (SNM) license and Technical Specifications (TS) for the Prairie Island Independent Spent Fuel Storage Installation (ISFSI) (License No. SNM-2506) to modify the TN-40 cask for storage of fuel with higher enrichment and higher burnup. References 2, 3, and 4 provided supplemental information for the LAR. In Reference 5, the NRC Staff requested additional information to support their review of Reference 1. In References 6 and 7, NSPM provided supplemental information to respond to the request for additional information in Reference 5.

By email dated June 8, 2010, NRC transmitted draft license amendment documents and requested a courtesy review by NSPM. During this review, NSPM identified several changes to the TS and the license that were not proposed by the licensee. As discussed with the Nuclear Material Safety and Safeguards (NMSS) Project Manager on June 28, 2010, several of these incremental changes posed unintended consequences on future cask loading, including adverse impact on the upcoming TN-40 cask loading.

One particular incremental change to the ISFSI TS drafted by NMSS involved “incorporating by reference” three sections of the ISFSI Safety Analysis Report (SAR) into TS Section 4.3. In Reference 8, NSPM provided a regulatory basis for not including this SAR descriptive material in TS. Lacking any regulatory guidance or NSPM experience complying with this practice of incorporating the SAR “by reference” into TS, and notwithstanding NSPM’s stated positions in Reference 8, NSPM is supplementing the subject LAR to propose a TS revision to incorporate those subject SAR sections directly into the ISFSI TS.

NSPM submits this supplement in accordance with the provisions of 10 CFR 72.56.

This letter contains the following enclosures:

- Enclosure 1 to this letter contains the oath or affirmation statement for this supplement required pursuant to 10 CFR 72.16(b).

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* On September 22, 2008, the NMC transferred its operating authority to Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy. By letter dated September 3, 2008, NSPM assumed responsibility for actions and commitments previously submitted by NMC.

- Enclosure 2 to this letter contains the proposed TS changes to Section 4.3 incorporating text from ISFSI SAR Sections A9.7.3, A9.7.4, and A9.7.5, shown as a markup to the version proposed in Reference 1. These TS pages replace TS pages 4.0-1 through 4.0-7 previously submitted.

- Enclosure 3 to this letter contains the re-typed pages of the TS Section 4. These TS pages replace TS pages 4.0-1 through 4.0-7 previously submitted.

The supplemental information provided in this letter does not impact the conclusions presented in the March 28, 2008 submittal as supplemented on June 26, 2008, August 29, 2008, June 26, 2009, January 18, 2010, and May 4, 2010. There is no regulatory evaluation enclosed for the proposed changes because these changes simply reflect ISFSI SAR information transferred to the TS and supplementary information as NMSS Staff requested.

If there are any questions or if additional information is needed, please contact Mr. Glenn Adams at (612) 330-6777.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

Mark A. Schimmel
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (3)

cc: Administrator, Region III, USNRC (letter only)
NMSS Project Manager, TN-40HT LAR, USNRC (8 copies)
NRR Project Manager, Prairie Island Nuclear Generating Plant, USNRC (letter only)
Resident Inspector, Prairie Island Nuclear Generating Plant, USNRC (letter only)
State of Minnesota (letter only)

ENCLOSURE 1

Oath or Affirmation Pursuant to 10 CFR 72.16

1 Page Follows

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY - MINNESOTA

PRAIRIE ISLAND INDEPENDENT SPENT FUEL STORAGE INSTALLATION
DOCKET NO. 72-10

REQUEST FOR AMENDMENT TO
MATERIALS LICENSE No. SNM-2506

SUPPLEMENT TO LICENSE AMENDMENT REQUEST (LAR)
TO MODIFY TN-40 CASK DESIGN (DESIGNATED AS TN-40HT)

Northern States Power Company - Minnesota, provides additional information that supports the request for changes to the Prairie Island Independent Spent Fuel Storage Installation Material License.

This letter contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY - MINNESOTA

By [signature]
Mark A. Schimmel
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

State of Minnesota

County of Ramsey

On this 27th day of July 2010 before me a notary public acting in said County, personally appeared Mark A. Schimmel, Site Vice President, Prairie Island Nuclear Generating Plant, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company - Minnesota, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true.

[signature]

CHRISTINE SINN
Notary Public-Minnesota
My Commission Expires Jan 31, 2015

ENCLOSURE 2

Marked-Up Technical Specifications
Section 4

17 Pages Follow

4.0 DESIGN FEATURES

4.1 Design Drawings

The Prairie Island ISFSI design approval was based on use of the TN-40 and TN-40HT storage casks and review of specific design drawings, some of which have been deemed appropriate for inclusion in the Prairie Island ISFSI Safety Evaluation Report (SER). Drawings listed in Section 1.2 of the Prairie Island ISFSI SER have been reviewed and approved by NRC. These drawings may be revised under the provisions of 10 CFR 72.48, as appropriate.

4.2 Maximum Cask Lifting Height

The casks have been evaluated for drops up to 18 inches. All lifts of a loaded cask greater than 18 inches must be performed with a single-failure-proof system.

