Package Descriptions

The following information for each package was extracted from the certificate of compliance issued by the U.S. Nuclear Regulatory Commission (NRC).

1. Model No. NAC-LWT

The certificate of compliance for the Model No. NAC-LWT can be found in the NRC's Agencywide Documents Access and Management System (ADAMS) using Accession No. ML15203A049.

a. Physical description of the packaging

The NAC-LWT is a steel-encased, lead-shielded package. The overall dimensions of the package, with impact limiters, are 232 inches long by 65 inches in diameter. The package body is approximately 200 inches in length and 44 inches in diameter. The package cavity is 178 inches long and 13.4 inches in diameter. The volume of the cavity is approximately 14.5 cubic feet.

The package body consists of a 0.75-inch-thick stainless steel inner shell, a 5.75-inch-thick lead gamma shield, a 1.2-inch-thick stainless steel outer shell, and a neutron shield tank. The inner and outer shells are welded to a 4-inch-thick stainless steel bottom end forging. The package bottom consists of a 3-inch-thick, 20.75-inch-diameter lead disk enclosed by a 3.5-inch-thick stainless steel plate and bottom end forging. The package lid is 11.3-inch-thick stainless steel stepped design, secured to a 14.25-inch-thick ring forging with twelve, 1-inch diameter bolts. The package seal is a metallic O-ring. A second Teflon O-ring and a test port are provided to leak test the seal. Other penetrations in the package cavity include the fill and drain ports, which are sealed with port covers and O-rings.

The neutron shield tank consists of a 0.24-inch-thick stainless steel shell with 0.50-inch-thick end plates. The neutron shield region is 164 inches long and 5 inches thick. The neutron shield tank contains an ethylene glycol/water solution that is 1% boron by weight.

The maximum weight of the package is 52,000 pounds and the maximum weight of the contents and basket is 4,000 pounds.

b. Physical description of the impact limiters

The impact limiters are constructed of aluminum honeycomb. The top impact limiter has an outside diameter of 65.25 inches and a maximum thickness of 27.8 inches. The bottom impact limiter has an outside diameter of 60.25 inches and maximum thickness of 28.3 inches. Both impact limiters extend 12 inches along the side of the package body.

c. Design waste volume (contents listed as number of fuel assemblies)

The NAC-LWT package has been approved for a variety of contents, including commercial spent fuel assemblies, research reactor spent fuel and uranyl nitrate. The contents include:

- One pressurized-water reactor (PWR) fuel assembly,
- Two boiling-water reactor (BWR) fuel assemblies,
- Up to 42 materials testing reactor (MTR) fuel elements,
- Up to 15 intact metallic fuel rods. Metallic fuel rods contain natural enrichment uranium pellets with aluminum cladding. A maximum of six canisters containing one defective metallic fuel rod per canister or up to three canisters each containing either a maximum of three defective metallic fuel rods per canister or a maximum of 10 failed fuel filters per canister,
- A maximum of 140 intact Training, Research, Isotopes, General Atomics (TRIGA) fuel elements in a poisoned basket. Mixed intact and damaged TRIGA fuel contents and TRIGA fuel debris are authorized. A maximum of seven damaged fuel cans is authorized per top and bottom basket modules with a maximum of 14 per package,
- Up to 120 intact TRIGA fuel elements in a non-poisoned basket. Up to four fuel elements per basket cell only loaded in the six periphery cells. A maximum of six damaged fuel cans is authorized only in the periphery cells per top and base basket modules with a maximum of 12 per package,
- Up to 480 intact TRIGA fuel cluster rods per package in a non-poisoned TRIGA fuel baskets (up to six periphery cells loaded with 16 cluster rods each), and up to 560 intact cluster rods per package in the poisoned TRIGA fuel baskets (up to 7 total cells loaded with 16 cluster rods each), damaged TRIGA fuel cluster rods or cluster rod debris (up to six equivalent rods) may be transported in a sealed damaged fuel can,
- A maximum of 25 high burnup PWR fuel rods,
- A maximum of 25 high burnup BWR fuel rods,
- A maximum of 42 DIDO fuel elements,
- A mixed fuel load of up to 42 DIDO fuel elements and spiral and MOATA fuel assemblies,
- Two General Atomics high-temperature gas cooled reactor fuel units,
- Twenty irradiated Reduced-Enrichment Research and Test Reactor (RERTR) type TRIGA fuel elements; 13 of the elements are intact, and the remaining seven are sectioned,
- A maximum of 300 Tritium-producing burnable absorber rods, including a maximum of two damaged rods, positioned within a consolidation canister or a maximum of 25 Tritium-producing burnable absorber rods, including a maximum of two prefailed rods, positioned within a PWR/BWR rod transport canister,
- Up to 700 intact or damaged PULSTAR fuel elements in either assembly or element form, including fuel debris, pellets, pieces and non-fuel components of PULSTAR fuel assemblies. The contents of a PULSTAR can are restricted to the equivalent of the fuel material in 25 intact

PULSTAR fuel elements and of the displaced volume of 25 intact PULSTAR fuel elements,

