~~ENCLOSURE 5 CONTAINS PROPRIETARY INFORMATION –~~
~~WITHHOLD FROM PUBLIC DISCLOSURE IN ACCORDANCE WITH 10 CFR 2.390~~

Xcel Energy®

L-PI-12-030
10 CFR 72.56

June 18, 2012

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
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

License Amendment Request (LAR) to Revise the Thermal Conductance Requirement for Neutron Absorbers and Aluminum Plates in the TN-40HT Cask

Pursuant to 10 CFR 72.56, the Northern States Power Company, a Minnesota corporation doing business as Xcel Energy (hereafter "NSPM") hereby requests an amendment to the Special Nuclear Materials (SNM) license number SNM-2506 Technical Specifications (TS) for the Prairie Island Independent Spent Fuel Storage Installation (PI ISFSI), to revise the minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate, from 3.98 BTU/hr-deg F to 3.55 BTU/hr-deg F (TS 4.3.2.b - Thermal Conductivity Testing Of Neutron Absorbers).

The changes requested in this LAR (as described in Enclosure 2) include certain aspects of the thermal analysis of the TN-40HT dry cask system and the associated changes to the PI ISFSI Technical Specifications. The dry cask system changes are needed to provide additional fabrication flexibility and to allow the use of certain fabricated TN-40HT baskets which are only able to meet the changed value for conductance.

NSPM requests review of this LAR and approval by May 1, 2013 to support planning for future cask fabrication and loading campaigns.

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

Enclosure 2 to this letter contains the technical evaluation and regulatory safety analysis of the proposed changes. This enclosure includes several attachments that provide the details of the proposed changes along with additional supporting information.

Enclosure 3 to this letter contains a summary and description of the computer files contained in Enclosure 5.

NMSS26

Enclosure 4 to this letter provides the affidavit and withholding request, pursuant to the requirements in 10 CFR 2.390(b)(1)(iii), of trade secret information contained in Enclosure 5.

Enclosure 5 to this letter is a computer portable hard drive containing certain updated computer input and output files that were used in the thermal analysis of the TN-40HT cask design. These files are provided to aid NRC review of the requested changes. These files contain trade secret information that is proprietary to Transnuclear, Inc. (TN) (the cask supplier).

NSPM and TN personnel are available for conference calls or public meetings, to facilitate the review of this amendment request.

Upon NRC approval, NSPM requests 30 days to implement the associated changes. If there are any questions or if additional information is needed, please contact Glenn Adams at (612) 330-6777.

Summary of Commitments

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

James E. Molden
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

Enclosures (5)

cc: Administrator, Region III, USNRC (letter only)
SFST Project Manager, PI ISFSI, USNRC
(8 copies of Enclosures 1, 2, and 4; 1 copy of Enclosures 3 and 5)
NRR Project Manager, Prairie Island Nuclear Generating Plant (PINGP), USNRC (letter only)
Resident Inspector, PINGP, 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

LICENSE AMENDMENT REQUEST
TO REVISE THE THERMAL CONDUCTANCE REQUIREMENT FOR NEUTRON ABSORBERS AND ALUMINUM PLATES IN THE TN-40HT CASK

The Northern States Power Company, a Minnesota corporation, d/b/a Xcel Energy (hereafter "NSPM") requests authorization for changes to the Prairie Island Independent Spent Fuel Storage Installation Materials License and Appendix A as shown in Enclosure 2 which contains the evaluation of the proposed changes.

This letter contains trade secret information, pursuant to 10 CFR 2.390(a)(4) in Enclosure 5. The designated information is of commercial value and the competitive position of the owner, Transnuclear, Inc., would be harmed if disclosed.

NORTHERN STATES POWER COMPANY - MINNESOTA

By James E. Molden
James E. Molden
Site Vice President
Prairie Island Nuclear Generating Plant
Northern States Power Company - Minnesota

State of Minnesota

County of Hennepin

On this 18 day of June, 2012 before me a notary public acting in said County, personally appeared James E. Molden, 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 NSPM, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true.

Aimie L. Mims

AIMIE L. MIMS
NOTARY PUBLIC MINNESOTA
MY COMMISSION
EXPIRES JAN. 31, 2015

ENCLOSURE 2

Evaluation of Proposed Changes

License Amendment Request (LAR) to Revise the Thermal Conductance Requirement for Neutron Absorbers and Aluminum Plates in the TN-40HT Cask

ATTACHMENTS:

1. ISFSI Technical Specifications Marked-Up Pages
2. ISFSI SAR Marked-Up Pages (for information only)

1. Summary Description

Pursuant to 10 CFR 72.56, the Northern States Power Company – Minnesota (NSPM) hereby requests an amendment to the Special Nuclear Materials (SNM) license number SNM-2506 Technical Specifications (TS) for the Prairie Island Independent Spent Fuel Storage Installation (PI ISFSI), to revise TS Design Features Section 4.3.2.b to change the minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate, from 3.98 BTU/hr-deg F to 3.55 BTU/hr-deg F. In this license amendment request (LAR), the thermal performance of the TN-40HT cask is evaluated using ANSYS Version 10.0 computer code on a 3-dimensional model of the cask.

2. Detailed Description

2.1 Background

The TN-40HT fuel basket consists of an assembly of 40 rectangular stainless steel tubes. Sandwiched between the tube walls are slotted neutron absorber plates and aluminum plates assembled in an egg-crate construction. The thermal conductivity of the aluminum plates is known (values established by American Society of Mechanical Engineers – ASME), but the thermal conductivity of the neutron absorber plates must be verified through acceptance testing. To maintain the thermal performance of the basket, the minimum thermal conductivity must be such that the total thermal conductance (sum of conductivity multiplied by thickness) of the neutron absorber and the aluminum plate must at least equal the conductance assumed in the thermal analysis.