4.3 Neutron Poison Loading in the TN-40HT Casks

The minimum areal boron-10 density of the neutron poison plates shall meet that specified in Table 4.3-1. This will ensure that the poison loading is consistent with that assumed in the criticality analysis.

4.3.1 TN-40HT Neutron Absorber Requirements

The neutron absorber used for criticality control in the TN-40HT basket may consist any of the following types of material: (a) Boron-aluminum alloy (borated aluminum), (b) Boron carbide / aluminum metal matrix composite (MMC), or (c) Boral®. The TN-40HT safety analyses do not rely upon the tensile strength of these materials. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only visual inspections, thermal conductivity testing, and the presence / uniformity of boron-10 (B10) need to be verified with testing requirements specific to each material. References to metal matrix composites throughout Section 4.3 are not intended to refer to borated aluminum or Boral®.

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

a. Boron Aluminum Alloy (Borated Aluminum)

Description - The material is produced by direct chill (DC) or permanent mold casting with boron precipitating primarily as a uniform fine dispersion of discrete aluminum diboride (AlB_2) or Titanium diboride (TiB_2) particles in the matrix of aluminum or aluminum alloy (other boron compounds, such as AlB12, can also occur). For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, the AlB_2, the TiB_2, or a hybrid may be used. Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product. The boron may have the natural isotopic distribution or may be enriched in B10. The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section 4.3.2.c.

Requirements - The boron content in the aluminum or aluminum alloy shall not exceed 5% by weight. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via neutron transmission testing as described in Section 4.3.2.c.

b. Boron Carbide / Aluminum Metal Matrix Composites (MMC)

Description – The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. It is a low-porosity product, with a metallurgically bonded matrix. The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section 4.3.2.c.

Requirements – For non-clad MMC products, the boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume. Non-clad

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

MMC products shall have a density greater than 98% of theoretical density, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product. Boron carbide particles for the products considered here typically have an average size in the range 10-40 microns, although the actual specification may be by mesh size, rather than by average particle size. No more than 10% of the particles shall be over 60 microns. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via neutron transmission testing as described in Section 4.3.2.c. The MMCs material shall be qualified in accordance with the requirements specified in Section 4.3.3, and shall subsequently be subject to the process controls specified in SAR Section A9.7.6.

c. Boral®

Description - This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an "ingot" consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. Before rolling, at least 80% by weight of the B_4C particles in Boral® shall be smaller than 200 microns. The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®.

Requirements - The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via chemical analysis and by certification of the B10 isotopic fraction for the

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

boron carbide powder, or by neutron transmission testing described in Section 4.3.2.c. Areal density testing shall be performed on a coupon taken from the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing

a. Visual Inspections Of Neutron Absorbers

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and Castings". Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable. Widespread blisters, rough surface, or cracking shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges. For Boral®, visual inspection shall verify that there are no cracks through the cladding, exposed core on the face of the sheet, or solid aluminum at the edge of the sheet.

b. Thermal Conductivity Testing Of Neutron Absorbers

Testing shall conform to ASTM E1225, ASTM E1461, or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Previous testing of borated aluminum and metal matrix composite, Table 4.3-2, shows that thermal conductivity increases slightly with temperature. Initial sampling shall be one test per lot, defined by the heat or ingot, and may be reduced if the first five tests meet the specified minimum thermal conductivity. If a thermal conductivity test result is below the specified minimum, at least four additional tests shall be performed on the material from that lot. If the mean value of those tests, including the original test, falls below the specified minimum the associated lot shall be rejected. After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the same primary boron

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase. The thermal analysis in SAR Chapter A3.3.2.2 considers a dual plate basket construction base model with 0.125" thick neutron absorber with a 0.312" thick aluminum 1100 plate. This model gives the bounding values for the maximum component temperatures. Either a dual plate basket construction or an alternate single plate (borated aluminum or MMC) construction basket may be utilized. For the dual plate construction, the specified thickness of the neutron absorber may vary, and the thermal conductivity acceptance criterion for the neutron absorber will be based on the nominal thickness specified. In either construction type, to maintain the thermal performance of the basket, the minimum thermal conductivity shall be such that the total thermal conductance (sum of conductivity * thickness) of the neutron absorber and the aluminum 1100 plate shall at least equal the conductance assumed in the analysis for the base model, 3.98 BTU/hr-deg F. Samples of the acceptance criteria for various neutron absorber thicknesses are highlighted in Table 4.3-3. The aluminum 1100 plate does not need to be tested for thermal conductivity; the material may be credited with the values published in the ASME Code Section II part D. The neutron absorber material need not be tested for thermal conductivity if the nominal thickness of the aluminum 1100 plate is 0.359 inch or greater.

c. Neutron Transmission Testing of Neutron Absorbers

Neutron Transmission acceptance testing procedures shall be subject to approval by Transnuclear. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot. Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon's physical thickness. A lot is defined as all the pieces produced from a single ingot or heat or from a group of billets from the same heat. If this definition results in a lot size too small to provide a meaningful statistical analysis of results, an