- Up to 42 spiral Australian Nuclear Science and Technology Organisation (ANSTO) fuel assemblies, MOATA plate bundles, or any combination of spiral fuel assemblies and MOATA plate bundles,
- A mixed fuel load of up to 42 spiral ANSTO fuel assemblies and MOATA fuel assemblies and DIDO fuel elements,
- A maximum of 55 equivalent Tritium-Producing Burnable Absorber Rods (TPBARs) as segments and segmentation debris,
- Up to 4,000 pounds of solid irradiated hardware, including spacers, dunnage and containers,
- Up to 16 undamaged irradiated PWR mixed-oxide (MOX) rods or a combination of PWR MOX and high burnup PWR fuel rods. Up to nine non-stainless burnable poison rods may be loaded,
- Up to 100 Safe Low-Power Kritical Experiment (SLOWPOKE) fuel rods (or the equivalent quantity of damaged material),
- Up to 18 undamaged National Research Universal Reactor (NRU) or National Research Experimental Reactor (NRX), fuel assemblies (or the equivalent number of loose rods),
- Up to a maximum of 58.1 liters of high-enriched uranyl nitrate liquid may be loaded per inner container. A total of four inner containers may be loaded per package for a total of 232.4 liters per package, or
- One undamaged SLOWPOKE fuel core, containing up to 298 fuel rods, upper and lower plates and the center tube.

d. Mode of transportation

The NAC-LWT can be transported by truck, boat, or rail. Air transport is not authorized.

2. Model No. GA-4

The certificate of compliance for the Model No. GA-4 can be found in ADAMS using Accession No. ML13269A329.

a. Physical description of the packaging

The GA-4 legal weight truck spent fuel package is designed to transport up to four intact PWR irradiated spent fuel assemblies. The packaging includes the packaging assembly and two impact limiters, each of which is attached to the package body with eight bolts.

The overall dimensions of the packaging are approximately 90 inches in diameter and 234 inches long. The containment system includes the packaging body (packaging body wall, flange, and bottom plate); package closure; closure bolts; gas sample valve body; drain valve; and primary O-ring seals for the closure, gas sample valve, and drain valve.

The package assembly includes the package, the closure, and the closure assemblies to limit the movement of the fuel. The package is constructed of

stainless steel, depleted uranium, and a hydrogenous neutron shield. The package external dimensions are approximately 188 inches long and 40 inches in diameter. A fixed fuel support structure divides the package cavity into four spent fuel compartments, each approximately 8.8 inches square and 167 inches long. The closure is recessed into the package body and is attached to the package flange with twelve (12), 1-inch diameter bolts. The closure lid is approximately 26 inches square, 11 inches thick, and weighs about 1510 lbs. The package has two ports allowing access to the package cavity. The closure lid has an integral half-inch diameter port (hereafter referred to as the gas sample valve) for gas sampling, venting, pressurizing, vacuum drying, leakage testing, or inerting. A 1-inch diameter port in the bottom plate allows draining, leakage testing, or filling the cavity with water. A separate drain valve opens and closes the port. The primary seals for the gas sample valve and drain valve are recessed from the outside package surface as protection from punctures. The gas sample valve and the drain valve also have covers to protect them during transport.

The package includes the containment (flange, package body, bottom plate and drain valve seals); the cavity liner and fuel support structure; the impact limiter support structure; the trunnions, and redundant lift sockets; the depleted uranium gamma shield; and the neutron shield and its outer shell. The package body is square, with rounded corners and a transition to a round outer shell for the neutron shield. The package has approximately a 1.5-inch thick stainless steel body wall, 2.6-inch thick depleted uranium shield (reduced at the corners), and 0.4-inch thick stainless steel fuel cavity liner.

The cruciform fuel support structure consists of stainless steel panels with boron-carbide (B4C) pellets for criticality control. A continuous series of holes in each panel, at right angles with the fuel support structure axis, provides cavities for the B4C pellets. The fuel support structure is welded to the cavity liner and is approximately 18 inches square by 166 inches long and weighs about 750 lbs. The flange connects the package body wall and fuel cavity liner at the top of the package, and the bottom plate connects the package body wall and fuel cavity liner at the bottom. The gamma shield is made up of five rings, which are assembled with zero axial tolerance clearance within the depleted uranium cavity, to minimize gaps. The impact limiter support structure is a slightly tapered 0.4 inch thick shell on each end of the package. The shell mates with the impact limiter's cavity and is connected to the package body by 36 ribs.

The neutron shield is located between the package body and the outer shell. The neutron shield design maintains continuous shielding immediately adjacent to the package body under normal conditions of transport.

Two lifting and tie-down trunnions are located about 34 inches from the top of the package body, and another pair is located about the same distance from the bottom. The trunnion outside diameter is 10 inches, increasing to 11.5 inches at the package interface. Two redundant lift sockets are located about 26 inches from the top of the package body and are flush with the outer skin.

All major package components are stainless steel, except the neutron shield, the depleted uranium gamma shield, and the B4C pellets contained in the fuel support structure. All O-ring seals are fabricated of ethylene propylene.

b. Physical description of the impact limiters

The impact limiters are fabricated of aluminum honeycomb, completely enclosed by an all-welded austenitic stainless steel skin. Each of the two identical impact limiters is attached to the package with eight bolts. Each impact limiter weighs approximately 2,000 lbs.

c. Design waste volume (contents listed as number of fuel assemblies)

Four PWR spent fuel assemblies. Fuel assemblies are authorized to be transported with or without control rods or other non-fuel assembly hardware.

d. Mode of transportation

The GA-4 package can be transported by truck, rail or boat. Air transport is not authorized.

