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CHAPTER 1

GENERAL DESCRIPTION

This Safety Analysis Report (SAR) addresses the safety related aspects of storing spent fuel in TN-68 dry transport/storage casks. The format follows the guidance provided in NRC Regulatory Guide 3.61(1). The report is intended for review by the NRC under 10CFR72(2). A second SAR will be submitted to address the safety related aspects of transporting spent fuel in TN-68 casks in accordance with 10CFR71(3).

The TN-68 dry transport/storage cask provides confinement, shielding, criticality control and passive heat removal independent of any other facility structures or components. The cask also maintains structural integrity of the fuel during storage.

It is intended that a Certificate of Compliance under the requirements of 10CFR72 Subpart L be issued such that the casks can be used for the storage of spent fuel in an independent spent fuel storage installation (ISFSI) at power reactor sites under the conditions of a general license in accordance with 10CFR72 Subpart K.

1.1 Introduction

The TN-68 cask accommodates 68 BWR fuel assemblies with or without channels. It consists of the following components in its storage configuration:

- A basket assembly which locates and supports the fuel assemblies, transfers heat to the cask body wall, and provides neutron absorption to satisfy nuclear criticality requirements.

- A confinement vessel including a closure lid and seals which provides radioactive material confinement and a cavity with an inert gas atmosphere.

- Gamma shielding surrounding the confinement vessel.

- Radial neutron shielding surrounding the gamma shield which provides additional radiation shielding. This neutron shielding is enclosed in an outer steel shell.

- A top neutron shield which rests on the cask lid and provides additional neutron shielding.

- An overpressure system which monitors the pressure between the cask closure seals and provides a positive pressure differential between the seals.

- A protective cover which provides weather protection for the closure lid, top neutron shield and overpressure system.

- Sets of upper and lower trunnions which provide support, lifting and rotation capability for the cask.

The type of fuel to be stored in the TN-68 cask is light water reactor (LWR) fuel of the Boiling Water Reactor (BWR) type. The maximum allowable initial lattice-average enrichment varies from 3.7 to 4.7 wt% U235 depending on the B10 areal density in the basket neutron absorber plates. The maximum bundle average burnup, maximum decay heat, and minimum cooling time are 40 GWd/MTU, 0.312 kW/assembly, and 10 years for 7x7 fuel, 60 GWd/MTU, 0.441 kW/assembly, and 7 years for all other fuel. The cask is designed for a maximum heat load of 30 kW. Damaged fuel that can be handled by normal means may be stored in eight peripheral compartments fitted with damaged fuel end caps designed to retain gross fragments of fuel within the compartment.

The fuel which may be stored within the TN-68 cask is determined from Table 2.1-4 and Figure 2.1-4.

The casks are intended for storage on a reinforced concrete pad at a nuclear power plant.

1.2 General Description of the TN-68

1.2.1 Cask Characteristics

Each storage cask consists of a fuel basket, a cask body (shell, bottom and lid), a protective cover, an overpressure system, four trunnions, penetrations with bolted and sealed covers for leak detection and venting, closure bolts and locating pins.

A set of reference drawings is presented in Section 1.5. The casks are self-supporting cylindrical vessels. Dimensions and the estimated weight of the cask are shown in Table 1.2-1. The materials used to fabricate the cask are shown in the Parts List on Drawing 972-70-2. Where more than one material has been specified for a component, the most limiting properties are used in the analyses in the subsequent chapters of this SAR.

The confinement boundary components are shown in Figure 1.2-1. The confinement vessel for the TN-68 cask consists of: an inner shell (1) which is a welded, low alloy steel cylinder with an integrally-welded, low alloy steel bottom closure; a welded flange forging (3); a flanged and bolted low alloy steel lid with bolts and metallic seals (2); and vent and drain covers with bolts and metallic seals (4 and 5). The overall confinement vessel length is 184 in. with a wall thickness of 1.5 in. The cylindrical cask cavity has a diameter of 69.5 in. and a length of 178 in.