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes. The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot. The B10 areal density is measured using a collimated thermal neutron beam of up to 1 inch diameter. The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard. Standards will be calibrated, traceable to nationally recognized standards, or by attenuation of a monoenergetic neutron beam correlated to the known cross section of boron 10 at that energy. Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be up to 0.75 sq. inch. The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. If a goodness-of-fit test demonstrates that the sample comes from a normal population, the one-sided tolerance limit for a normal distribution may be used for this purpose. Otherwise, a non-parametric (distribution-free) method of determining the one-sided tolerance limit may be used. Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with Transnuclear's Quality Assurance (QA) procedures. The following illustrates one acceptable method and is intended to be utilized as an example. The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The B10 areal densities determined by neutron transmission are converted to volume density, i.e., the B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined as the mean value of B10 volume density for the sample less K times the

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

standard deviation, where K is the one-sided tolerance limit factor with 95% probability and 95% confidence. Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density. Any plate which is thinner than the statistically derived minimum thickness or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness. Non-conforming material shall be evaluated for acceptance in accordance with Transnuclear's QA procedures.

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites

a. Applicability And Scope

Prior to initial use in a spent fuel dry storage system, new MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per SAR Section A9.7.6 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage system. ASTM methods and practices are referenced below for guidance. Alternative methods may be used with the approval of Transnuclear.

b. Durability

There is no need to include accelerated radiation damage testing in the qualification. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel storage. Thermal damage and corrosion (hydrogen generation) testing shall be performed unless such tests on materials of the same chemical composition have already been performed and found acceptable. The following paragraphs illustrate two cases where such testing is not required. Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842 °F, well

4.0 DESIGN FEATURES

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites (continued)

above the basket temperature under normal conditions of storage or transport. Corrosion testing is not required for MMCs (clad or unclad) consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear.

c. Delamination Testing Of Clad MMC

Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage. An example of such a test would be: (1) immerse a specimen at least 6 x 6 inches in water under pressure >30 psig for at least 24 hours, (2) Place the specimen in a vacuum furnace preheated to at least 300°F, and evacuate the furnace. Acceptance criterion: no blistering or delamination of the cladding.

d. Required Tests And Examinations To Demonstrate Mechanical Integrity

At least three samples, one each from approximately the two ends and middle of the test material production run shall be subjected to:

(1) room temperature tensile testing (ASTM- B557) demonstrating that the material has a 0.2% offset yield strength no less than 1.5 ksi; has an ultimate strength no less than 5.0 ksi; and has minimum elongation in two inches no less than 0.5%. As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290. The radius of the pin or mandrel shall be no greater than three times the material thickness, and the material shall be bent at least 90 degrees without complete fracture.

(2) testing by ASTM-B311 to verify more than 98% theoretical density for non-clad MMCs and 97% for the matrix of clad MMCs. Testing or examination for interconnected porosity on the faces and edges of unclad MMC, and on the edges of clad MMC shall be performed by a method to be approved by Transnuclear. The maximum interconnect porosity is 0.5 volume %.

4.0 DESIGN FEATURES

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites (continued)

(3) and for at least one sample, for MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a minimum 24 hour soak in either pure or borated water, then insertion into a preheated oven at approximately 825°F for a minimum of 24 hours, the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test (1) of this section.

e. Required Tests And Examinations To Demonstrate B10 Uniformity

Uniformity of the boron distribution shall be verified either by: (a) Neutron radioscopy or radiography (ASTM E94, E142, and E545) of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or (b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section 4.3.2.c, or by chemical analysis for boron carbide content in the composite.

f. Approval of Procedures

Qualification procedures shall be subject to approval by Transnuclear.

4.4 Codes and Standards for the TN-40HT Casks

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, 2004 Edition including the 2006 Addenda (the Code), is the governing code for the TN-40HT cask, except that the material properties from later editions of Section II Part D may be used for design. The TN-40HT cask containment boundary is designed, fabricated and inspected in accordance with Subsection NB of the ASME Code to the maximum practical extent. Exceptions to the Code are listed in Table 4.4-1.

4.0 DESIGN FEATURES

4.4 Codes and Standards for the TN-40HT Casks (continued)

The TN-40HT basket is designed, fabricated and inspected in accordance with Subsection NG of the ASME Code to the maximum practical extent. Exceptions to the Code are listed in Table 4.4-1.

The ASME Code requirements apply only to important to safety items.

Proposed alternatives to the Code, including exceptions allowed by Table 4.4-1 may be used when authorized by the Director of the Office of Nuclear Material Safety and Safeguards or Designee. Requests for exceptions shall demonstrate that:

1. The proposed alternatives would provide an acceptable level of quality and safety; or

2. Compliance with the specified requirements of the Code would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Requests for exceptions in accordance with this section shall be submitted in accordance with 10 CFR 72.4

TABLE 4.3-1
MINIMUM B10 AREAL CONTENT FOR TN-40HT FIXED POISON PLATES

Minimum Areal B10 Content for Boral® (mg/cm^2)	Minimum Areal B10 Content for B-Al[(a)] (mg/cm^2)
45.0	37.5

(a) B-Al = Metal Matrix Composites and Borated Aluminum Alloys.