The current thermal analysis and TS limit for the minimum total thermal conductance of the neutron absorber and aluminum 1100 plate is 3.98 BTU/hr-deg F, based on design values for the thicknesses and thermal conductivity of the aluminum 1100 plate and the various available neutron absorber materials. However, following fabrication, certain manufactured TN-40HT baskets have plate thicknesses which result in total conductance values which would not meet the current TS limit.

A change to the TS limit is needed in order to use these TN-40HT baskets. To support planning for future cask fabrication and loading campaigns, NRC review and approval is requested by May 1, 2013.

2.2 Proposed Technical Specifications Changes

The changes requested in this LAR include certain aspects of the thermal analysis of the TN-40HT dry cask system and the associated changes to the PI ISFSI Technical Specifications.

Attachment 1 to this enclosure shows markups to TS Section 4.3.2.b – Thermal Conductivity Testing Of Neutron Absorbers and TS Table 4.3-3 – Sample Determination of Thermal Conductivity Acceptance Criterion, as follows:

- In TS 4.3.2.b, the minimum total thermal conductance in the thermal analysis of the TN-40HT neutron absorber and aluminum 1100 plate is changed from 3.98 BTU/hr-deg F to 3.55 BTU/hr-deg F.
- In TS 4.3.2.b, the nominal thickness of the aluminum 1100 plate at which the neutron absorber material need not be tested for thermal conductivity is changed from 0.359 inches or greater to 0.320 inches or greater.
- TS Table 4.3-3 is changed for conductivity and conductance values, based on the changes to TS Section 4.3.2.b.

2.3 Non-Technical Specifications Design Basis Analysis Changes

The original TN-40HT thermal design basis analysis was performed using ANSYS Computer Code and Online User's Manuals, Version 8.0. As Version 8.0 is no longer supported, the new design basis analysis performed for this amendment request used Version 10.0. Precedent for using Version 10.0 is provided in Section 4.2 below.

2.4 Safety Analysis Report (SAR) Changes

Attachment 2 to this enclosure provides (for information only) the current ISFSI Safety Analysis Report (SAR) pages marked-up to reflect the following changes necessary to support the revised TS:

- SAR Section A3.3.2.2.1.4 is added to evaluate the thermal performance of the TN-40HT cask with reduced conductivity for neutron absorber plates for normal, off-normal, fire accident, buried cask accident, and vacuum drying conditions.
- SAR Section 3.6, Reference 44 is added to reflect the revised version of ANSYS that is used for the thermal dynamic analysis.
- In SAR Section A9.7.4.2, the wording of the thermal testing requirements is changed to be consistent with the wording in the revised TS 4.3.2.b.
- In SAR Section A9.7.4.2, the nominal thickness of the aluminum 1100 plate at which the neutron absorber material need not be tested for thermal conductivity is changed from 0.359 inches or greater to 0.320 inches or greater.
- SAR Table A9.7-2 is changed for conductivity and conductance values, based on the changes to SAR Section A9.7.4.2.

With the revised thermal analysis and TS changes proposed in this LAR, the PI ISFSI will continue to operate safely and the health and welfare of the public is protected.

3. Technical Evaluation

Proposed Technical Specifications Changes

This LAR proposes to change the TS 4.3.2 minimum total thermal conductance of the TN-40HT neutron absorber and aluminum 1100 plate from 3.98 BTU/hr-deg F to 3.55 BTU/hr-deg F. That change results in a corresponding change to the nominal thickness of the aluminum 1100 plate at which the neutron absorber material need not be tested for thermal conductivity, from 0.359 inches or greater to 0.320 inches or greater. Lastly, the "Sample Determination of Thermal Conductivity Acceptance Criterion" information in TS Table 4.3-3 must be changed in order to remain consistent with the new minimum total thermal conductance.

Technical Basis for Change

The technical basis for the proposed changes associated with the TN-40HT cask design thermal analysis is contained in Attachment 2, which provides marked-up SAR pages. The information in Attachment 2 shows that the TN-40HT dry cask system thermal design performance continues to meet the applicable requirements set forth in 10 CFR Part 72 when the revised value of minimum total thermal conductance is applied. This evaluation is summarized further, below.

In the model, the thermal conductivity of the neutron absorber plate was reduced to the value of 0.68 Btu/hr-in-°F which correlates with the as-modeled plate construction and the minimum total thermal conductance value (3.55 Btu/hr -°F) in the proposed TS (See TS Table 4.3-3). To achieve acceptable temperature results, the thermal analysis offset this assumed reduction in thermal conductivity by: (1) reducing the uncertainty associated with using a cross-section thermal model, and (2) incorporating a correction to the transverse effective fuel conductivities. These changes and the revised thermal analysis models used in the ANSYS, Version 10.0 computer code are described further in Attachment 2.

As discussed in current SAR Section A3.3.2.2.3.6.5, the transverse effective fuel conductivity (listed in Table A3.3-8) in the current analysis-of-record was calculated using an incorrect Stefan-Botzmann constant, which had been 60 times lower than the correct value in the analysis documented in current SAR Section A3.3.2.2 (Revision 13). Use of the transverse effective fuel conductivity as listed in Table A3.3-8 was assessed as conservative, as discussed in SAR Section A3.3.2.2.3.6.5. The models used for reanalysis of the TN-40HT cask use the correct transverse effective fuel conductivity values.