3. Model No. 2000

The certificate of compliance for the Model No. 2000 can be found in ADAMS using Accession No. ML14245A208.

a. Physical description of the packaging

The packaging is constructed of two concentric 1-inch thick 304 stainless steel cylindrical shells (ASTM A 240) joined at the bottom end to a 6-inch thick 304 stainless steel forging (ASTM A 182). The packaging overall dimensions are approximately 131.5 inches in height and 72.0 inches in diameter, and its gross weight is approximately 33,550 lbs. The cavity of the packaging is approximately 26.5 inches in diameter and 54.0 inches deep. The lid is fully recessed into the packaging top flange and secured to the packaging body by fifteen, 1.25-inch diameter socket head screws. The packaging is equipped with a seal test port on the side of the body, a vent port in the lid, and a drain port near the bottom of the packaging.

The overpack is constructed from two 0.5-inch thick concentric 304 stainless steel cylindrical shells (ASTM A 240), separated radially by eight equally spaced tubes and horizontally by two tube sections. The lifting devices are detached during transport.

b. Physical description of the impact limiters

A 304 stainless steel toroidal shell impact limiter is attached to each end of the overpack. The overpack opens just above the lower impact limiter for access to the package. The top of the overpack is joined to the base by fifteen (15), 1-3/8-inch diameter shoulder screws. Gussets on the top and bottom impact limiters provide tie-down points for the package.

c. Design waste volume (contents are not listed as number of fuel assemblies, but limited as described below)

- Irradiated fuel rods, which may be cut or segmented:

  Fissile contents not to exceed 1,175 grams U-235 equivalent mass with initial enrichment not to exceed 5 weight percent in the fissile isotope; minimum pellet diameter of 0.3 inch, maximum burnup of 45 GWd/MTU, and minimum cooling time of 120 days; or

  Fissile contents not to exceed 1,750 grams U-235 equivalent mass with initial enrichment not to exceed 5 weight percent in the fissile isotope; minimum pellet diameter of 0.35 inch, maximum burnup of 38 GWd/MTU, and minimum cooling time of 120 days. Fuel rods must be contained in closed, 5-inch schedule 40 pipe, with a maximum of 437.5 grams U-235 equivalent per pipe; or

  Fissile contents not to exceed 242 grams U-235 equivalent mass with initial enrichment not to exceed 5 weight percent in the fissile isotope; minimum pellet diameter of 0.3-inch, maximum burnup of 52 GWd/MTU, and minimum cooling time of 180 days.

- Byproduct, source, or special nuclear material in solid form:

  2,000 watts decay heat. Fissile contents not to exceed 500 grams U-235 equivalent mass. A single package shall not mix nuclides except as allowed below. Quantities and minimum shielding and shoring requirements for isotopes listed in the certificate of gamma emitting nuclides are specified as follows:

^{137}Cs	422,000 Ci. The source must be divided in two, each source not exceeding 211,000 Ci, and placed into the "two-tier" option of the multifunctional rack
^{60}Co	7,000 Ci, with an allowed concurrent maximum of 100 Ci Zr/Nb-95
^{181}Hf, or $^{90}Sr/Y$	456,000 Ci for ^{181}Hf 596,000 Ci for $^{90}Sr/Y$
$^{95}Zr/Nb$	100 Ci

- One Irradiated High Flux Isotope Reactor (HFIR) fuel assembly,

- Irradiated Tower Shielding Reactor (TSR) fuel elements, positioned within the TSR fuel basket

  A maximum of 4,393 grams U-235 per package. The lower fuel basket section may contain up to four upper or lower fuel elements, or a combination of upper and lower fuel elements, for a total U-235 mass of 1,412 grams. The middle fuel basket section may contain up to four fuel cover (lune) plates, for a total U-235 mass of 304 grams. The upper fuel

basket section may contain up to six annular fuel elements plus one cylindrical fuel

- Irradiated MTR-type fuel assemblies, positioned within the MTR fuel basket

  Weight of contents, including fuel elements, spacers, shoring, and hardware, not to exceed 42.8 lbs per fuel basket cell.

  Decay heat not to exceed any of the following: 1,500 watts per package, 120 watts per cell, 35 watts per cell in the upper half of the fuel basket, 85 watts per cell in the lower half of the fuel basket, 765 watts in the lower half of the fuel basket.

- Irradiated TRIGA fuel elements, positioned with the MTR fuel basket

  Weight of contents, including fuel elements, spacers, shoring, and hardware, not to exceed 42.8 lbs per fuel basket cell.

  For stainless steel and inconel clad fuel, decay heat not to exceed any of the following: 1,500 watts per package, 120 watts per cell, 35 watts per cell in the upper half of the fuel basket, 85 watts per cell in the lower half of the fuel basket, 765 watts in the lower half of the fuel basket (i.e., the lower half of all 21 cells combined).

d. Mode of transportation

   The 2000 can be transported by truck, rail or boat. Air transport is not authorized.

4. Model No. NAC-STC

The certificate of compliance for the Model No. NAC-STC can be found in ADAMS using Accession No. ML14148A305.

a. Physical description of the packaging

A steel, lead and polymer shielded shipping package for (a) directly loaded irradiated PWR fuel assemblies, (b) intact, damaged and/or the fuel debris of Yankee Class or Connecticut Yankee irradiated PWR fuel assemblies in a canister, and (c) non-fissile, solid radioactive materials, Greater-Than-Class C (GTCC) waste, in a canister. The package body is a right circular cylinder with an impact limiter at each end. The package has approximate dimensions as follows:

Cavity diameter……..71 inches
Cavity length……..165 inches
Package body outer diameter……..87 inches
Neutron shield outer diameter……..99 inches
Lead shield thickness……3.7 inches
Neutron shield thickness……..5.5 inches

Impact limiter diameter……124 inches
Package length: without impact limiters……193 inches
with impact limiters……...257 inches

The maximum gross weight of the package is about 260,000 lbs.