TABLE 4.3-2
THERMAL CONDUCTIVITY FOR SAMPLE NEUTRON ABSORBERS

Temperature	Material			
°C	1	2	3	4
20	193	170	194	194
100	203	183	207	201
200	208	-	-	
250	-	201	218	206
300	211	204	220	203
314	-	-	-	202
342	-	-	-	202

Units: W/mK

Materials:
1) Boralyn® MMC, aluminum 1100 with 15% B_4C
2) Borated aluminum 1100, 2.5% boron as TiB_2
3) Borated aluminum 1100, 2.0% boron as TiB_2
4) Borated aluminum 1100, 4.3% boron as AlB_2

TABLE 4.3-3
SAMPLE DETERMINATION OF THERMAL CONDUCTIVITY ACCEPTANCE CRITERION

Single Plate Model	Al 1100	n absorber	total
thickness (inch)	0	0.437	0.437
conductivity at 70°F (Btu/hr-in-°F)	n/a	**9.11**	n/a
conductance (Btu/hr-°F)	0	3.98	3.98*

Dual Plate Construction	Al 1100	n absorber	total	
thickness (inch)	0.312	0.125	0.437	as modeled
conductivity at 70°F (Btu/h-.in-°F)	11.09	**4.17**	n/a	
conductance (Btu/hr-°F)	3.46	0.52	3.98	
thickness (inch)	0.187	0.250	0.437	thicker neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**7.62**	n/a	
conductance (Btu/hr-°F)	2.07	1.91	3.98	
thickness (inch)	0.359	0.078	0.437	thinner neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**0**	n/a	
conductance (Btu/hr-°F)	3.98	0	3.98	

The acceptance criterion is identified by boldface type for each thickness.

TABLE 4.4-1
TN-40HT ASME CODE EXCEPTIONS
(Page 1 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
TN-40HT Cask, Basket	NB/NF/ NG-1100 NB/NF/ NG-2130 NB/NF/ NG-4121	Stamping and preparation of reports by the Certificate Holder, Use of ASME Certificate Holders	The TN-40HT cask is not stamped, nor is there a code design specification or stress report generated. A design criteria document is generated in accordance with Transnuclear's (TN) Quality Assurance (QA) Program and the design and analysis is performed under TN's QA Program. The cask may also be fabricated by other than N-stamp holders and materials may be supplied by other than ASME Certificate holders.
TN-40HT Cask, Basket	NCA	All	Not compliant with NCA. TN Quality Assurance requirements, which are based on 10 CFR72 Subpart G, are used in lieu of NCA-4000. Fabrication oversight is performed by TN personnel in lieu of an Authorized Nuclear Inspector.
Pressure Test of the Containment Boundary	NB-6000	Hydrostatic testing	The containment vessel is hydrostatically tested in accordance with the requirements of the ASME B&PV Code, Section III, Articles NB-6200 with the exception that some of the containment vessel may be installed in the shield shell during testing. The containment vessel is supported by the shield shell during all design and accident events.
Weld of Bottom Inner Plate to the Containment Shell	NB-5231	Full penetration corner welded joints require the fusion zone and the parent metal beneath the attachment surface to be UT'd after welding	The joint may be welded after the containment shell is shrink-fit into the shield shell. The geometry of the joint does not allow for UT inspection. In this case, the joint will be examined by RT and either PT or MT methods in accordance with ASME subsection NB requirements. If the containment shell is welded complete before shrink fitting, UT examination per NB-5231 will be performed.

TABLE 4.4-1
TN-40HT ASME CODE EXCEPTIONS
(Page 2 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
Containment Shell Rolling Qualification	NB-4213	The rolling process used to form the inner vessel should be qualified to determine that the required impact properties of NB-2300 are met after straining by taking test specimens from three different heats	If the plates are made from less than three heats, each heat will be tested to verify the impact properties.
Welds of the Bottom Shield to Shield Shell and Shield Shell to Shell Flange	NB-4243 and NB-5230	Category C weld joints in vessels and similar weld joints in other components shall be full penetration joints. These welds shall be examined by UT or RT and either PT or MT	Certain welds are partial penetration welds. As an alternative to the NDE requirements of NB-5230, for Category C welds, all of these closure welds are multi-layer welds that are progressive PT examined.
Containment Vessel	NB-7000	Vessels are required to have overpressure protection	No overpressure protection is provided. Function of containment vessel is to contain radioactive contents under normal and accident conditions. The containment vessel is designed to withstand maximum internal pressure considering 100% fuel rod failure and maximum accident temperatures.
Containment Vessel, Basket	NB-8000 NG-8000	Requirements for nameplates, stamping and reports per NCA-8000	The TN-40HT cask is to be marked and identified in accordance with 10 CFR 72 requirements. Code stamping is not required. QA data package to be in accordance with TN approved QA program.