A revised analysis was performed for the normal/off-normal storage conditions, the fire and buried cask accident transients, and for vacuum drying conditions, with results provided in proposed SAR Section A3.3.2.2.1.4. The results of reanalysis demonstrate that using a lower thermal conductivity (of 0.68 Btu/hr-in-°F) for the neutron absorber plates is compensated for by using the correct values for the

transverse effective fuel assembly conductivity in the full length model. The reanalysis resulted in lower fuel cladding temperatures for all cases and lower cask component temperatures for all cases except one. The one exception relates to an off-normal storage case basket rail temperature result that is one degree Fahrenheit higher than the design basis model result. This exception is insignificant as explained in proposed SAR Section A3.3.2.2.1.4.

Therefore, the results and conclusion in current SAR Section A3.3.2.2.2 remain valid and are retained as the results / conclusion of record. In addition, the reanalysis shows that the time limit of 34 hours for vacuum drying as specified in current SAR Section A3.3.2.2.5.1 remains valid.

Conclusions

With the TS changes proposed in this LAR, revised thermal analysis indicates that operation of the PI ISFSI will continue to protect the health and safety of the public.

4. Regulatory Safety Analysis

4.1 Applicable Regulatory Requirements/Criteria

Title 10 Code of Federal Regulations (CFR) 72.44, "License Conditions"

Title 10, CFR Subsection 72.44 states, "(c) Each license issued under this part must include technical specifications. Technical specifications must include requirements in the following categories ... ". This regulation requires Technical Specifications to include: 1) functional and operating limits and monitoring instruments and limiting control settings; 2) limiting conditions; 3) surveillance requirements; 4) design features; and 5) administrative controls.

This license amendment request proposes changes to the TN-40HT cask design analysis which involves changes to certain Technical Specifications Design Features acceptance criteria, but the amendment does not involve addition or deletion of any specifications.

Thus, with the changes proposed in this license amendment request, the requirements of Title 10 CFR 72.44 continue to be met.

10 CFR Part 72, Subpart F - General Design Criteria

Subpart F of 10 CFR 72 provides general criteria for storage of high level nuclear wastes of which some apply to independent spent fuel storage facilities. The Prairie Island Independent Spent Fuel Storage Installation comprises storage of dry spent fuel casks within a licensed storage facility. Since this license amendment request proposes to modify only the thermal analysis of the cask design, criteria applicable to the facility are not affected by this amendment. Table

1 below lists the sections of Part 72 which contain general criteria and identifies if the section is affected by the changes proposed in this amendment request. For those sections which are affected, more detailed discussion is provided.

Table 1
Criteria Sections Affected by the TN-40HT Design Modifications

Regulation	Title	Affected by this Amendment
72.120	General consideration	No
72.122	Overall requirements	Yes
72.124	Criteria for nuclear criticality safety	No
72.126	Criteria for radiological protection	No
72.128	Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling	Yes
72.130	Criteria for decommissioning	No

<u>72.122 Overall requirements</u>

This Section defines criteria applicable to dry spent fuel storage casks with respect to quality standards, protection against environmental conditions and natural phenomena, fires and explosions, confinement barriers and systems, instrumentation and controls, and retrievability. With these amendment changes, the TN-40HT cask design continues to meet the applicable criteria for protection against environmental conditions and natural phenomena, fires and explosions, and confinement barriers and systems.

<u>72.128 Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling</u>

Based on the technical evaluation provided herein as supported by the proposed SAR changes, the TN-40HT cask design continues to ensure adequate safety under normal and accident conditions in accordance with the applicable criteria in this Section. Thus, with the changes proposed in this license amendment request, the requirements of Title 10 CFR Part 72, Subpart F continue to be met.

4.2 Precedent

Precedent for the use of ANSYS Computer Code and Online User's Manuals, Version 10.0, for thermal evaluations may be found in the following submittal:

- Letter from Jayant Bondre to Document Control Desk, "Initial Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Docket No. 72-1029," December 15, 2011 (ML12004A156/ ML12004A157)

4.3 Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

5. Environmental Consideration

The changes proposed by this LAR will not require a change to the PI ISFSI Environmental Report, Revision No. 2, as all current SAR analyses remain bounding.

6. References

None.

Attachment 1

ISFSI Technical Specifications

Marked-Up Pages

Affected Pages:

4.0-5
4.0-13

Two Pages Follow

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 thermal analysis ~~for the base model~~, 3.55~~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 0.320~~59~~ 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

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	**8.12~~9.11~~**	n/a
conductance (Btu/hr-°F)	0	3.55~~98~~	3.55~~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	**0.68~~4.17~~**	n/a	
conductance (Btu/hr-°F)	3.46	0.09~~52~~	3.55~~98~~	

thickness (inch)	0.187	0.250	0.437	thicker neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**5.90~~7.62~~**	n/a	
conductance (Btu/hr-°F)	2.07	1.48~~91~~	3.55~~98~~	

thickness (inch)	0.320~~59~~	0.117~~078~~	0.437	thinner neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**0**	n/a	
conductance (Btu/hr-°F)	3.55~~98~~	0	3.55~~98~~	

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

Attachment 2

ISFSI SAR

Marked-Up Pages

(for information only)

Affected Pages:

A3.6-3
A9.7-5
A9.7-6
Table A9.7-2
New Section A3.3.2.2.1.4 (10 pages)

14 Pages Follow

31. Bentz, D. P., "A Computer Model to Predict the Surface Temperature and Time-of-Wetness of Concrete Pavements and Bridge Decks," Report # NISTIR 6551, National Institute of Standards and Technology, 2000.