The package body is made of two concentric stainless steel shells. The inner shell is 1.5 inches thick and has an inside diameter of 71 inches. The outer shell is 2.65 inches thick and has an outside diameter of 86.7 inches. The annulus between the inner and outer shells is filled with lead.

The inner and outer shells are welded to steel forgings at the top and bottom ends of the package. The bottom end of the package consists of two stainless steel circular plates which are welded to the bottom end forging. The inner bottom plate is 6.2 inches thick and the outer bottom plate is 5.45 inches thick. The space between the two bottom plates is filled with a 2-inch thick disk of a synthetic polymer (NS4FR) neutron shielding material.

The package is closed by two steel lids which are bolted to the upper end forging. The inner lid (containment boundary) is 9 inches thick and is made of Type 304 stainless steel. The outer lid is 5.25 inches thick and is made of SA-705 Type 630, H1150 or 17-4PH stainless steel. The inner lid is fastened by forty two (42), 1-1/2-inch diameter bolts and the outer lid is fastened by thirty six (36), 1-inch diameter bolts. The inner lid is sealed by two O-ring seals. The outer lid is equipped with a single O-ring seal. The inner lid is fitted with a vent and drain port which are sealed by O-rings and cover plates. The containment system seals may be metallic or Viton. Viton seals are used only for directly-loaded fuel that is to be shipped without long-term interim storage.

The package body is surrounded by a ¼-inch thick jacket shell constructed of 24 stainless steel plates. The jacket shell is 99 inches in diameter and is supported by 24 longitudinal stainless steel fins which are connected to the outer shell of the package body. Copper plates are bonded to the fins. The space between the fins is filled with NS4FR shielding material.

Four lifting trunnions are welded to the top end forging. The package is shipped in a horizontal orientation and is supported by a cradle under the top forging and by two trunnion sockets located near the bottom end of the package.

The contents are transported either directly loaded (uncanistered) into a stainless steel fuel basket or within a stainless steel transportable storage canister (TSC). The directly loaded fuel basket within the package cavity can accommodate up to 26 PWR fuel assemblies. The fuel assemblies are positioned within square sleeves made of stainless steel. Boral or TalBor sheets are encased outside the walls of the sleeves. The sleeves are laterally supported by 31, ½-inch thick, 71-inch diameter stainless steel disks. The basket also has 20 heat transfer disks made of Type 6061-T651 aluminum alloy. The support disks and heat transfer disks are connected by six, 1-5/8-inch diameter by 161-inch long threaded rods made of Type 17-4 PH stainless steel.

The Yankee Class multipurpose canister (MPC) and Connecticut Yankee MPC (CY-MPC) TSC assemblies include a vessel shell, bottom plate, and welded shield and structural lids that are fabricated from stainless steel. The bottom is a 1-inch thick steel plate for the Yankee Class MPC and 1.75-inch thick steel plate for the CY-MPC. The shell is constructed of 5/8-inch thick rolled steel plate and is 70 inches in diameter. The shield lid is a 5-inch thick steel plate and contains drain and fill penetrations for the canister. The structural lid is a 3-inch thick steel plate. The canister contains a stainless steel fuel basket that can accommodate up to 36 intact Yankee Class fuel assemblies and Reconfigured Fuel Assemblies (RFAs), or up to 26 intact Connecticut Yankee fuel assemblies with RFAs, with a maximum weight limit of 35,100 lbs. Alternatively, a stainless steel GTCC waste basket is used for up to 24 containers of waste.

The Yankee Class MPC TSC fuel basket configuration can store up to 36 intact Yankee Class fuel assemblies or up to 36 RFAs within square sleeves made of stainless steel. Boral sheets are encased outside the walls of the sleeves. The sleeves are laterally supported by 22 ½- inch thick, 69-inch diameter stainless steel disks, which are spaced about 4 inches apart. The support disks are retained by split spacers on eight, 1.125-inch diameter stainless steel tie rods. The basket also has 14 heat transfer disks made of Type 6061-T651 aluminum alloy.

The CY-MPC fuel basket is designed to store up to 26 Connecticut Yankee Zirc-clad assemblies enriched to 3.93 wt. percent, stainless steel clad assemblies enriched up to 4.03 wt. percent, RFAs, or damaged fuel in CY-MPC damaged fuel cans (DFCs). Zirc-clad fuel enriched to between 3.93 and 4.61 wt. percent, such as Westinghouse Vantage 5H fuel, must be stored in the 24-assembly basket. Assemblies approved for transport in the 26-assembly configuration may also be shipped in the 24-assembly configuration. The construction of the two basket configurations is identical except that two fuel loading positions of the 26-assembly basket are blocked to form the 24-assembly basket. RFAs can accommodate up to 64 Yankee Class fuel rods or up to 100 Connecticut Yankee fuel rods, as intact or damaged fuel or fuel debris, in an 8x8 or 10x10 array of stainless steel tubes, respectively. Intact and damaged Yankee Class or Connecticut Yankee fuel rods, as well as fuel debris, are held in the fuel tubes. The RFAs have the same external dimensions as a standard intact Yankee Class, or Connecticut Yankee fuel assembly.