TABLE 4.4-1
TN-40HT ASME CODE EXCEPTIONS
(Page 3 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
Weld of Shield Plate to Lid Outer Plate	NB-4335 NB-4620	Impact testing of weld and heat affected zone of lid to shield plate Post weld heat treatment	The lid shield plate is not in the component support path, and has no pressure-retaining function; it is a non-structural attachment, and NB jurisdiction does not apply to the plate or weld. The weld must conform to NB-4430.
Gamma Shielding and Trunnion	NB-1132 NF-1132	Attachments in the component support load path and not performing a pressure retaining function shall conform to Subsection NF	The gamma shield shell and trunnions are not fabricated completely in accordance with Subsection NF. The shield shell's primary function is not structural. The weld of the bottom shield plate to the shield shell is subject to multilevel PT or MT to prevent complete loss of the bottom shielding in an accident. Other shield shell weld (shield shell to the shell flange) failures would not lead to loss of shielding. The trunnions and trunnion welds are designed to load factors much higher than those of subsection NF, the trunnion weld is subject to root and final PT or MT, and the trunnions are tested to 1.5 times design load.
Basket Neutron Poison Material	NG-2000	Use of ASME Materials	The basket neutron poison material is not considered in the structural analysis of the basket. The material provides criticality control and adds a heat transfer path. The poison material is not a Code material.

(Page 4 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
Basket	NG-3352	Table NG 3352-1 lists the permissible welded joints	The fusion welds between the stainless steel insert plates and the stainless fuel compartment tube are not included in Table NG-3352-1. The required minimum tested capacity of the welded connection (at each side of the tube) shall be 35 kips (at room temperature). The capacity shall be demonstrated by qualification and production testing. ASME Code Section IX does not provide tests for qualification of these types of welds. Therefore, these welds are qualified using Section IX to the degree applicable together with the testing described here. The welds will be visually inspected to confirm that they are located over the insert plates, in lieu of the visual acceptance criteria of NG-5260 which are not appropriate for this type of weld. A joint efficiency (quality) factor of 1.0 is utilized for the fuel compartment longitudinal seam welds. Table NG-3352-1 permits a joint efficiency (quality) factor of 0.5 to be used for full penetration weld examined by ASME Section V visual examination (VT). For the TN-40HT basket, the compartment seam weld is thin (0.188″ thick) and the weld will be made in one pass. Both surfaces of weld (inside and outside) will be fully examined by VT and therefore a factor of 2 x 0.5=1.0 will be used in the analysis. This is justified as both surfaces of the single weld pass/layer will be fully examined, and the stainless steel material that comprises the fuel compartment tubes is very ductile.

ENCLOSURE 3

Retyped Technical Specifications
Section 4

17 Pages Follow

4.0 DESIGN FEATURES

4.1 Design Drawings

The Prairie Island ISFSI design approval was based on use of the TN-40 and TN-40HT storage casks and review of specific design drawings, some of which have been deemed appropriate for inclusion in the Prairie Island ISFSI Safety Evaluation Report (SER). Drawings listed in Section 1.2 of the Prairie Island ISFSI SER have been reviewed and approved by NRC. These drawings may be revised under the provisions of 10 CFR 72.48, as appropriate.

4.2 Maximum Cask Lifting Height

The casks have been evaluated for drops up to 18 inches. All lifts of a loaded cask greater than 18 inches must be performed with a single-failure-proof system.

4.3 Neutron Poison Loading in the TN-40HT Casks

The minimum areal boron-10 density of the neutron poison plates shall meet that specified in Table 4.3-1. This will ensure that the poison loading is consistent with that assumed in the criticality analysis.

4.3.1 TN-40HT Neutron Absorber Requirements

The neutron absorber used for criticality control in the TN-40HT basket may consist any of the following types of material: (a) Boron-aluminum alloy (borated aluminum), (b) Boron carbide / aluminum metal matrix composite (MMC), or (c) Boral®. The TN-40HT safety analyses do not rely upon the tensile strength of these materials. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only visual inspections, thermal conductivity testing, and the presence / uniformity of boron-10 (B10) need to be verified with testing requirements specific to each material. References to metal matrix composites throughout Section 4.3 are not intended to refer to borated aluminum or Boral®.

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

a. Boron Aluminum Alloy (Borated Aluminum)

Description - The material is produced by direct chill (DC) or permanent mold casting with boron precipitating primarily as a uniform fine dispersion of discrete aluminum diboride (AlB_2) or Titanium diboride (TiB_2) particles in the matrix of aluminum or aluminum alloy (other boron compounds, such as AlB12, can also occur). For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, the AlB_2, the TiB_2, or a hybrid may be used. Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product. The boron may have the natural isotopic distribution or may be enriched in B10. The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section 4.3.2.c.

Requirements - The boron content in the aluminum or aluminum alloy shall not exceed 5% by weight. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via neutron transmission testing as described in Section 4.3.2.c.

b. Boron Carbide / Aluminum Metal Matrix Composites (MMC)

Description – The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. It is a low-porosity product, with a metallurgically bonded matrix. The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section 4.3.2.c.

Requirements – For non-clad MMC products, the boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume. Non-clad

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

MMC products shall have a density greater than 98% of theoretical density, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product. Boron carbide particles for the products considered here typically have an average size in the range 10-40 microns, although the actual specification may be by mesh size, rather than by average particle size. No more than 10% of the particles shall be over 60 microns. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via neutron transmission testing as described in Section 4.3.2.c. The MMCs material shall be qualified in accordance with the requirements specified in Section 4.3.3, and shall subsequently be subject to the process controls specified in SAR Section A9.7.6.

c. Boral®

Description - This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an “ingot” consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. Before rolling, at least 80% by weight of the B_4C particles in Boral® shall be smaller than 200 microns. The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®.