32. Siegel, Robert, Howell, R. H., "Thermal Radiation Heat Transfer," 4th Edition, 2002.

33. AAR Brooks & Perkins, Advanced Structures Division, "Standard Specification for Boral™ Composite Sheets."

34. Not used.

35. USNRC, SFPO, NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems - Final Report," 1997.

36. ANSYS Computer Code and User's Manuals, Version 8.0.

37. TN Letter to NRC, "Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 1 to the NUHOMS® HD System, Response to Request for Additional Information (Docket No. 72-1030; TAC No. L24153)", Enclosure 2, Response to RAI 4.1, TN Document No. E-27377, December 15, 2008.

38. USNRC, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material," 2004.

39. Gregory, J. J., Mata, R., Keltner, N. R., "Thermal Measurements in a Series of Long Pool Fires," SANDIA Report, SAND 85-0196, TTC-0659, 1987.

40. IAEA Safety Standards, "Regulations for the Safe Transport of Radioactive Material," 1985.

41. USNRC, SFPO, NUREG/CR-0497, "A Handbook of Materials Properties for Use in the Analysis of Light Water Reactor Fuel Rod Behavior," MATPRO - Version II (Revison 2), EG&G Idaho, Inc., TREE-1280, 1981.

42 Letter, Ashok Thadani (NRC) to S. R. Tritch (Westinghouse), "Acceptance for Referencing of Topical Report WCAP-12610 'Vantage+ Fuel Assembly Reference Core Report' (TAC No. 77258)" July 1, 1991.

43. SANDIA Report, SAND90-2406, "A Method for Determining the Spent Fuel Contribution to Transport Cask Containment Requirements," 1992.

44. ANSYS Computer Code and User's Manuals, Version 10.0.

A9.7.4 NEUTRON ABSORBERS ACCEPTANCE TESTING

A9.7.4.1 VISUAL INSPECTIONS OF NEUTRON ABSORBERS

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data (Reference 6), 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.

A9.7.4.2 THERMAL CONDUCTIVITY TESTING OF NEUTRON ABSORBERS

Testing shall conform to ASTM E1225 (Reference 7), ASTM E1461 (Reference 8), 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 A9.7-1, 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 ~~may~~ 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 ~~appearing in the same~~ 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 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 thermal analysis ~~for the base model.~~ , 3.55 BTU/hr-deg F. Samples of the acceptance criteria for various neutron absorber thicknesses are highlighted in Table A9.7-2.

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~~ 0.320 inch or greater.

A9.7.4.3 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 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.

TABLE A9.7-2
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~~ 8.12**	n/a	
conductance (Btu/hr-°F)	0	~~3.98~~ 3.55	~~3.98*~~ 3.55	

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~~ 0.68**	n/a	
conductance (Btu/hr-°F)	3.46	~~0.52~~ 0.09	~~3.98~~ 3.55	

thickness (inch)	0.187	0.250	0.437	thicker neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**~~7.62~~ 5.90**	n/a	
conductance (Btu/hr-°F)	2.07	~~1.91~~ 1.48	~~3.98~~ 3.55	

thickness (inch)	~~0.359~~ 0.320	~~0.078~~ 0.117	0.437	thinner neutron absorber
conductivity at 70°F (Btu/hr-in-°F)	11.09	**0**	n/a	
conductance (Btu/hr-°F)	~~3.98~~ 3.55	0	~~3.98~~ 3.55	

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

A3.3.2.2.1.4 Thermal models with Lower Poison Plate Conductivity

To provide more flexibility in the manufacturing of the baskets, models were created and analyses performed utilizing a lower conductivity for poison plates than the models described in the previous sections.

The lower conductivity models were created by combining the poison plate conductivity of 0.68 Btu/hr-in-°F (independent of temperature) and the conductivities of the aluminum 1100 plate taken from Table A3.3-8 together as one set of effective conductivities for both materials. The paired aluminum and poison plates build up parallel thermal resistances in the basket. The effective conductivity for these resistances is calculated as follows.

$$k_{eff,along} = \frac{k_{Al} \times t_{Al} + k_p \times t_p}{t_{Al} + t_p}$$

Where

k_{Al} = thermal conductivity of Al-1100, see Table A3.3-8
t_{Al} = aluminum plate thickness as modeled = 0.312 in.
k_P = thermal conductivity of poison plate = 0.68 Btu/hr-in-°F
t_P = poison plate thickness as modeled = 0.125 in.

The gaps of 0.01" and 0.02" considered between the aluminum/poison plates and the stainless steel bars/fuel compartment walls remain the same as those described in Section A3.3.2.2.1.1.1.

The full length model of the TN-40HT cask described in Section A3.3.2.2.1.1.1 and the ANSYS computer code (Reference 44) were used to evaluate the cask thermal performance with reduced conductivity of the poison plates. In addition to changing the poison plate conductivity to 0.68 Btu/hr-in-°F, the transverse effective fuel conductivities were changed to the values presented in Table A3.3-9 for evaluation of the off-normal storage, hypothetical fire accident, and postulated buried cask accident conditions. The other material properties used in these models are the same as those listed in Table A3.3-8.