There are two penetrations through the confinement vessel, both in the lid: one is for draining and the other is for venting. A double-seal mechanical closure is provided for each penetration. The confinement lid is 5 in. thick and is fastened to the body by 48 bolts. Double metallic o-ring seals with interspace leakage monitoring are provided for the lid closure. To preclude air in-leakage, the cask cavity is pressurized above atmospheric pressure with helium.

The interspace between the metallic seals is connected to an overpressure tank and a pressure monitoring system. The overpressure tank and the interspace between the metallic seals are pressurized with helium to a higher level than the cavity so that any seal leakage would be into rather than out of the cavity. A decrease in the pressure of the monitoring system would be signaled by a pressure transducer/switch wired to a monitoring/alarm panel.

For weather protection, a torispherical weather cover with an elastomeric seal is provided above the lid.

A gamma shield is provided around the walls and bottom of the confinement vessel by an independent shell and bottom plate of carbon steel which is welded to the closure flange. The gamma shield completely surrounds the confinement vessel inner shell and bottom closure. Gamma shielding is also welded to the inside of the confinement lid.

Neutron shielding is provided by a borated polyester resin compound surrounding the body. The resin compound is cast into long, slender aluminum containers. The array of resin-filled containers is enclosed within a smooth outer steel shell constructed of two half cylinders. In addition to serving as resin containers, the aluminum provides a conduction path for heat transfer from the cask body to the outer shell. A pressure relief valve is mounted on the top of the resin enclosure for venting pressure due to heating of the resin and entrapped air after fuel loading.

A 4.0 inch disc of polypropylene is attached to the cask lid to provide neutron shielding during storage.

A shear key is welded to the inner wall of the confinement vessel to prevent the basket from rotating during normal operations. Similarly, a hold down fixture is installed above the basket after fuel loading is complete to prevent the basket from moving axially during normal handling.

The basket structure consists of an assembly of stainless steel cells joined by a proprietary fusion welding process to 1.75 in. wide stainless steel plates. Above and below the plates are slotted borated aluminum or boron carbide/aluminum metal matrix composite plates (neutron poison plates) which form an egg-crate structure. The poison plates provide the necessary criticality control and provide the heat conduction paths from the fuel assemblies to the cask cavity wall. This method of construction forms a very strong honeycomb-like structure of cell liners which provide compartments for 68 fuel assemblies. The minimum open dimension of each cell is 6.0 in. x 6.0 in. which provides clearance around the fuel assemblies. The overall basket length (164 in.) is less than the cask cavity length to allow for thermal expansion and fuel assembly handling.

Eight peripheral compartments in the basket may be outfitted to accept damaged fuel. The outfitting consists of an extension welded to the top of the fuel compartment, and end caps that slide into these compartments above and below the fuel.

The cask cavity surfaces are uncoated, but are protected by the inert gas environment inside the cask during storage. The external surfaces of the cask are painted for ease of decontamination and corrosion protection.

A stainless steel overlay is applied to the o-ring seating surfaces on the body and lid for corrosion protection.

Four trunnions are attached to the cask body for lifting and rotation of the cask. Two of the trunnions are located near the top of the body and two near the bottom. The upper trunnions are bolted to the gamma shielding and sized for single failure proof lifting. It is not intended to remove the upper trunnions during storage. The lower trunnions are welded to the gamma shielding and may be used for rotating the cask between vertical and horizontal positions.

Threaded holes are provided in the lid and top neutron shield for attachment of component lifting devices. These are used for attachment points for sling systems or other lifting tools.

Impact limiters are not used during storage.

During dry storage of the spent fuel, no active systems are required for the removal and dissipation of the decay heat from the fuel. The TN-68 cask is designed to transfer the decay heat from the fuel to the basket, from the basket to the cask body and ultimately to the surrounding air by radiation and natural convection. The cask is capable of removing 30 kW of decay heat without external fins, thus providing a smooth outer surface for ease of decontamination.

