71-9293

TRANSNUCLEAR, INC.

January 12, 2001
E-18693

Mr. David Tiktinsky, Project Manager
Licensing Section
Spent Fuel Project Office
Division of Industrial and Medical Nuclear Safety
Office of Nuclear Material Safety and Safeguards
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Subject: Docket 71-9293, Request for Additional Information for the Model No. TN-68 Transport Package Application.

Reference: TN letter E-18618

Dear Mr. Tiktinsky:

Enclosed are 10 copies of revised (Rev 4) SAR pages which support the supplementary information provided in the referenced letter and a subsequent request for clarification of Table 1-2 information.

Please feel free to contact me with any other questions or comments.

Sincerely,

Michael Mason
Chief Engineer

cc: 972 File
Jerry Philobaum, EXELON Nuclear
Dave Foss, EXELON Nuclear

Attachments: Transport SAR pages 1-i, 1-7/8, Tables 1-1/1-2, Tables 1-3/1-4, 2-9/10 and 8-1/2

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TN-68 Transport SAR Revision 4 Pages

1-i (Table of Contents), 1-7/8, Table 1-1/Table1-2, Table1-3/Table 1-4
2-9/10
8-1/2

Form 5.4-1

Record of Review

(TN-68 Transport Safety Analysis Report)

Record of Review
Rev. 4

Thermal Analyst	____________	(list the chapters reviewed)
Structural Analyst	____________	(Chapters 2 & 8)
Nuclear Analyst	____________	(Chapter 1)
Project Engineer	____________	(All Chapters)
Chief Engineer	____________	(All Chapters)

TN 68 TRANSPORT PACKAGING

CHAPTER 1

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horizontal transport orientation to the vertical orientation using a crane and lift beam attached to the front trunnions. The rear trunnions pivot in the shipping frame as the cask is rotated.

The cask is brought into the spent fuel building. Access to the cask cavity and fuel basket is obtained by untorquing and removing the 48 closure lid bolts, and removing the lid using the lifting lugs provided. The cask is then lowered into the cask pit/spent fuel pool. Fuel assemblies are loaded into the 68 basket compartments

The lid is installed and the cavity is vented and drained. The cask is lifted above the water and some of the lid bolts are installed hand tight. Venting/draining may occur while lifting the cask out of the pool. The cask is moved from the cask pit/spent fuel pool to the decontamination area. The remaining lid bolts are installed. The cask cavity is then evacuated and dried by means of a vacuum system and then back filled with helium. The lid seals and penetration cover seals are leak tested. The external surface radiation levels are checked to assure that they are within limits.

1.2.3 Contents of Packaging

The contents of the TN-68 packaging are limited to the following.

- Fuel parameters
  - Fuel is limited to 68 unconsolidated intact GE BWR fuel assemblies with zircalloy cladding. An intact fuel assembly is a spent nuclear fuel assembly without known or suspected cladding defects greater than pinhole leak or hairline cracks and which can be handled by normal means. Partial fuel assemblies that is spent fuel assemblies from which fuel rods are missing, shall not be classified as intact fuel assemblies unless dummy fuel rods are used to displace an amount of water equal to that displaced by the original rod(s).
  - Fuel may be transported with or without channels. Nominal channel thicknesses up to 0.120 inches thick are acceptable for transport.
  - Permissible fuel assembly types are listed below (fuel designs may be C, D, or S lattice)

GE Type	Designation	# of Fueled Rods	Uranium Content (MTU/assembly)
7x7	2A	49	0.1977
7x7	2, 2B	49	0.1977
7x7	3, 3A, 3B	49	0.1896
8x8	4, 4A, 4B	63	0.1880
8x8	5, 6, 6B, 7, 7B	62	0.1876
8x8	8, 8B	62	0.1885
8x8	8, 8B, 9, 9B, 10	60	0.1824
9x9	11,13	74	0.1757
10x10	12	92	0.1857

- Fuel characteristics of each assembly type are provided in Table 6.2-1
- Provided all the requirements listed in this section are met, the bounding fuel characteristics are:

Characteristic	Parameter
Maximum Initial lattice-average enrichment	3.7%
Minimum Initial bundle average enrichment	3.3%
Maximum assembly average burnup	40,000 MWD/MTU
Minimum cooling time	10 years[1]
Maximum Heat Load	0.313 KW/assy.