Requirements - The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight. The neutron absorbers shall be 100% visually inspected in accordance with the inspection requirements described in Section 4.3.2.a. The thermal conductivity of the material shall be tested in accordance with the testing requirements in Section 4.3.2.b. The minimum B10 areal density specified in Table 4.3-1 shall be confirmed via chemical analysis and by certification of the B10 isotopic fraction for the

4.0 DESIGN FEATURES

4.3.1 TN-40HT Neutron Absorber Requirements (continued)

boron carbide powder, or by neutron transmission testing described in Section 4.3.2.c. Areal density testing shall be performed on a coupon taken from the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing

a. Visual Inspections Of Neutron Absorbers

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and Castings". Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable. Widespread blisters, rough surface, or cracking shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges. For Boral®, visual inspection shall verify that there are no cracks through the cladding, exposed core on the face of the sheet, or solid aluminum at the edge of the sheet.

b. Thermal Conductivity Testing Of Neutron Absorbers

Testing shall conform to ASTM E1225, ASTM E1461, or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Previous testing of borated aluminum and metal matrix composite, Table 4.3-2, shows that thermal conductivity increases slightly with temperature. Initial sampling shall be one test per lot, defined by the heat or ingot, and may be reduced if the first five tests meet the specified minimum thermal conductivity. If a thermal conductivity test result is below the specified minimum, at least four additional tests shall be performed on the material from that lot. If the mean value of those tests, including the original test, falls below the specified minimum the associated lot shall be rejected. After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the same primary boron

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase. The thermal analysis in SAR Chapter A3.3.2.2 considers a dual plate basket construction base model with 0.125" thick neutron absorber with a 0.312" thick aluminum 1100 plate. This model gives the bounding values for the maximum component temperatures. Either a dual plate basket construction or an alternate single plate (borated aluminum or MMC) construction basket may be utilized. For the dual plate construction, the specified thickness of the neutron absorber may vary, and the thermal conductivity acceptance criterion for the neutron absorber will be based on the nominal thickness specified. In either construction type, to maintain the thermal performance of the basket, the minimum thermal conductivity shall be such that the total thermal conductance (sum of conductivity * thickness) of the neutron absorber and the aluminum 1100 plate shall at least equal the conductance assumed in the analysis for the base model, 3.98 BTU/hr-deg F. Samples of the acceptance criteria for various neutron absorber thicknesses are highlighted in Table 4.3-3. The aluminum 1100 plate does not need to be tested for thermal conductivity; the material may be credited with the values published in the ASME Code Section II part D. The neutron absorber material need not be tested for thermal conductivity if the nominal thickness of the aluminum 1100 plate is 0.359 inch or greater.

c. Neutron Transmission Testing of Neutron Absorbers

Neutron Transmission acceptance testing procedures shall be subject to approval by Transnuclear. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot. Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon's physical thickness. A lot is defined as all the pieces produced from a single ingot or heat or from a group of billets from the same heat. If this definition results in a lot size too small to provide a meaningful statistical analysis of results, an

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes. The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot. The B10 areal density is measured using a collimated thermal neutron beam of up to 1 inch diameter. The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard. Standards will be calibrated, traceable to nationally recognized standards, or by attenuation of a monoenergetic neutron beam correlated to the known cross section of boron 10 at that energy. Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be up to 0.75 sq. inch. The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. If a goodness-of-fit test demonstrates that the sample comes from a normal population, the one-sided tolerance limit for a normal distribution may be used for this purpose. Otherwise, a non-parametric (distribution-free) method of determining the one-sided tolerance limit may be used. Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with Transnuclear's Quality Assurance (QA) procedures. The following illustrates one acceptable method and is intended to be utilized as an example. The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The B10 areal densities determined by neutron transmission are converted to volume density, i.e., the B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined as the mean value of B10 volume density for the sample less K times the

4.0 DESIGN FEATURES

4.3.2 TN-40HT Neutron Absorbers Acceptance Testing (continued)

standard deviation, where K is the one-sided tolerance limit factor with 95% probability and 95% confidence. Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density. Any plate which is thinner than the statistically derived minimum thickness or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness. Non-conforming material shall be evaluated for acceptance in accordance with Transnuclear's QA procedures.

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites

a. Applicability And Scope

Prior to initial use in a spent fuel dry storage system, new MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per SAR Section A9.7.6 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage system. ASTM methods and practices are referenced below for guidance. Alternative methods may be used with the approval of Transnuclear.

b. Durability

There is no need to include accelerated radiation damage testing in the qualification. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel storage. Thermal damage and corrosion (hydrogen generation) testing shall be performed unless such tests on materials of the same chemical composition have already been performed and found acceptable. The following paragraphs illustrate two cases where such testing is not required. Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842 °F, well

4.0 DESIGN FEATURES

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites (continued)

above the basket temperature under normal conditions of storage or transport. Corrosion testing is not required for MMCs (clad or unclad) consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear.

c. Delamination Testing Of Clad MMC

Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage. An example of such a test would be: (1) immerse a specimen at least 6 x 6 inches in water under pressure ≥30 psig for at least 24 hours, (2) Place the specimen in a vacuum furnace preheated to at least 300°F, and evacuate the furnace. Acceptance criterion: no blistering or delamination of the cladding.

d. Required Tests And Examinations To Demonstrate Mechanical Integrity

At least three samples, one each from approximately the two ends and middle of the test material production run shall be subjected to:

(1) room temperature tensile testing (ASTM- B557) demonstrating that the material has a 0.2% offset yield strength no less than 1.5 ksi; has an ultimate strength no less than 5.0 ksi; and has minimum elongation in two inches no less than 0.5%. As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290. The radius of the pin or mandrel shall be no greater than three times the material thickness, and the material shall be bent at least 90 degrees without complete fracture.