Each cask is identified and marked with the empty weight in accordance with Section 9.3.

1.2.2 Operational Features

1.2.2.1 General Features

The TN-68 cask is designed to safely store 68 BWR fuel assemblies with or without channels. The TN-68 cask is designed to maintain the fuel cladding temperature below 400° C during storage and short term fuel loading operations. It is also designed to maintain the fuel cladding temperature below 570° C during short-term accident and off-normal conditions.

The shielding features of the TN-68 cask are designed to maintain the maximum combined gamma and neutron dose rate at accessible surfaces to less than 650 mrem/hr under normal operating conditions.

The criticality control features of the TN-68 cask are designed to maintain the neutron multiplication factor k-effective less than the upper subcritical limit equal to 0.95 minus benchmarking bias and modeling bias under all conditions.

In order to prevent potential human error, prior to loading the first cask at a utility, a dry run will be performed. This dry run will be used to demonstrate that the loading and unloading processes are sound and the operations personnel are adequately trained. The loading and unloading operations which have an impact on safety will be verified and recorded. These operations include loading and identifying each fuel assembly, ensuring that the fuel assembly meets the fuel acceptance criteria, torquing of the lid and cover bolts, drying, leak testing, backfilling and pressurizing the cask and pressure monitoring system, gas sampling and flooding the cask.

1.2.2.2 Sequence of Operations

The sequence of operations to be performed in loading fuel into the TN-68 storage cask is presented in Chapter 8. These operations are summarized below.

The cask is designed to be loaded in the spent fuel pool or cask pit. Upon arrival, the empty cask is inspected, and the protective cover, overpressure tank, top neutron shield and lid are removed. The cask is then lowered into the cask pit/spent fuel pool. Fuel assemblies may be installed in each of the 68 basket compartments. If the basket is outfitted for damaged fuel, bottom end caps are installed in the compartments that will be loaded with damaged fuel, then top end caps are installed after the fuel is inserted.

The lid is installed and the cavity is vented and drained. While checking for appropriate surface radiation levels, 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 top neutron shield is installed on the lid. The external surface radiation levels are checked to assure that they are within acceptable limits.

The overpressure system is installed and the overpressure system and seal interspace is pressurized with helium. The protective cover may be installed either in the decontamination area or at the ISFSI.

The cask is transferred to the ISFSI by a transport vehicle. The cask is set in its storage position, and connected to the site storage cask monitoring system. A channel operational test to verify proper functioning of the pressure switch/transducer is performed.

To unload the cask, these steps are performed in reverse. The cask is brought back to the reactor building. The protective cover, pressure monitoring system, overpressure tank and top neutron shield are removed. Prior to opening the cask, the cavity gas is sampled through the vent or drain port. The cavity is depressurized and the cask is lowered into the spent fuel pool. The cask is slowly filled with pool water or demineralized water through the vent or drain port. The cask is vented during this process. The water/steam mixture from the vent line may contain some radioactive gas. If the gas is radioactive, protective measures shall be imposed in accordance with ALARA such as routing the gas through the plant gaseous radwaste system. Pressure and temperature should be monitored during this operation. When the cask is full of water, the lid is removed and the fuel is accessible for unloading.

1.2.2.3 Identification of Subjects for Safety and Reliability Analysis

1.2.2.3.1 Criticality Prevention

Criticality is controlled by utilizing neutron absorption materials in the fuel basket. These features are only necessary during the loading and unloading operations that occur in the cask loading pool (underwater). During storage, with the cavity dry and sealed from the environment, criticality control measures within the installation are not necessary because of the low reactivity of the fuel in the dry cask and the assurance that no water can enter the cask during storage.

1.2.2.3.2 Chemical Safety

There are no chemical safety hazards associated with operations of the TN-68 dry storage cask.