The boundary conditions used in the reanalysis for the off-normal storage, hypothetical fire accident, and postulated buried cask accident conditions were the same as those described in Sections A3.3.2.2.1.1.3, A3.3.2.2.1.2.1, A3.3.2.2.1.2.2, respectively. Similar to the evaluation methodology described in Section A3.3.2.2.1.2.1, the transient evaluation of the full length cask model for the fire accident condition is followed by a steady-state evaluation to verify that the maximum fuel cladding temperature for the post-fire conditions has been identified.

The full length model of the TN-40HT cask was also used for the vacuum drying reanalysis. This reanalysis included an additional conservatism by assuming that the cask remains in a boiling spent fuel pool during the entire vacuum drying operations. A constant temperature of 215°F was considered at the radial outer surface of the cask to simulate this condition. Similar to the approach described in Section A3.3.2.2.5.1, adiabatic boundary conditions were applied on the cask lid and cask bottom shield of the full length model and an average initial temperature of 215°F was assumed for the cask components at the start of water draining.

Identical to the conditions described in Section A3.3.2.2.5.1, effective conductivity values in a vacuum were considered for elements representing homogenized fuel assemblies and air conductivity was given to the elements representing the gas within the cask cavity for the vacuum drying reanalysis. Except for the conductivity of poison plate, the other material properties used in this model were the same as those listed in Table A3.3-8.

The results of the reanalysis are compared to the results utilizing the design basis models in the previous sections in Table A3.3-35 through Table A3.3-37 for the off-normal storage, hypothetical fire accident, and postulated buried cask accident conditions. The resulting maximum temperature histories of the cask components during fire accident are illustrated in Figure A3.3-42.

As seen in Table A3.3-35, the evaluations of the TN-40HT cask with a poison plate conductivity of 0.68 Btu/hr-in-°F for off-normal storage conditions result in a lower maximum fuel cladding temperature. The maximum basket and cask component temperatures remain either unaffected or bounded by the values calculated with the design basis model, except for the basket rail temperature for the off-normal storage condition. Table A3.3-35 shows the basket rail temperature increasing from 459°F to 460°F for the off-normal storage condition. This increase is judged to be negligible for this component and does not warrant changing the thermal design basis results used as input in other analyses. The average cavity gas temperature is also bounded by the design basis model.

The amount of conduction heat flow rate from the cask top toward the protective cover is retrieved from the low conductivity model using the same approach used in Section A3.3.2.2.1.1.3. The amount of conduction heat from the cask to the protective cover is 1.00 kW, which is the same as that determined in Section A3.3.2.2.1.1.3 for the design basis model. As described in Section A3.3.2.2.1.1.3, the top cask model uses a uniform heat flux equivalent to a heat flow of 1.2 kW. Therefore, the maximum component temperatures at the top of the cask, such as cask lid, cask lid seal, etc., remain bounded by those determined using the top cask sub-model described in Section A3.3.2.2.1.1.2 and no reevaluation using the top cask sub-model is required.

The evaluation for the minimum ambient temperature of -40°F and no insolance described in Section A3.3.2.2.2.2 maximizes the temperature gradient across the cask body for structural evaluation. Since the maximum temperatures remain bounded by the design basis model and the cold ambient temperature is unchanged, the temperature gradient across the cask body remains bounded by the design basis model.

As seen in Table A3.3-36 and Figure A3.3-42, the evaluations of the TN-40HT cask with a poison plate conductivity of 0.68 Btu/hr-in-°F using the full length cask model for fire accident conditions result in a peak maximum fuel cladding temperature during the transient. As discussed in Section A3.3.2.2.2.4, the cask cross-section model used as the design basis model does not show a peak temperature until steady state conditions are reached after the fire. The reason for this behavior is that the full length model provides a heat dissipation area which is larger than the active fuel length. Given the long period of time during cool-down and available large heat dissipation area, the maximum fuel cladding temperature decreases slightly as shown in Figure A3.3-42 for the full-length model. The peak maximum temperature and the steady state temperature reported in Table A3.3-36 for the low conductivity model remain bounded by the values resulting from the design basis model.

A comparison of Figure A3.3-14 (page 1 of 2) and Figure A3.3-42 indicates a higher peak maximum temperature for the outer shell when the full length model is used to evaluate the fire accident condition. This higher peak temperature is located at the joint between the outer shell and the top and bottom outer shell ring, which is included in the full length model but not in the cross section model. The outer shell joint region provides a larger area for fire heat intake and thus a higher peak temperature. The high temperature region is localized and concentrated in the joint as shown in Figure A3.3-43 and does not result in a higher volumetric average temperature as shown on Table A3.3-36.

As seen in Table A3.3-37, the evaluations of the TN-40HT cask with a poison plate conductivity of 0.68 Btu/hr-in-°F using the full length cask model for buried cask accident conditions result in a lower fuel cladding and cask component temperatures. Thus, the values calculated with the design basis model remain bounding.

This evaluation shows that using the lower conductivity of 0.68 Btu/hr-in-°F for the poison plates in the basket is compensated for by removing the conservatism in the transverse effective fuel assembly conductivity and utilizing the full length model. Therefore, the results and conclusion in Section A3.3.2.2.2 remain conservatively bounding or unaffected.

The reanalysis of the vacuum drying conditions for the TN-40HT cask with lower poison plate conductivity results in a maximum fuel cladding temperature of 628°F at the end of vacuum drying (34 hours). This is significantly lower than the maximum design basis

model fuel cladding temperature of 725°F listed in Table A3.3-14 . The maximum component temperatures resulting from the vacuum drying reanalysis are listed in Table A3.3-38. The maximum temperatures for fuel cladding, radial neutron shielding material, and seals remain well below the allowable limits for vacuum drying condition as shown in Table A3.3-38.