Note 1: Fuel assemblies are categorized into three types, Type I, Type II and Type III. There are two basic loading configurations for the cask. The first configuration is a mixture of Type I and Type II fuel assemblies. Type I assemblies are the 40,000 MWD/MTU, 3.3% initial enrichment, 10 year cooled or equivalent, i.e. assemblies with various combinations of burnup, enrichment and cool time that provides an equivalent source term/dose rate as the bounding fuel assembly. Type I assemblies shall be placed into the interior compartments of the fuel basket as shown in Figure 5.3-3. Type II assemblies are those with various combinations of burnup, initial enrichment and cool time that provide a source term/dose rate that is less than the bounding fuel assembly. Type II assemblies may be placed in any basket fuel compartment. It may be necessary to place the "colder" fuel in the peripheral basket compartments to meet the external dose rate requirements. The other basic loading configuration is up to 68, Type III fuel assemblies. Type III assemblies are 40,000 MWT/MTU, 3.3% initial enrichment, 16 year cooled or equivalent, i.e. assemblies with various combinations of burnup, enrichment and cool time that provides an equivalent source term/dose rate. The loaded casks containing Type II and Type I or Type III assemblies must meet the following conditions:

- The maximum contents weight shall not exceed 75.6 kips. The total weight of the BWR fuel assemblies shall not exceed 47.9 kips.

- The total decay heat of the cavity contents shall not exceed 21.2 kW.

- Measured external radiation levels shall not exceed the requirements of 10 CFR 71.47. Measured surface contamination levels shall not exceed the requirements of 10 CFR 71.87(i).

- Tables 1-2, 1-3 and 1-4 provide the minimum cooling time required for various combinations of minimum initial enrichment and maximum burnup for Type I, Type II and Type III assemblies, respectively

TABLE 1-1

NOMINAL DIMENSIONS AND WEIGHTS OF THE TN-68 PACKAGING

Overall length (with impact limiters, in)	269.33
Overall length (without impact limiters, in)	197.25
Impact Limiter Outside diameter (in)	144
Outside diameter (without impact limiters, in)	98
Cavity diameter (in)	69.5
Cavity length (in)	178
Containment shell thickness (in)	1.5
Containment vessel length (in)	184
Body wall thickness (in)	7.5
Containment Lid thickness (in)	5
Overall Lid thickness (in)	9.5
Bottom thickness (in)	9.75
Resin and aluminum box thickness (in)	6
Outer shell thickness (in)	0.75
Overall basket length (in)	164

Weight of Fuel Assemblies	47.9	kips
Loaded Weight of TN-68 Cask (without impact limiters)	227.4	kips
Weight of Impact Limiters, Aluminum Spacer, and Tie-Rods	32.7	kips
Total Loaded Weight of TN-68 Packaging (w/o shipping frame)	260.1	kips

TABLE 1-2

COOLING TIME AS A FUNCTION OF MAXIMUM BURNUP AND MINIMUM INITIAL ENRICHMENT

TYPE I BWR FUEL

COOLING TIMES (YEARS)

Initial Enrichment	Burnup (GWd/MTU)											
(bundle ave %w)	15	20	30	32	33	34	35	36	37	38	39	40
1.0	10	10										
1.1	10	**10**										
1.2	10	10										
1.3	10	10										
1.4	10	10										
1.5	10	10	**10**	10	**11**	11	**11**					
1.6	10	10	10	10	10	11	11	11				
1.7	10	10	10	10	**10**	11	11	11	**12**			
1.8	10	10	10	10	10	11	11	11	**11**	**12**		
1.9	10	10	10	10	10	11	11	11	11	12		
2.0	10	10	10	10	10	**10**	11	11	**11**	12	**12**	
2.1	10	10	10	10	10	10	11	11	11	12	12	**12**
2.2	10	10	10	10	10	10	11	11	11	12	12	12
2.3	10	10	10	10	10	10	11	11	11	**11**	12	12
2.4	10	10	10	10	10	10	**10**	11	11	11	12	12
2.5	10	10	10	10	10	10	10	11	11	11	12	12
2.6	10	10	10	10	10	10	10	11	11	11	12	12
2.7	10	10	10	10	10	10	10	**10**	11	11	**11**	12
2.8	10	10	10	10	10	10	10	10	10	11	11	12
2.9	10	10	10	10	10	10	10	10	10	11	11	12
3.0	10	10	10	10	10	10	10	10	**10**	10	11	12
3.1	10	10	10	10	10	10	10	10	10	10	11	12
3.2	10	10	10	10	10	10	10	10	10	10	**10**	**11**
3.3	10	10	10	10	10	10	10	10	10	10	10	**10**
3.4	10	10	10	10	10	10	10	10	10	10	10	10
3.5	10	10	10	10	10	10	10	10	10	10	10	10
3.6	10	10	10	10	10	10	10	10	10	10	10	10
3.7	10	10	10	10	10	10	10	10	10	10	10	10

■ - not evaluated

Notes:

1. Total dose from gamma and neutron considered.
2. Cooling times in bold are cases actually run. Others are interpolated.