(2) testing by ASTM-B311 to verify more than 98% theoretical density for non-clad MMCs and 97% for the matrix of clad MMCs. Testing or examination for interconnected porosity on the faces and edges of unclad MMC, and on the edges of clad MMC shall be performed by a method to be approved by Transnuclear. The maximum interconnect porosity is 0.5 volume %.

4.0 DESIGN FEATURES

4.3.3 TN-40HT Qualification Testing Of Metal Matrix Composites (continued)

(3) and for at least one sample, for MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a minimum 24 hour soak in either pure or borated water, then insertion into a preheated oven at approximately 825°F for a minimum of 24 hours, the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test (1) of this section.

e. Required Tests And Examinations To Demonstrate B10 Uniformity

Uniformity of the boron distribution shall be verified either by: (a) Neutron radioscopy or radiography (ASTM E94, E142, and E545) of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or (b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section 4.3.2.c, or by chemical analysis for boron carbide content in the composite.

f. Approval of Procedures

Qualification procedures shall be subject to approval by Transnuclear.

4.4 Codes and Standards for the TN-40HT Casks

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, 2004 Edition including the 2006 Addenda (the Code), is the governing code for the TN-40HT cask, except that the material properties from later editions of Section II Part D may be used for design. The TN-40HT cask containment boundary is designed, fabricated and inspected in accordance with Subsection NB of the ASME Code to the maximum practical extent. Exceptions to the Code are listed in Table 4.4-1.

4.0 DESIGN FEATURES

4.4 Codes and Standards for the TN-40HT Casks (continued)

The TN-40HT basket is designed, fabricated and inspected in accordance with Subsection NG of the ASME Code to the maximum practical extent. Exceptions to the Code are listed in Table 4.4-1.

The ASME Code requirements apply only to important to safety items.

Proposed alternatives to the Code, including exceptions allowed by Table 4.4-1 may be used when authorized by the Director of the Office of Nuclear Material Safety and Safeguards or Designee. Requests for exceptions shall demonstrate that:

1. The proposed alternatives would provide an acceptable level of quality and safety; or

2. Compliance with the specified requirements of the Code would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Requests for exceptions in accordance with this section shall be submitted in accordance with 10 CFR 72.4

TABLE 4.3-1
MINIMUM B10 AREAL CONTENT FOR TN-40HT FIXED POISON PLATES

Minimum Areal B10 Content for Boral® (mg/cm^2)	Minimum Areal B10 Content for B-Al[(a)] (mg/cm^2)
45.0	37.5

(a) B-Al = Metal Matrix Composites and Borated Aluminum Alloys.

TABLE 4.3-2
THERMAL CONDUCTIVITY FOR SAMPLE NEUTRON ABSORBERS

Temperature	Material			
°C	1	2	3	4
20	193	170	194	194
100	203	183	207	201
200	208	-	-	
250	-	201	218	206
300	211	204	220	203
314	-	-	-	202
342	-	-	-	202

Units: W/mK

Materials:
1) Boralyn® MMC, aluminum 1100 with 15% B_4C
2) Borated aluminum 1100, 2.5% boron as TiB_2
3) Borated aluminum 1100, 2.0% boron as TiB_2
4) Borated aluminum 1100, 4.3% boron as AlB_2

TABLE 4.3-3
SAMPLE DETERMINATION OF THERMAL CONDUCTIVITY ACCEPTANCE CRITERION

Single Plate Model	Al 1100	n absorber	total	
thickness (inch)	0	0.437	0.437	
conductivity at 70°F (Btu/hr-in-°F)	n/a	**9.11**	n/a	
conductance (Btu/hr-°F)	0	3.98	3.98*	

Dual Plate Construction	Al 1100	n absorber	total	
thickness (inch)	0.312	0.125	0.437	as modeled
conductivity at 70°F (Btu/h-.in-°F)	11.09	**4.17**	n/a	
conductance (Btu/hr-°F)	3.46	0.52	3.98	

thickness (inch)	0.187	0.250	0.437	thicker neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**7.62**	n/a	
conductance (Btu/hr-°F)	2.07	1.91	3.98	

thickness (inch)	0.359	0.078	0.437	thinner neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**0**	n/a	
conductance (Btu/hr-°F)	3.98	0	3.98	

The acceptance criterion is identified by boldface type for each thickness.