This evaluation shows that using a conductivity of 0.68 Btu/hr-in-°F for the poison plates does not affect the time limit for vacuum drying, and the time limit of 34 hours for vacuum drying as specified in Section A3.3.2.2.5.1 remains valid.

TABLE A3.3-35
TEMPERATURES FOR OFF-NORMAL STORAGE CONDITIONS WITH LOWER POISON PLATE CONDUCTIVITY

	Design Basis Model Off-Normal Storage 100°F ambient (Table A3.3-3)	Lower Conductivity Model Off-Normal Storage 100°F ambient	
Component	Maximum Temperature (°F)	Maximum Temperature (°F)	Temperature Limit (°F)
Fuel Cladding	680	658	752
Fuel Compartment	630	630	---
Basket Rails	459	460	---
Inner Bottom Plate	364	364	---
Bottom Shield	264	264	---
Cask Inner Shell *	305	305	---
Shield Shell *	298	298	---
Radial Resin †	285	285	300
Cask Outer Shell †	260	260	---
Average Cavity Gas ($\overline{T}_{cavity}$)	456 **	450	---

* This value is the volumetric average temperature at the hottest cross section.
† This value is the volumetric average temperature at the hottest cross section plus 18 °F to bound the effects of storage pad on the cask view factor. See Section A3.3.2.2.4 for discussion.
** This value is taken from Table A3.3-15.

Table A3.3-36
TEMPERATURES FOR FIRE ACCIDENT CONDITIONS WITH LOWER POISON PLATE CONDUCTIVITY

	Design Basis Model Fire Accident (Table A3.3-6)		Lower Conductivity Model Fire Accident				
	Transient / Steady State		Transient		Steady State		
Component	Maximum Temperature (°F)	Time (hr)	Maximum Temperature (°F)	Time (hr)	Maximum Temperature (°F)	Time (hr)	Temperature Limit (°F)
Fuel Cladding	772	∞	679	36.6	674	∞	1058
Fuel Compartment	725	∞	652	36.6	646	∞	---
Basket Rails	542	∞	484	12.6	477	∞	---
Cask Inner Shell *	370	∞	351	2.0	323	∞	---
Shield Shell *	361	∞	322	0.25 (end of fire)	316	∞	---
Radial Resin	N/A ‡	---	N/A ‡	---	N/A ‡	---	---
Cask Outer Shell †	913	0.25 (end of fire)	911	0.25 (end of fire)	277	∞	---
Average Cavity Gas ($\overline{T}_{cavity}$)	592 **	∞	474	36.6	468	∞	---

* This value is the volumetric average temperature at the hottest cross section.
† This value is the volumetric average temperature at the hottest cross section plus 18 °F to bound the effects of storage pad on the cask view factor. See Section A3.3.2.2.4 for discussion.
‡ Neutron shield resin is assumed to burn and decomposed during the fire
** This value is taken from Table A3.3-15.

TABLE A3.3-37
TEMPERATURES FOR BURIED CASK ACCIDENT CONDITIONS WITH LOWER POISON PLATE CONDUCTIVITY

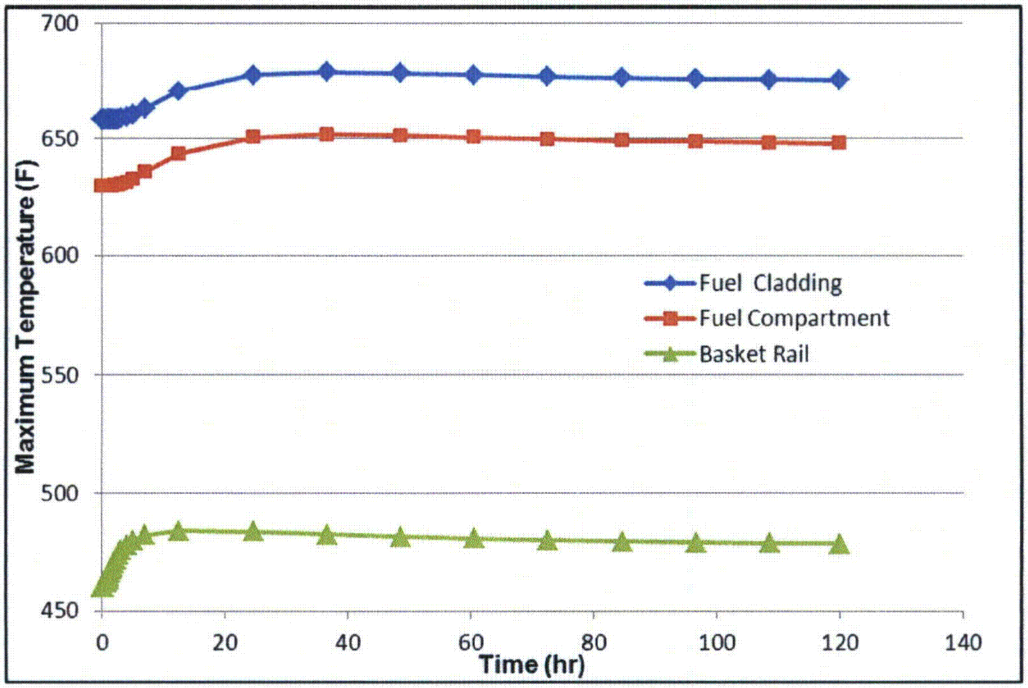
	Design Basis Model Buried Cask Accident (Table A3.3-7)		Lower Conductivity Model Buried Cask Accident		
Component	Maximum Temperature (°F)	Time (hr)	Maximum Temperature (°F)	Time (hr)	Temperature Limit (°F)
Fuel Cladding	1058	95.75	905	95.75	1058
Fuel Compartment	1024	95.75	888	95.75	---
Basket Rails	892	95.75	761	95.75	---
Cask Inner Shell *	804	95.75	659	95.75	---
Shield Shell *	799	95.75	654	95.75	---
Radial Resin †	300	1.85	299	1.85	300
Cask Outer Shell †	791	95.75	664	95.75	---
Average Cavity Gas ($\overline{T}_{cavity}$)	929 **	95.75	738	95.75	---