TABLE 1-3

COOLING TIME AS A FUNCTION OF MAXIMUM BURNUP AND MINIMUM INITIAL ENRICHMENT

TYPE II BWR FUEL

COOLING TIMES (YEARS)

Initial Enrichment	Burnup (GWd/MTU)											
(bundle ave %wt)	15	20	30	32	33	34	35	36	37	38	39	40
1.0	**18**	21										
1.1	**17**	20										
1.2	**17**	**20**										
1.3	**17**	20										
1.4	**17**	20										
1.5	**16**	19	**25**	26	**26**							
1.6	16	19	25	26	26							
1.7	16	19	25	**25**	26	**26**	27					
1.8	16	19	**24**	25	26	26	27	**27**				
1.9	16	19	24	25	25	26	27	27				
2.0	**16**	**18**	24	25	**25**	26	**26**	27	28			
2.1	15	18	**23**	25	25	26	26	27	**27**			
2.2	**15**	18	23	25	25	**25**	26	27	27			
2.3	**15**	18	23	**24**	25	25	26	**26**	27	27		
2.4	15	18	**22**	24	24	25	26	26	27	27		
2.5	15	**17**	22	24	24	25	**25**	26	**26**	**27**		
2.6	15	17	22	24	24	24	25	26	26	27		
2.7	15	17	22	24	**24**	24	25	26	26	**26**	27	**27**
2.8	**14**	17	22	23	24	24	25	**25**	26	26	**27**	27
2.9	**14**	17	22	**23**	23	24	**24**	25	26	26	27	27
3.0	**14**	17	**21**	23	23	**23**	24	25	**25**	26	27	27
3.1	**14**	17	21	23	23	23	24	25	25	**26**	27	27
3.2	**13**	**16**	21	23	23	23	24	**24**	25	25	26	27
3.3	**13**	16	**21**	23	**22**	23	**23**	24	25	25	26	**26**
3.4	13	16	21	23	22	23	23	24	25	**25**	26	26
3.5	13	16	21	**22**	22	**23**	23	24	25	25	26	26
3.6	13	**16**	**21**	21	22	22	23	**24**	25	25	26	26
3.7	**12**	15	20	21	**22**	22	**23**	24	**24**	25	**25**	26

■ - not evaluated

Notes:

1. Total dose from gamma and neutron considered.
2. Cooling times in bold are cases actually run. Others are interpolated.

TABLE 1-4

COOLING TIME AS A FUNCTION OF MAXIMUM BURNUP AND MINIMUM INITIAL ENRICHMENT

TYPE III BWR FUEL

COOLING TIMES (YEARS)

Initial Enrichment	Burnup (GWd/MTU)											
(bundle ave %w)	15	20	30	32	33	34	35	36	37	38	39	40
1.0	**10**	**11**										
1.1	10	11										
1.2	10	10										
1.3	10	10										
1.4	10	10										
1.5	10	**10**	**15**	16	**16**	17	17					
1.6	10	10	14	16	16	17	17	**17**				
1.7	10	10	14	**15**	16	16	17	17	17			
1.8	10	10	14	15	**15**	16	**16**	17	17	**18**		
1.9	10	10	**14**	15	15	16	16	17	17	18		
2.0	10	10	14	**15**	15	**16**	16	16	**17**	17	18	
2.1	10	10	14	15	15	15	16	16	16	17	**18**	18
2.2	10	10	**13**	14	**15**	15	**16**	16	16	17	17	18
2.3	10	10	13	14	15	15	16	**16**	16	**17**	17	18
2.4	10	10	13	14	15	**15**	15	16	16	17	17	**18**
2.5	10	10	**13**	14	14	15	**15**	16	**16**	**16**	17	18
2.6	10	10	13	14	**14**	15	15	16	16	16	**17**	17
2.7	10	10	13	14	14	15	15	15	16	16	17	17
2.8	10	10	13	**13**	14	**14**	15	**15**	16	16	**17**	17
2.9	10	10	**13**	13	14	14	15	15	**15**	16	16	**17**
3.0	10	10	12	13	**14**	14	**14**	15	15	**16**	16	17
3.1	10	10	12	13	14	14	14	15	15	15	**16**	16
3.2	10	10	12	13	14	14	14	**15**	15	15	16	16
3.3	10	10	**12**	13	13	**14**	14	14	**15**	15	16	**16**
3.4	10	10	12	13	13	13	14	14	15	15	16	16
3.5	10	10	12	**13**	13	13	14	14	14	**15**	15	16
3.6	10	10	12	12	13	13	14	**14**	14	15	15	15
3.7	10	10	**12**	12	**13**	13	**14**	14	14	15	**15**	15