The LaCrosse Boiling Water Reactor (LACBWR) multi-purpose canister MPC-TSC assembly consists of a vessel shell, a bottom plate and a welded closure lid/closure ring assembly that are fabricated from stainless steel. The MPC-LACBWR TSC bottom stainless steel thickness is 1.25 inches. The shell is ½-inch thick rolled steel plate and 70.6 inches in diameter. The closure lid is a 7.0-inch thick steel plate/forging. The closure lid redundant welded closure is provided by a closure ring. The closure lid is provided with vent and drain penetrations to access the TSC cavity and they are closed by redundant welded port cover plates. The MPC-LACBWR TSC fuel basket is designed to hold up to 68 irradiated LACBWR fuel assemblies, including up to 32 damaged fuel assemblies contained in DFCs and up to 36 intact fuel assemblies.

The TSC GTCC basket positions up to 24 Yankee Class or Connecticut Yankee waste containers within square stainless steel sleeves. The Yankee Class basket is supported laterally by eight, 1-inch thick, 69-inch diameter stainless steel disks. The Yankee Class basket sleeves are supported full-length by 2.5-inch thick stainless steel support walls. The support disks are welded into position at the support walls. The Connecticut Yankee GTCC basket is a right-circular cylinder formed by a series of 1.75-inch thick Type 304 stainless steel plates, laterally supported by 12 equally spaced welded 1.25-inch thick Type 304 stainless steel outer ribs. The GTCC waste containers accommodate radiation activated and surface contaminated steel, cutting debris (dross) or filter media, and have the same external dimensions of Yankee Class or Connecticut Yankee fuel assemblies.

The Yankee Class TSC is axially positioned in the package cavity by two aluminum honeycomb spacers. The spacers, which are enclosed in a Type 6061-T651 aluminum alloy shell, position the canister within the package during normal conditions of transport. The bottom spacer is 14-inches high and 70-inches in diameter, and the top spacer is 28 inches high and also 70 inches in diameter. The Connecticut Yankee TSC is axially positioned in the package cavity by one stainless steel spacer located in the bottom of the package cavity.

West Valley Demonstration Project high-level waste[1] canisters are built from 304L stainless steel and have a manufactured overall height of 117.7 inches nominal and an outside diameter of 24 inches. The canisters are filled with high-level waste vitrified in borosilicate glass closed with a permanent welded closure. The maximum gross weight allowed is 5,500 pounds, corresponding to 100% full. A total of five (5) HLW canisters with a total weight of 27,500 pounds can be placed in the HLW overpack/basket.

b. Physical description of the impact limiters

Two impact limiter designs consisting of a combination of redwood and balsa wood, encased in Type 304 stainless steel are provided to limit the g-loads acting on the package during an accident. The predominantly balsa wood impact limiter is designed for use with all the proposed contents. The predominately redwood impact limiters may only be used with directly loaded fuel or the CY-MPC configuration.

c. Design waste volume (contents listed as number of fuel assemblies)

- 26 PWR fuel assemblies,
- 36 intact Yankee Class PWR assemblies in a TSC,
- 36 RFAs in a TSC,
- 26 CY fuel assemblies in a CY-MPC,
- 26 RFA in a CY-MPC,
- 68 intact LaCrosse Boiling Water Reactor assemblies in a LACBWR TSC,

[1] Although not currently approved, NRC is currently reviewing an application for approval for transport of high-level waste in the NAC-STC and expects to complete the review by the end of calendar year 2015.

- 32 intact LaCrosse BWR assemblies and 32 damaged LaCrosse BWR assemblies in a LACBWR TSC,
- Five welded canisters with vitrified high-level waste or debris from the West Valley Demonstration Project (which corresponds to approximately 53,240 in^3 per canister), or
- One high-level waste overpack will be loaded with two melter-evacuated canisters partially filled with glass and one high-level waste debris canister.

d. Mode of transportation

The NAC-STC can be transported by rail, truck or boat transport. Air transport is not authorized.

5. Model No. TN-FSV

The certificate of compliance for the Model No. TN-FSV can be found in ADAMS using Accession No. ML14167A316.

a. Physical description of the packaging

A steel and lead shielded shipping package for irradiated nuclear fuel. The package has three shipping configurations: Configuration 1 for shipping irradiated Fort St. Vrain high temperature gas cooled reactor fuel elements; Configuration 2 for shipping irradiated fuel parts and intact irradiated Peach Bottom Unit 1 fuel elements within a secondary containment vessel; and Configuration 3 for shipping irradiated PWR fuel rods within a shielded basket. The package is a right circular cylinder, with a balsa and redwood impact limiter at each end. The package has approximate dimensions and weights as follows:

Cavity diameter……..…..18 inches
Cavity length……..…….199 inches
Package body outer diameter……..…..……..31 inches
Lead shield thickness……..…….3.44 inches
Package overall outer diameter, including impact limiters……78 inches
Package overall length, including impact limiters…….247 inches
Packaging weight (Configuration 1)……..…….42,000 pounds

The gross package weight, including contents (Configurations 1 and 2) is 47,000 pounds.

The package body is made of two concentric shells of Type 304 stainless steel, welded to a bottom plate and a top closure flange. The inner shell has an inner diameter of 18 inches and is 1.12 inches thick. The outer shell has an outer diameter of approximately 30 inches and is 1.5 inches thick. The annular space between the inner and outer shells is filled with lead. The bottom plate is 5.5-inch-thick Type 304 stainless steel. The closure lid is 2.5-inch-thick Type 304 stainless steel, and is fully recessed into the package top flange. The lid is fastened to the package body by twelve, 1-inch diameter closure bolts. The lid is sealed with double O-ring seals with a leak test port. A vent port and drain port are sealed with single O-rings and cover plates.