1.2.2.3.3 Operation Shutdown Modes

The TN-68 dry storage cask is a totally passive system so that consideration of operation shutdown modes is unnecessary.

1.2.2.3.4 Instrumentation

The only instrumentation pertinent to storage is the pressure transducers/switches which monitor the cask seals for leakage. The transducers/switches monitor the pressure in an interspace between the inner and outer seals to provide an indication of seal failure before any release is possible.

An initial functional check of the transducers/switches is performed at the manufacturer's plant and a channel operational test is performed at the commencement of storage. Two identical transducers/switches are provided to assure a functional system through redundancy.

1.2.2.3.5 Maintenance Techniques

Because of their passive nature, the storage casks will require little, if any, maintenance over their lifetime. Typical maintenance would be limited to external paint touch-up and repressurizing the overpressure system. No special maintenance techniques are necessary.

1.2.3 Cask Contents

The TN-68 cask is designed to store up to 68 Boiling Water Reactor (BWR) fuel assemblies with or without fuel channels. The maximum allowable initial lattice-average enrichment varies from 3.7 to 4.7 wt% U235 depending on the B10 areal density in the basket neutron absorber plates. The maximum bundle average burnup, maximum decay heat, and minimum cooling time are 40 GWd/MTU, 0.312 kW/assembly, and 10 years for 7x7 fuel, 60 GWd/MTU, 0.441 kW/assembly, and 7 years for all other fuel. The cask is designed for a maximum heat load of 30 kW.

In addition to satisfying these limits, the fuel to be stored must also meet the fuel qualification requirements developed in Chapter 5. This assures that the radioactive source for shielding and confinement is bounded by the design basis fuel assembly, which is an 8x8 lattice with 63 fuel rods and with burnup, bundle average enrichment, and cooling time of 48 GWd/MTU, 2.6 wt % U235, and 7 years, respectively.

Damaged fuel that can be handled by normal means may be stored in eight peripheral compartments fitted with damaged fuel end caps designed to retain gross fragments of fuel within the compartment. A description of the fuel assemblies is provided in Section 2.1.

The quantity and type of radionuclides in the spent fuel assemblies are described and tabulated in Chapter 5. Chapter 6 covers the criticality safety of the TN-68 cask and its contents, listing material densities, moderator ratios, and geometric configurations.

1.3 Identification of Agents and Contractors

Transnuclear, Inc., (TN), provides the design, analysis, licensing support and quality assurance for the TN-68 cask. Fabrication of the cask is done by one or more qualified fabricators under TN's quality assurance program. Personnel are trained and qualified in accordance with industry standards such as SNT-TC-1A for non-destructive testing and the ASME code, Section IX for welding. TN's quality assurance program is described in Chapter 13. This program is written to satisfy the requirements of 10 CFR 72, Subpart G and covers control of design, procurement, fabrication, inspection, testing, operations and corrective action. Experienced TN operations personnel provide training to utility personnel prior to first use of the cask and prepare generic operating procedures.

The construction of the ISFSI (other than the casks) is performed by others under the direction of the utility. Cask operations and maintenance is performed by utility personnel. Decommissioning activities will be performed by utility personnel in accordance with site procedures.

Managerial and administrative controls which are used to ensure safe operation of the casks are provided by the host utility.

Modifications to the TN-68 cask design, when required, may not be performed without the concurrence of Transnuclear. The host utility may make changes to the cask as specified in 10CRF72.48, as described in the Safety Analysis Report or changes in the procedures described in the Safety Analysis Report or conduct tests or experiments not described in the Safety Analysis Report, unless the proposed change, test or experiment involves a change in the license conditions incorporated in the license, an unreviewed safety question, a significant increase in occupational exposure or a significant unreviewed environmental impact.

Transnuclear, Inc. provides specialized services for the nuclear fuel cycle that support transportation, storage and handling of spent nuclear fuel, radioactive waste and other radioactive materials. Transnuclear was incorporated in the state of New York in 1965.