■ - not evaluated

Notes:

1. Total dose from gamma and neutron considered.
2. Cooling times in bold are cases actually run. Others are interpolated

2.3 MECHANICAL PROPERTIES OF MATERIALS

2.3.1 Cask Material Properties

This section provides the mechanical properties of materials used in the structural evaluation of the TN-68 cask. Table 2-7 lists the materials selected, the applicable components, and the minimum yield, ultimate, and design stress values specified by the ASME Code, Section II, Part D(9). All values reported in Table 2-7 are for metal temperatures up to 100°F. For higher temperatures, the temperature dependency of the material properties is reported in Table 2-8.

Table 2-9 summarizes the thermal analysis results from Chapter 3. These results support the selection of cask body and basket component design temperatures for structural analysis purposes.

2.3.2 Basket Material Properties

The material properties of the 304 stainless steel plates are taken from the ASME Code, Section II, Part D(9). The material properties of the aluminum alloy (6061-T6) are also taken from the ASME Code. These properties are listed with specific references in Tables 2-10 and 2-11.

2.3.3 Impact Limiter Material Properties

Mechanical properties of the energy absorbing wood and wood adhesive used in the impact limiters are are both unique and specific. They are specified in Appendix 2.10.8 (Table 2.10.8-1).

2.3.4 Fracture Toughness Requirements

The cask body and closure lid material is a ferritic steel and is therefore subject to fracture toughness requirements in order to assure ductile behavior at the lowest service temperature (LST) of –20°F. The containment boundary materials (including lid bolts) are selected to meet the fracture toughness criteria of ASME Code Section III, Division 3, Subsection WB(4),. Transnuclear has also performed a fracture mechanics evaluation of the TN-68 package gamma shield based on a service temperature of -20°F. Detail of the fracture toughness evaluations of the containment boundary materials, lid bolt material, and gamma shield materials are specified in Appendix 2.10.4.

The impact limiter attachment bolt material will be tested to show that the Charpy fracture toughness is at least 20 ft-lbs at -20°F. The tie rod material will be tested to show that the Charpy fracture toughness is at least 35 ft-lbs at -20°F.

2.4 GENERAL STANDARDS FOR ALL PACKAGES

The TN-68 is designed to comply with the general standards for all packages specified by 10CFR71.43.

2.4.1 Minimum Package Size

The overall package dimensions of 269.33 inches long and 144 inches in diameter exceed the minimum dimension requirement of 10 cm (4 inches).

2.4.2 Tamper-proof Feature

The only access path into the package is through the closure lid and associated closure bolts. During transport the top (front) impact limiter entirely covers and prevents access to the cask closure lid and the vent and access port penetrations in the lid. A security wire seal is installed in the upper impact limiter attachment tierod prior to each shipment. The presence of this seal demonstrates that unauthorized entry into the package has not occurred.

2.4.3 Positive Closure

Positive fastening of all access openings through the containment vessel is accomplished by bolted closures which preclude unintentional opening. In addition, the presence of the impact limiters and security seals described in Section 2.4.2 provide further protection against unintentional opening.

2.4.4 Chemical and Galvanic Reactions

The materials of the TN-68 cask have been reviewed to determine whether chemical, galvanic or other reactions among the materials, contents and environment might occur during any phase of loading, unloading, handling or transport. This review is summarized below:

The TN-68 cask components are exposed to the following environments:

- During loading and unloading, the casks are submerged in pool water. For BWR plants the pool water is deionized. This affects the interior and exterior surfaces of the cask body, lid and the basket. The casks are only kept in the spent fuel pool for a short period of time, typically about 6 hours to load or unload fuel, 1 - 2 hours to drain, and another 8 - 10 hours to completely dry, evacuate and backfill the cask with helium.

- During handling and transportation, the exterior of the cask is exposed to normal environmental conditions of temperature, rain, snow, etc. All of the exterior surfaces with the exception of stainless steel components are protected from environmental exposure by a polyamide enamel epoxy coating. The paint is touched up periodically if there are any areas which peel or otherwise deteriorate. Therefore, the cask exterior is protected from chemical, galvanic or other reactions during storage.