* This value is the volumetric average temperature at the hottest cross section.
† This value is the volumetric average temperature at the hottest cross section plus 18 °F to bound the effects of storage pad on the cask view factor. See Section A3.3.2.2.4 for discussion.
** This value is taken from Table A3.3-15.

TABLE A3.3-38
TEMPERATURES FOR VACUUM DRYING OPERATIONS WITH LOWER POISON PLATE CONDUCTIVITY

	Lower Conductivity Model Vacuum Drying		
Component	Time (hr	Maximum Temperature (°F)	Temperature Limit (°F)
Fuel Cladding	34	628	752
Fuel compartment	34	567	---
Basket Rails	34	409	---
Cask Inner Shell *	34	273	---
Shield Shell †	34	268	---
Radial Resin	34	249	300
Top Resin	34	<273 **	300
Lid Seal	34	<273 **	536
Vent and port Seal	34	<273 **	536

* The volumetric average temperature of the cask inner shell at the hottest cross section is 269°F.
† The volumetric average temperature of the shield shell at the hottest cross section is 262°F.
** This temperature is bounded by maximum temperature of the cask inner shell.



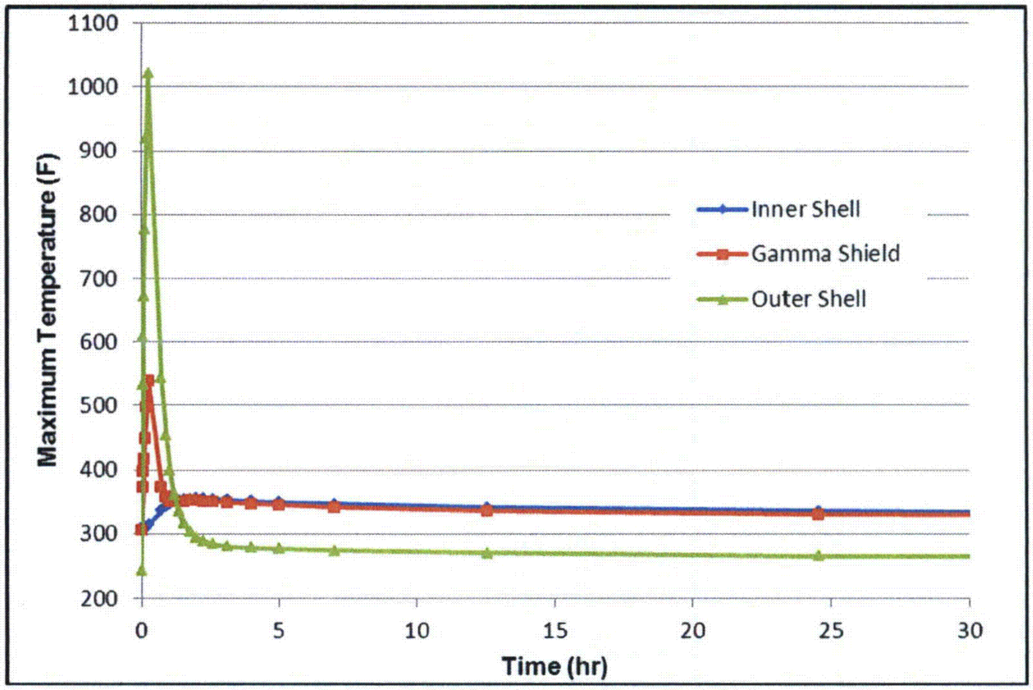


FIGURE A3.3-42
COMPONENT TIME-TEMPERATURE HISTORY FOR FIRE ACCIDENT WITH LOWER POISON PLATE CONDUCTIVITY

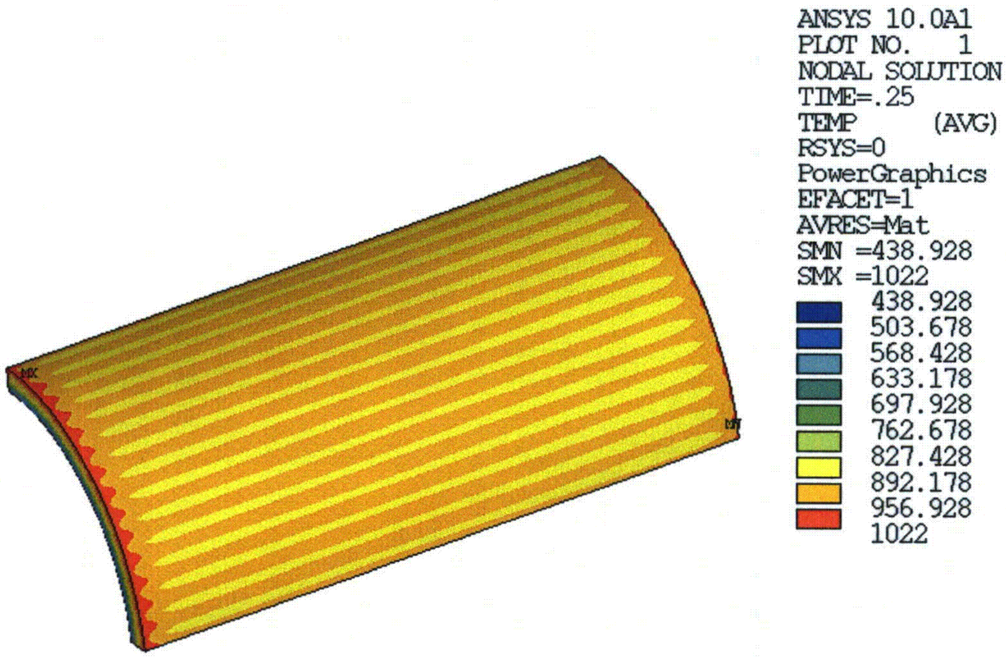


FIGURE A3.3-43
OUTER SHELL TEMPERATURE DISTRIBUTION AT THE END OF FIRE WITH LOWER POISON PLATE CONDUCTIVITY

ENCLOSURE 3

Summary Description of

Computer Files in Enclosure 5

Disk ID No. (size)	Discipline	System/Component	File Series (topics)	Number of files
(Enclosure 5) One Portable Hard Drive **Thermal Folder** (2.63 GB) (Part 1 of 3)	**Thermal**	**TN-40HT Off-Normal Storage Analysis**	**001-Normal-OffNormal – Directory**	
			1-TN40HT_S100A– **Folder** TN-40HT Thermal Evaluation for Off-Normal Storage, 100°F ambient with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	44
			2-cond_PC_A– **Folder** Post-processing run to determine the heat flow from the cask top toward the protective cover for Off-Normal Storage, 100°F ambient with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	3
(Enclosure 5) One Portable Hard Drive **Thermal Folder** (47.4 GB) (Part 2 of 3)		**TN-40HT Fire and Buried Cask Accident Analysis**	**002-Accident – Directory**	
			1-TN40HT_FA TN-40HT Fire Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	40
			2-TN40HT_FSA TN-40HT Post-Fire Accident Steady-State Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	39
			3-TN40HT_BA TN-40HT Buried Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	14
			4-Pix_FA Post-Processing to retrieve the Outer Shell temperature profile at the end of the fire for TN-40HT Fire Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	5
			5-PPT_FA Post-Processing to retrieve the maximum temperatures for TN-40HT Fire Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F to generate time temperature histories	4
			6-PP_BA Post-Processing to retrieve the maximum and average temperatures for TN-40HT Buried Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	3