Transnuclear, Inc. has been involved in the design, analysis, fabrication, testing, certification and operation of packagings for spent fuel, radioactive waste, and other radioactive materials for over three decades. Transnuclear, Inc. was granted a Certificate of Compliance under 10 CFR 72 Subpart L for the TN-24 storage cask. Transnuclear, Inc. also developed the TN-40 dry storage cask for use at Northern States Power Prairie Island Nuclear Plant and the TN-32 dry storage cask for use at Virginia Power's Surry Power Station and North Anna Power Station.

Transnuclear, Inc also maintains an NRC Quality Assurance Program Approval for Radioactive Material Transportation Packages.

1.4 Generic Cask Arrays

The installation for storing spent fuel may be designed to include one or more TN-68 casks. The casks will be stored on a concrete slab in a free standing, vertical orientation. Typically, one, two or three concrete pads are utilized at an ISFSI with each pad containing a 2 by xx array of casks. One possible configuration for a dry storage installation is shown in Figure 1.4-1. Fourteen foot spacing is assumed between casks for the thermal analysis.

1.5 Supplemental Data

The following Transnuclear Drawings are enclosed:

1. TN-68 Dry Storage Cask, General Arrangement, Drawing No. 972-70-1

2. TN-68 Dry Storage Cask, General Arrangement Cross Section & Details, Drawing No. 972-70-2

3. TN-68 Dry Storage Cask, Lid Assembly & Details, Drawing No. 972-70-3

4. TN-68 Dry Storage Cask, Basket, General Arrangement, Drawing No. 972-70-4

5. TN-68 Dry Storage Cask, Basket, Typical Cross Section, Drawing No. 972-70-5

6. TN-68 Dry Storage Cask, Pressure Monitoring System, Drawing No. 972-70-6

7. TN-68 Dry Storage Cask, Damaged Fuel Assembly, Drawing No. 972-70-7

8. TN-68 Dry Storage Cask, Damaged Fuel Top & Bottom Caps, Drawing No. 972-70-8

1.6 References

1. US Nuclear Regulatory Commission, Regulatory Guide 3.61, Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask, February, 1989

2. 10CFR72, Rules and Regulations, Title 10, Chapter 1, Code of Federal Regulations - Energy, U.S. Nuclear Regulatory Commission, Washington, D.C., "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"

3. 10CFR71, Rules and Regulations, Title 10, Chapter 1, Code of Federal Regulations - Energy, U.S. Nuclear Regulatory Commission, Washington, D.C., "Packaging and Transportation of Radioactive Material"

TABLE 1.2-1

NOMINAL DIMENSIONS AND WEIGHT OF THE TN-68 CASK

Overall length (with protective cover, in)	215
Outside diameter (in)	98
Cavity diameter (in)	69.5
Cavity length (in)	178
Confinement shell thickness (in)	1.5
Confinement vessel length (in)	189
Body wall thickness (in)	7.5
Confinement 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
Top neutron shield thickness (in)	4
Protective cover thickness (in)	.25

Nominal Cask weight:

Loaded on storage pad (tons)	114.5

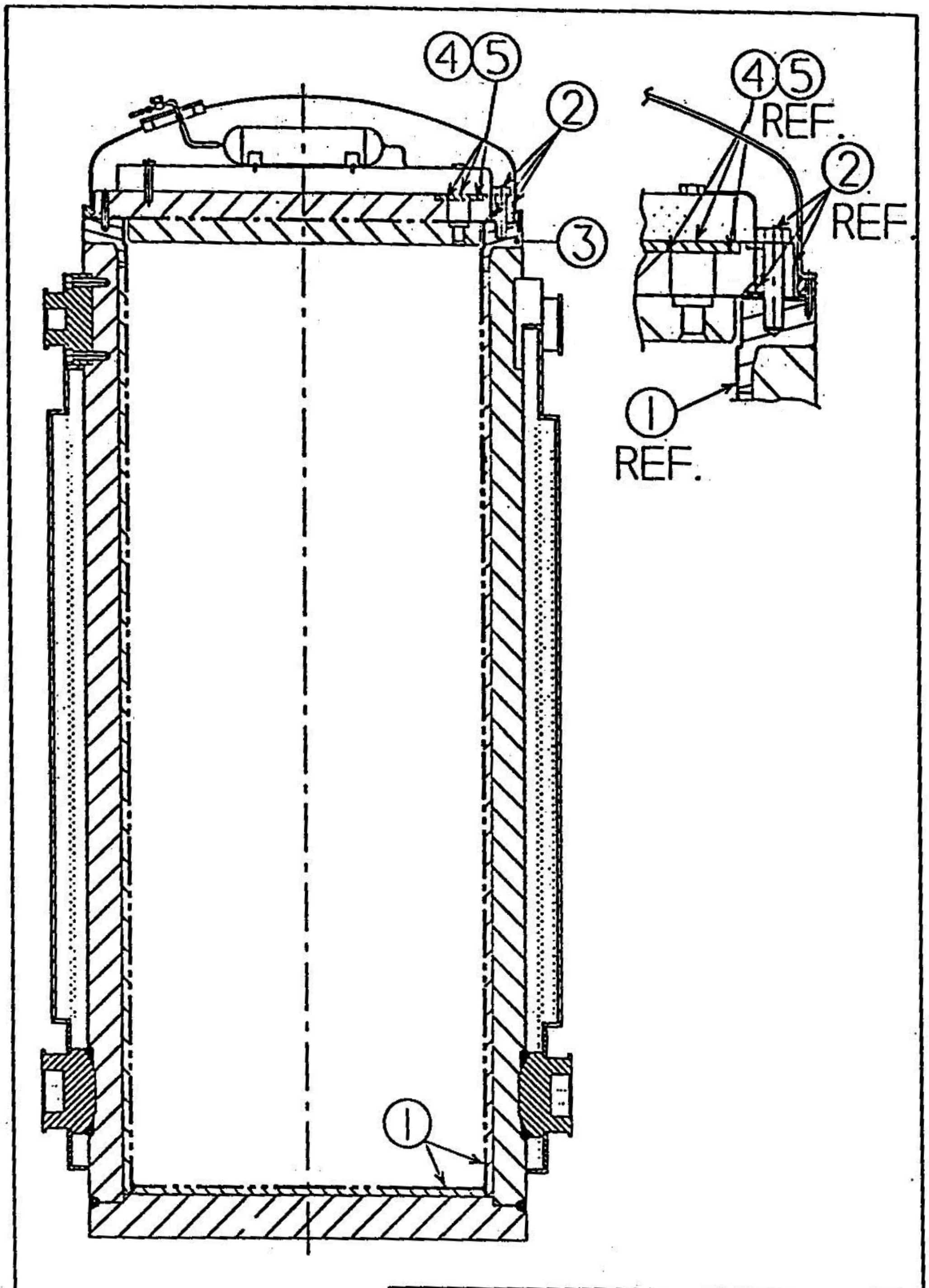


FIGURE 1.2-1
TN-68 CONFINEMENT
BOUNDARY COMPONENTS

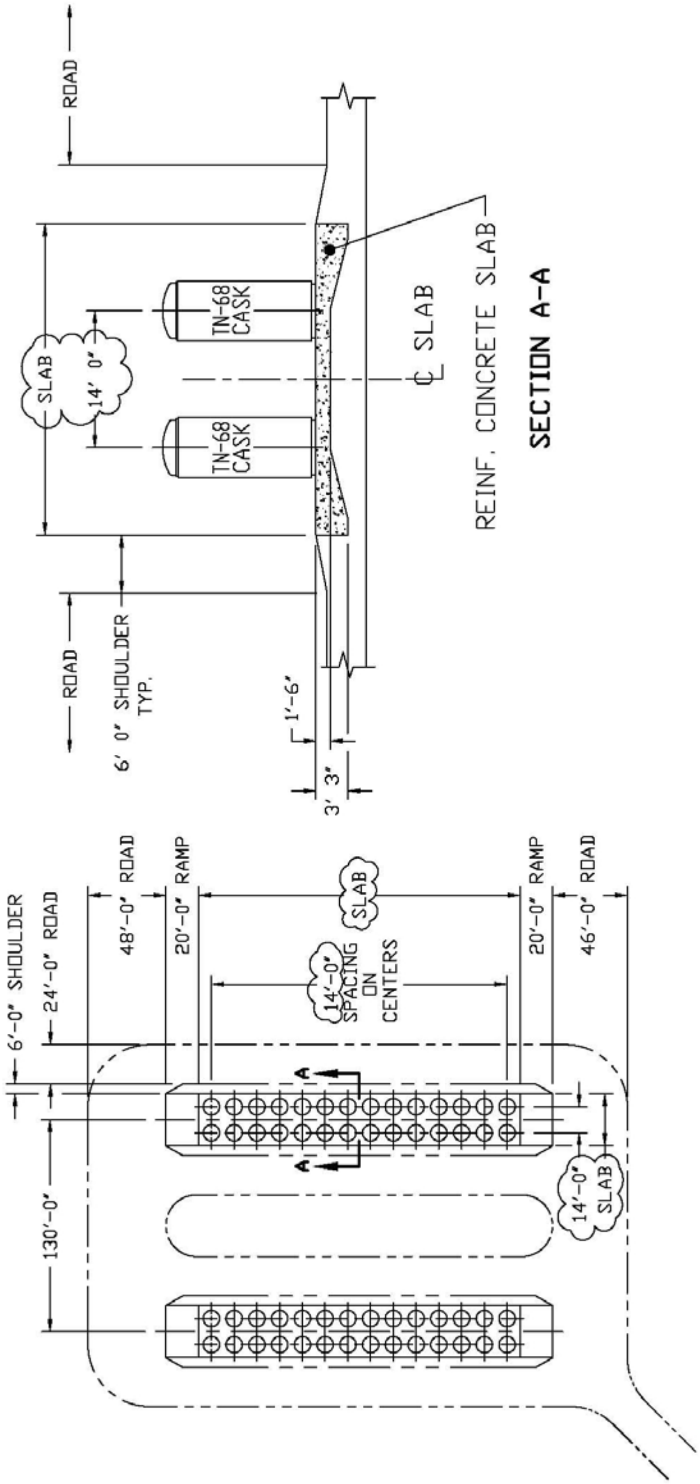
FIGURE 1.2-1 (Continued)

1. Figure not to scale. Features exaggerated for clarity.
2. Phantom line (--- - --- -) indicates confinement boundary.
3. Confinement boundary components are listed below:

    1. Cask body inner shell
    2. Lid assembly outer plate, closure bolts and inner o-ring
    3. Bolting flange
    4. Vent port cover plate, bolts and seals
    5. Drain port cover plate, bolts and seals

Figure 1.4-1

Typical ISFSI Vertical Storage



[Drawings 972-70-1, 972-70-3, 972-70-4, and 972-70-6 are unchanged from TN-68 FSAR rev 2]

Figure Withheld Under 10 CFR 2.390

TRANSNUCLEAR, INC.			
TN-68 DRY STORAGE CASK GENERAL ARRANGEMENT			
SAR			
NONE SCALE	B SIZE	972-70-1 DWG. NO.	6 REV.

Figure Withheld Under 10 CFR 2.390

11A	TRANSNUCLEAR HAWTHORNE, N.Y.		
TN-68 DRY STORAGE CASK GENERAL ARRANGEMENT CROSS SECTION & DETAILS			
11A	72-1027 AMENDMENT 1		
NONE SCALE	B SIZE	972-70-2 DWG. NO.	11A REV.