TABLE 4.4-1
TN-40HT ASME CODE EXCEPTIONS
(Page 1 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
TN-40HT Cask, Basket	NB/NF/ NG-1100 NB/NF/ NG-2130 NB/NF/ NG-4121	Stamping and preparation of reports by the Certificate Holder, Use of ASME Certificate Holders	The TN-40HT cask is not stamped, nor is there a code design specification or stress report generated. A design criteria document is generated in accordance with Transnuclear's (TN) Quality Assurance (QA) Program and the design and analysis is performed under TN's QA Program. The cask may also be fabricated by other than N-stamp holders and materials may be supplied by other than ASME Certificate holders.
TN-40HT Cask, Basket	NCA	All	Not compliant with NCA. TN Quality Assurance requirements, which are based on 10 CFR72 Subpart G, are used in lieu of NCA-4000. Fabrication oversight is performed by TN personnel in lieu of an Authorized Nuclear Inspector.
Pressure Test of the Containment Boundary	NB-6000	Hydrostatic testing	The containment vessel is hydrostatically tested in accordance with the requirements of the ASME B&PV Code, Section III, Articles NB-6200 with the exception that some of the containment vessel may be installed in the shield shell during testing. The containment vessel is supported by the shield shell during all design and accident events.
Weld of Bottom Inner Plate to the Containment Shell	NB-5231	Full penetration corner welded joints require the fusion zone and the parent metal beneath the attachment surface to be UT'd after welding	The joint may be welded after the containment shell is shrink-fit into the shield shell. The geometry of the joint does not allow for UT inspection. In this case, the joint will be examined by RT and either PT or MT methods in accordance with ASME subsection NB requirements. If the containment shell is welded complete before shrink fitting, UT examination per NB-5231 will be performed.

TABLE 4.4-1
TN-40HT ASME CODE EXCEPTIONS
(Page 2 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
Containment Shell Rolling Qualification	NB-4213	The rolling process used to form the inner vessel should be qualified to determine that the required impact properties of NB-2300 are met after straining by taking test specimens from three different heats	If the plates are made from less than three heats, each heat will be tested to verify the impact properties.
Welds of the Bottom Shield to Shield Shell and Shield Shell to Shell Flange	NB-4243 and NB-5230	Category C weld joints in vessels and similar weld joints in other components shall be full penetration joints. These welds shall be examined by UT or RT and either PT or MT	Certain welds are partial penetration welds. As an alternative to the NDE requirements of NB-5230, for Category C welds, all of these closure welds are multi-layer welds that are progressive PT examined.
Containment Vessel	NB-7000	Vessels are required to have overpressure protection	No overpressure protection is provided. Function of containment vessel is to contain radioactive contents under normal and accident conditions. The containment vessel is designed to withstand maximum internal pressure considering 100% fuel rod failure and maximum accident temperatures.
Containment Vessel, Basket	NB-8000 NG-8000	Requirements for nameplates, stamping and reports per NCA-8000	The TN-40HT cask is to be marked and identified in accordance with 10 CFR 72 requirements. Code stamping is not required. QA data package to be in accordance with TN approved QA program.

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Gamma Shielding and Trunnion	NB-1132 NF-1132	Attachments in the component support load path and not performing a pressure retaining function shall conform to Subsection NF	The gamma shield shell and trunnions are not fabricated completely in accordance with Subsection NF. The shield shell's primary function is not structural. The weld of the bottom shield plate to the shield shell is subject to multilevel PT or MT to prevent complete loss of the bottom shielding in an accident. Other shield shell weld (shield shell to the shell flange) failures would not lead to loss of shielding. The trunnions and trunnion welds are designed to load factors much higher than those of subsection NF, the trunnion weld is subject to root and final PT or MT, and the trunnions are tested to 1.5 times design load.
Basket Neutron Poison Material	NG-2000	Use of ASME Materials	The basket neutron poison material is not considered in the structural analysis of the basket. The material provides criticality control and adds a heat transfer path. The poison material is not a Code material.

(Page 4 of 4)

Component	Reference ASME Code/Section	Code Requirement	Alternatives, Justification & Compensatory Measures
Basket	NG-3352	Table NG 3352-1 lists the permissible welded joints	The fusion welds between the stainless steel insert plates and the stainless fuel compartment tube are not included in Table NG-3352-1. The required minimum tested capacity of the welded connection (at each side of the tube) shall be 35 kips (at room temperature). The capacity shall be demonstrated by qualification and production testing. ASME Code Section IX does not provide tests for qualification of these types of welds. Therefore, these welds are qualified using Section IX to the degree applicable together with the testing described here. The welds will be visually inspected to confirm that they are located over the insert plates, in lieu of the visual acceptance criteria of NG-5260 which are not appropriate for this type of weld. A joint efficiency (quality) factor of 1.0 is utilized for the fuel compartment longitudinal seam welds. Table NG-3352-1 permits a joint efficiency (quality) factor of 0.5 to be used for full penetration weld examined by ASME Section V visual examination (VT). For the TN-40HT basket, the compartment seam weld is thin (0.188″ thick) and the weld will be made in one pass. Both surfaces of weld (inside and outside) will be fully examined by VT and therefore a factor of 2 x 0.5=1.0 will be used in the analysis. This is justified as both surfaces of the single weld pass/layer will be fully examined, and the stainless steel material that comprises the fuel compartment tubes is very ductile.