Configuration 1 uses silicone O-ring seals and Configurations 2 and 3 use butyl O-ring seals. The package body is covered with a stainless steel thermal shield composed of 0.25-inch thick stainless steel plate over a wire wrap.

The package has two lifting sockets bolted to the package top flange. Two rear trunnions are provided for package tie-down.

For Configuration 1:

Irradiated hexagonal HTGR fuel elements are shipped in Configuration 1. The fuel elements are stacked in a carbon steel fuel storage container, which has an outer diameter of approximately 17.6 inches and an overall length of 195 inches. The fuel storage container has a 0.5-inch thick shell, a 2.0-inch thick bottom plate, and a 1.5-inch thick lid. The lid accommodates a removable depleted uranium plug.

For Configuration 2:

Irradiated fuel parts and intact Peach Bottom Unit 1 fuel elements are shipped in Configuration 2. Canisters, containing either fuel parts or a single intact Peach Bottom fuel element, are loaded into a separate, secondary containment vessel, the Oak Ridge Container. The Oak Ridge Container is composed of a right circular cylindrical vessel and a basket assembly. The stainless steel vessel has a 10-gauge (0.135-inch) wall thickness, an overall length of approximately 198 inches, and an outside diameter of approximately 20 inches at the lid end. The lid is approximately 7 inches thick and is closed by twelve (12), 1/2-inch diameter bolts and two butyl O-ring seals. There is a single penetration through the lid which is closed by a bolted port cover and two butyl O-ring seals. The basket is composed of a series of discs, tie rods, and support tubes, with five fuel compartment tubes arranged in a star-like configuration. The basket incorporates fixed borated aluminum neutron poison plates. Flux trap spacers are positioned axially between stacked fuel parts canisters, and the canisters and spacers are positioned within a stainless steel sleeve that forms the fuel compartment. Canisters containing fuel parts (called Oak Ridge canisters) and canisters containing intact Peach Bottom fuel elements may be shipped together.

For Configuration 3:

Irradiated PWR fuel rods are shipped in Configuration 3. The fuel rods are loaded into a PWR fuel rod shielded basket. The basket has an overall length of 166 inches and an overall diameter of 17.5 inches, and fits closely within the TN-FSV package cavity. The basket consists of a bottom end spacer, a cylindrical body with an inner diameter of 4 inches and an outer diameter of 10-½ inches with lateral support discs, and an 11-inch thick top lid. The basket is constructed of stainless steel. Up to seven PWR fuel rods are loaded into individual stainless steel tubes within the basket.

b. Physical description of the impact limiters

The impact limiters are constructed of balsa and redwood encased in stainless steel shells.

c. Design waste volume (contents listed as number of fuel assemblies)

- Six High Temperature Gas Reactor fuel elements in a fuel storage canisters,
- 1789 pounds of intact Peach Bottom graphite fuel elements, or
- Seven PWR fuel rods, or less, depending on burnup in a shielded basket

d. Mode of transportation

The TN-FSV package can be transported by truck, rail or boat. Air transport is not authorized.

6. NUHOMS® MP187 Multi-Purpose Cask

The certificate of compliance for the Model No. NUHOMS® MP187 Multi-Purpose Cask can be found in ADAMS using Accession No. ML14069A390.

a. Physical description of the packaging

The NUHOMS® MP187 Multi-Purpose Package consists of an outer packaging, into which one of the four different dry shielded canisters (DSC) is placed. During shipment, energy-absorbing impact limiters are utilized for additional package protection.

The purpose of the package is to provide containment and shielding of the radioactive materials contained within the DSC during shipment. The package is constructed of stainless steel and lead with a neutron shield of cementitious material. The inside cavity of the package is a nominal 68 inches in diameter and 187 inches long. The bottom access closure is approximately 5-inches-thick and 17 inches in diameter, secured by twelve (12), 1-inch diameter bolts. The top closure is approximately 6.5 inches thick and is secured by thirty six (36), 2-inch-diameter bolts. Both closures are sealed by redundant O-rings.

Containment is provided by a stainless steel closure lid bolted to the stainless steel package. The containment system of the NUHOMS® MP187 transportation package consists of (a) the inner shell, (b) the bottom end closure plate, (c) the top closure plate, (d) the top closure inner O-ring seal, (e) the ram closure plate, (f) the ram closure inner O-ring seal, (g) the vent port screw, (h) the vent port O-ring seal, (i) the drain port screw, and (j) the drain port O-ring seal. No credit is given to the DSC as a containment boundary.

Shielding is provided by 4 inches of stainless steel, 4 inches of lead, and approximately 4.3 inches of neutron shielding. The overall length of the package is approximately 200 inches; the outer diameter is approximately 93 inches. The maximum gross weight of the package, with impact limiters, is approximately 282,000 lbs. The total length of the package with the impact limiters attached is approximately 308 inches. Four removable trunnions (two upper and two lower) are provided for handling and lifting.

The purpose of the DSC, which is placed within the transport package, is to permit the transfer of spent fuel assemblies, into or out of a storage module, a dry transfer facility, or a pool as a unit. The DSC also provides additional axial biological shielding during handling and transport. The DSC consists of a stainless steel shell and a basket assembly. The approximately 5/8-inch-thick shell has an outside diameter of about 67 inches and an external length of about 186 inches. The DSC basket assembly provides criticality control and contains a storage position for each fuel assembly. The basket is composed of circular spacer discs machined from thick carbon steel plates. Axial support for the DSC basket is provided by four high strength steel support rod assemblies. Carbon steel components of each DSC basket assembly are electrolytically coated with a thin layer of nickel to inhibit corrosion.