			7-Tavg_FA Post-Processing to retrieve peak average temperatures for TN-40HT Buried Accident Transient Evaluation with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	3

Disk ID No. (size)	Discipline	System/Component	File Series (topics)	Number of files
			003-VacuumDrying – Directory	
(Enclosure 5) One Portable Hard Drive **Thermal Folder** (10.4 GB) (Part 3 of 3)	**Thermal**	**TN-40HT Vacuum Drying Analysis**	1-TN40HT_VA – **Folder** TN-40HT Thermal Evaluation for Vacuum Drying with reduced poison plate conductivity of 0.68 Btu/hr-in-°F	22

ENCLOSURE 4

PROPRIETARY AFFIDAVIT PURSUANT TO 10 CFR 2.390

2 Pages Follow

AFFIDAVIT PURSUANT
TO 10 CFR 2.390

Transnuclear, Inc.)
State of Maryland) SS.

County of Howard)

I, Jayant Bondre, depose and say that I am a Vice President of Transnuclear, Inc., duly authorized to execute this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding this information.

The information for which proprietary treatment is sought is contained in Enclosure 5 and is listed below:

- Computer files associated with the thermal analyses of the TN-40HT cask design

These documents have been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures utilized by Transnuclear, Inc. in designating information as a trade secret, privileged or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1) The information sought to be withheld from public disclosure are certain computer files associated with the TN-40HT spent fuel storage cask design analyses, which are owned and have been held in confidence by Transnuclear, Inc.,

2) The information is of a type customarily held in confidence by Transnuclear, Inc. and not customarily disclosed to the public. Transnuclear, Inc. has a rational basis for determining the types of information customarily held in confidence by it.

3) Public disclosure of the information is likely to cause substantial harm to the competitive position of Transnuclear, Inc. because the information consists of descriptions of the design of dry spent fuel storage systems, the application of which provide a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with Transnuclear, Inc., take marketing or other actions to improve their product's position or impair the position of Transnuclear, Inc.'s product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

Further the deponent sayeth not.

Jayant Bondre
Vice President, Transnuclear, Inc.

Subscribed and sworn to me before this 3rd day of May, 2012.

Notary Public

My Commission Expires 10 / 17 / 2015

ZORA M. DOUGHERTY
NOTARY PUBLIC
HOWARD COUNTY, MD
My Commission Expires 10-17-2015

(LABEL FOR PORTABLE HARD DRIVE)

~~WITHHOLD FROM PUBLIC DISCLOSURE UNDER 10 CFR 2.390~~

~~Proprietary~~

Transnuclear, Inc.

Enclosure 5 to L-PI-12-030

Certain computer input and output files that were used in the thermal analysis of the TN-40HT cask design