CHAPTER 8

ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

The following reviews, inspections, and tests shall be performed on the TN-68 packaging prior to initial transport. Many of these tests will be performed at the Fabricator's facility prior to delivery of the cask to the utility for use. Tests will be performed in accordance with written procedures approved by Transnuclear Inc.

8.1.1 Visual Inspection

Visual inspections are performed at the Fabricator's facility to ensure that the packaging conforms to the drawings and specifications. The visual inspection includes verifying that all specified coatings are applied and the packaging is clean and free of cracks, pinholes, uncontrolled voids or other defects that could significantly reduce its effectiveness. Visual inspection is also performed to verify that the packaging has been fabricated and assembled in accordance with the drawings and other requirements specified in the SAR. Weld inspection is performed in accordance with the applicable ASME code sections. Dimensions and tolerances shown on the drawings provided in Chapter 1 are confirmed by measurements. Prior to shipping, the packaging will be inspected to ensure that it is in good physical condition. This inspection shall include verification that all accessible cask surfaces are free of grease, oil or other contaminants, and that all cask components are in an acceptable condition for use. The sealing surfaces on the flange, lid and covers are inspected to ensure that there are no gouges, cracks or scratches that could result in an unacceptable leakage.

8.1.2 Structural and Pressure Tests

The structural analyses performed on the packaging are presented in Chapter 2. To ensure that the packaging can perform its design function, the structural materials are chemically and physically tested to confirm that the required properties are met. All welding is performed using qualified processes and qualified personnel, according to the ASME Boiler and the Pressure Vessel Code(1). Base materials and welds are examined in accordance with the ASME Boiler and Pressure Vessel code requirements. NDE requirements for welds are specified on the drawings provided in Chapter 1. All NDE is performed in accordance with written and approved procedures. The inspection personnel are qualified in accordance with SNT-TC-1A(2).

The confinement welds are designed, fabricated, tested and inspected, in accordance with ASME B&PV Code Subsection NB. Exceptions to the code taken regarding the containment vessel are described in Chapter 2, Section 2.11. The basket is designed, fabricated, and inspected in accordance with the ASME B&PV Code Subsection NG. Exceptions to the code taken regarding the basket are described in Section 2.1.2.2. Welds of the noncontainment structure are inspected as per the NDE acceptance criteria of ASME B&PV Code, Subsection NF.

The impact limiter attachment bolt material shall be tested to show the Charpy fracture toughness is at least 20 ft-lbs at -20°F. The tierod material shall be tested to show the Charpy fracture toughness is as least 35 ft-lbs at -20°F.

Pressure Tests

A pressure test is performed on the packaging assembly (containment vessel installed in the gamma shield shell) at a pressure of 125 psig. This is well above 1.5 times the maximum normal operating pressure of 18.5 psig. The test pressure is held for a minimum of 10 minutes. The test is performed in accordance with ASME B&PV Code, Section III, Subsection NB, Paragraph NB-6200 or NB-6300. The containment vessel is installed in the gamma shield shell during testing. All visible joints/surfaces are visually examined for possible leakage after application of the pressure. Temporary gaskets and seals may be used in place of the metallic seals during the test.

In addition, a bubble leak test is performed at a pressure equal to or greater than 4.5 psig, on the resin enclosure. The purpose of this test is to identify any potential leak passages in the enclosure welds. The bubble leak test pressure is set at 1.5 times the relief valve set pressure.

Load Tests

The lifting trunnions are fabricated and tested in accordance with ANSI N14.6[3] and are designed for nonredundant (single failure proof) lifting. A load test of three times the design lift load is applied to the trunnions for a period of ten minutes, to ensure that the trunnions can perform satisfactorily.

A force equal to 1.5 times the impact limiter weight will be applied to the lifting lugs of each limiter for a period of ten (10) minutes. At the conclusion of the test, the impact limiter lifting lugs (including welds) will be:

a) Visually examined for defects and permanent deformations.
b) Examined by the magnetic particle method for defects. Acceptance Standards will be in accordance with Article NF-5340 of Section III of the ASME Boiler and Pressure Vessel Code.

8.1.3 Leak Tests

Leakage tests are performed on the containment seals at the Fabricator's facility. These tests are usually performed using the helium mass spectrometer method. Alternative methods are acceptable, provided that the required sensitivity is achieved. The leak test is performed in accordance with ANSI N14.5[4]. The personnel performing the leakage test are qualified in accordance with SNT-TC-1A[2].

The permissible leakage rate for the containment boundary is less than or equal to 1×10^{-5} ref cm^3/sec. The sensitivity of the leakage test procedure is at least 5×10^{-6} ref cm^3/sec.