On the bottom of each DSC is a grapple ring, which is used to transfer a DSC horizontally from the package into and out of dry storage modules. Because of the nature of the fuel that is to be transported, four different types of DSCs are designed for the package. Variations in the DSC configurations are summarized below:

Fuel-Only Dry Shielded Canisters (FO-DSC)

The FO-DSC has a cavity length of approximately 167 inches and has solid carbon steel shield plugs at each end. The FO-DSC is designed to contain up to 24 intact Babcock and Wilcox (B&W) PWR spent fuel assemblies. The FO-DSC basket assembly consists of 24 guide sleeve assemblies with integral borated neutron absorbing plates, 26 spacer discs, and four support rod assemblies.

Fuel/Control Components Dry Shielded Canister (FC-DSC)

The FC-DSC has an internal cavity length of approximately 173 inches to accommodate fuel with the B&W control components installed. To obtain the increased cavity length, the shield plugs are fabricated from a composite of lead and steel. The FC basket is similar to the FO-DSC except that the support rod assemblies and guide sleeves are approximately 6 inches longer. The FC-DSC is also designed to contain up to 24 intact B&W PWR spent fuel assemblies with control components.

Failed Fuel Dry Shielded Canister (FF-DSC)

The FF-DSC has an internal cavity length of approximately 173 inches to accommodate 13 damaged B&W PWR spent fuel assemblies. Because the cladding has been locally degraded, individual (screened) fuel cans are provided to confine any gross loose material, maintain the geometry for criticality control, and facilitate loading and unloading operations. The FF-DSC is similar to FC-DSC in most respects with the exception of the basket assembly. The FF-DSC basket may be fabricated from austenitic stainless steel.

24PT1 Dry Shielded Canister (24PT1-DSC)

The 24PT1-DSC has an internal cavity length of approximately 167 inches with a solid carbon steel shield plug at each end. The 24PT1-DSC will accommodate

22 to 24 Westinghouse (WE) 14 x14 PWR spent fuel assemblies, including control components. Control components authorized that are integral to WE 14x14 fuel assemblies include rod cluster control assemblies, thimble plug assemblies, and neutron source assemblies only. Fuel assemblies may be damaged or intact. The 24PT1-DSC basket assembly consists of 24 guide sleeve assemblies with integral borated neutron absorbing plates, 26 spacer discs, and 4 support rod assemblies. Up to four screened individual failed fuel cans are provided for storage of damaged fuel within the guide sleeve assemblies. These failed fuel cans are similar in configuration to the FF-DSC failed fuel cans.

b. Physical description of the impact limiters

The impact limiter shells are fabricated from stainless steel. Within that shell are closed-cell polyurethane foam and aluminum honeycomb material. The impact limiter is attached to the package by carbon steel bolts. Each impact limiter is bolted to the package body through the neutron shield top and bottom support rings. The weight of each impact limiter is approximately 15,800 lbs.

c. Design waste volume (contents listed as number of fuel assemblies)

- 24 PWR intact fuel assemblies in the FO, FC or FF-DSCs,
- 13 damaged fuel assemblies, with no more than 15 damaged fuel rods per assembly in the FO, FC or FF-DSCs, or
- 22 to 24 PWR fuel assemblies of which up to four may be damaged assemblies with the balance intact fuel assemblies in the 24PT1-DSC.

d. Mode of transportation

This NUHOMS® MP187can be transported by rail, truck, or boat. Air transport is not authorized.

7. HI-STAR 100 System

The certificate of compliance for the Model No. HI-STAR 100 System can be found in ADAMS using Accession No. ML14101A465.

a. Physical description of the packaging

The HI-STAR 100 System is a canister system comprising a multi-purpose canister (MPC) inside of an overpack designed for both storage and transportation (with impact limiters) of irradiated nuclear fuel. The HI-STAR 100 consists of interchangeable MPCs that house the spent nuclear fuel and an overpack that provides the containment boundary, helium retention boundary, gamma and neutron radiation shielding, and heat rejection capability. The outer diameter of the overpack of the HI-STAR 100 is approximately 96 inches without impact limiters and approximately 128 inches with impact limiters. Maximum gross weight for transportation package (including overpack, MPC, fuel, and impact limiters) is 282,000 pounds. The HI-STAR 100 System includes the HI-STAR 100 Version HB (also referred to as the HI-STAR HB).

Multi-Purpose Canister

There are seven MPC models designated as the MPC-24, MPC-24E, MPC-24EF, MPC-32, MPC-68, MPC-68F, and the MPC-HB. All MPCs are designed to have identical exterior dimensions, except 1) MPC-24E/EFs custom-designed for the Trojan plant, which are approximately nine inches shorter than the generic MPC design; and 2) MPC-HBs custom-designed for the Humboldt Bay plant, which are approximately 6.3 feet shorter than the generic MPC designs. The two digits after the MPC designates the number of spent fuel assemblies for which the respective MPCs are designed. The MPC-24 series is designed to contain up to 24 PWR spent fuel assemblies; the MPC-32 is designed to contain up to 32 intact PWR spent fuel assemblies; and the MPC-68 and MPC-68F are designed to contain up to 68 BWR spent fuel assemblies. The MPC-HB is designed to contain up to 80 Humboldt Bay BWR spent fuel assemblies.