Figure Withheld Under 10 CFR 2.390

NO.	DATE	REVISIONS	DWN.	CHKD.	M.D.		Q/A	PROJ.
[illegible]	[illegible]	[illegible]	[illegible]	P.S.	P.S.		R.F.	W.B.
3	[illegible]	SEE DCN 972-59	J.T.G.	P.S.	P.S.		W.R.S.	T.J.N.
2	[illegible]	SEE DCN 972-33	J.T.G.	T.J.N.	P.S.		R.F.	T.J.N.
1	[illegible]	SEE DCN 972-12	J.T.G.	P.S.	P.S.		R.F.	T.J.N.

APPROVALS	DATE	
PROJ. T.J.N.	[illegible]	TRANSNUCLEAR, INC. HAWTHORNE, N.Y.
Q/A W.R.S.	[illegible]	TN-68 DRY STORAGE CASK
		LID ASSEMBLY & DETAILS
MECH. DES. P.S.	[illegible]	SAR
CHKD. BY T.J.N.	[illegible]	
DWN. BY J.T.G.	[illegible]	SCALE: NONE; SIZE: B; DWG. NO.: 972-70-3; REV.: 7

Figure Withheld Under 10 CFR 2.390

TRANSNUCLEAR, INC.

TN-68 DRY STORAGE CASK
BASKET
GENERAL ARRANGEMENT

SAR

SCALE	SIZE	DWG. NO.	REV.
NONE	B	972-70-4	6

Figure Withheld Under 10 CFR 2.390

5A TRANSNUCLEAR HAWTHORNE, N.Y.			
TN-68 DRY STORAGE CASK BASKET TYPICAL CROSS SECTION			
5A 72-1027 AMENDMENT 1			
NONE SCALE	B SIZE	972-70-5 DWG. NO.	5A REV.

Figure Withheld Under 10 CFR 2.390

NO.	DATE	REVISIONS	DWN.	CHKD.	[illegible]	[illegible]	[illegible]	PROJ.
[illegible]	[illegible]	SEE DCN 972-60	JTG	[illegible]	PS		VRS	TJN
1	[illegible]	SEE DCN 972-49	JTG	PS	PS		VRS	TJN

APPROVALS	DATE
TJN	SEPT.
VRS	SEPT.
PS	SEPT.
TJN	SEPT.
JTG	SEPT.

TRANSNUCLEAR INC.

TN-68 DRY STORAGE CASK

PRESSURE MONITORING SYSTEM

SAR

SCALE	SIZE	DWG. NO.	REV.
NONE	B	972-70-6	3

Figure Withheld Under 10 CFR 2.390

URE TION	DRAWING OR PART NUMBER	MATERIAL SPECIFICATION	CODE JURISDICTION	QUALITY CATEGORY
		SA240 TYPE 304	NC	A

PARTS LIST

APPROVALS	DATE
PROJ	
Q/A	
/T	
ECH DES	
HK'D BY	
'N BY	

TRANSNUCLEAR

HAWTHORNE, N.Y. 10532

TN-68 DRY STORAGE CASK DAMAGED FUEL ASSEMBLY

72-1027 AMENDMENT 1

SCALE	SIZE	DRAWING No.	REV
NONE	B	972-70-7	A

DO NOT SCALE DRAWING

E

1

Figure Withheld Under 10 CFR 2.390

APPROVALS	DATE	
PROJ.		TRANSNUCLEAR HAWTHORNE, N.Y. 10532
Q/A		TN-68 DRY STORAGE CASK DAMAGED FUEL TOP & BOTTOM CAPS 72-1027 AMENDMENT 1
N/T		
MECH DES		
CHK'D BY		NONE SCALE | B SIZE | 972-70-8 DRAWING No. | A REV.
DWN BY		DO NOT SCALE DRAWING

E

1