The HI-STAR 100 MPC is a welded cylindrical structure with flat ends. Each MPC is an assembly consisting of a honeycombed fuel basket, baseplate, canister shell, lid, and closure ring. The outer diameter and cylindrical height of each generic MPC is fixed. The outer diameter of the Trojan MPCs is the same as the generic MPC, but the height is approximately 9 inches shorter than the generic MPC design. A steel spacer is used with the Trojan plant MPCs to ensure the MPC-overpack interface is bounded by the generic design. The outer diameter of the Humboldt Bay MPCs is the same as the generic MPC, but the height is approximately 6.3 feet shorter than the generic MPC design. The Humboldt Bay MPCs are transported in a shorter version of the HI-STAR overpack, designated as the HI-STAR HB. The fuel basket designs vary based on the MPC model.

Overpack

The HI-STAR 100 overpack is a multi-layer steel cylinder with a welded baseplate and bolted lid (closure plate). The inner shell of the overpack forms an internal cylindrical cavity for housing the MPC. The outer surface of the overpack inner shell is buttressed with intermediate steel shells for radiation shielding. The overpack closure plate incorporates a dual O-ring design to ensure its containment function. The containment system consists of the overpack inner shell, bottom plate, top flange, top closure plate, top closure inner O-ring seal, vent port plug and seal, and drain port plug and seal.

b. Physical description of the impact limiters

The HI-STAR 100 overpack is fitted with two impact limiters fabricated of aluminum honeycomb completely enclosed by an all-welded austenitic stainless steel skin. The two impact limiters are attached to the overpack with 20 and 16 bolts at the top and bottom, respectively.

c. Design waste volume (contents listed as number of fuel assemblies)

24 PWR spent fuel assemblies in the MPC-24 canisters,
68 BWR spent fuel assemblies in the MPC-68 canisters,
32 PWR spent fuel assemblies in the MPC-32 canisters, or
80 BWR spent fuel assemblies in the MPC-HB canister.

d. Mode of transportation

The HI-STAR 100 can be transported by rail, truck or boat. Air transport is not authorized.

8. Model No. UMS Universal Transport Cask Package

The certificate of compliance for the Model No. UMS Universal Transport Cask Package can be found in ADAMS using Accession No. ML12306A575.

a. Physical description of the packaging

The Model No. UMS Universal Transport Cask Package (UMS) is a canister-based system for the transportation of spent nuclear fuel. The transportation component of the UMS system, designated the Universal Transport System, consists of a Universal Transport packaging body with a closure lid and energy-absorbing impact limiters loaded with a TSC containing either spent PWR or BWR spent fuel or Maine Yankee site-specific contents including Greater than Class C (GTCC) waste.

The packaging body of the UMS is a right-circular cylinder of multi-wall construction which consists of 304 stainless steel inner and outer shells separated by lead gamma radiation shielding that is poured in place. The inner and outer shells are welded to a 304 stainless steel top forging that mates to the package lid. The inner shell is also welded to a 304 stainless steel bottom forging and the outer shell is welded to the bottom plate. The package bottom

consists of the bottom forging and bottom plate with neutron shield material sandwiched between them. Layers of 4.5-inch-thick 304 stainless steel rings and two 0.75-inch-thick stainless steel disks are located at the bottom lead annulus between the bottom forging and the outer shell.

Neutron shield material is also placed in an annulus that surrounds the package outer shell along the length of the package cavity and is enclosed by a stainless steel shell with top and bottom plates. The neutron shield material is a solid synthetic polymer (NS-4-FR). Twenty-four bonded copper and Type 304 stainless steel fins are located in the radial neutron shield to enhance the heat rejection capability of the package and to support the neutron shield shell and end plates.

The containment boundary of the UMS consists of the inner shell; bottom forging; top forging; package lid and lid inner O-ring; vent port cover plate and vent port cover plate inner O-ring; and drain port cover plate and drain port cover plate inner O-ring.

There are five TSCs of different lengths, each to accommodate different classes of PWR or BWR spent fuel assemblies. Each TSC has an outside diameter of about 67 inches and the lengths vary from about 175 to 192 inches long. The TSC assembly consists of a right circular cylindrical shell with a welded bottom plate, a fuel basket, a shield lid, two penetration port covers, and a structural lid. The TSC contains the basket and fuel assemblies or GTCC waste. Spacers are placed below each Class 1, 2, 4 or 5 canister to locate and support the canister in the package cavity.

The spacers are free standing structures that are confined in place by the bottom of the canister and the package bottom inner surface. The spacer(s) ensure that the canister lid is laterally supported by the package top forging when the package is horizontal and minimizes axial movement of the canister. Each Class 1 PWR canister is positioned by a stainless steel spacer that is 16.75 inches in length. Each Class 2 PWR canister is positioned by a stainless steel spacer that is 7.65 inches in length. No spacers are used with the Class 3 PWR canister. The Class 4 BWR canister is located by four 1.5-inch-thick aluminum spacers and the Class 5 BWR canister is located with a 1.5-inch aluminum spacer.

The spent fuel basket design uses a series of high strength stainless steel PWR or carbon steel BWR neutron absorber on all four sides of the tubes. Three types of fuel tubes are designed to contain the BWR fuel: (1) tubes containing neutron absorber on two sides of the tubes; (2) tubes containing neutron absorber on one side; and (3) tubes containing no neutron absorber. Aluminum heat transfer disks are provided in both the PWR and BWR fuel baskets to enhance thermal performance of the basket. The heat transfer disks are supported by stainless steel tie rods and split spacers that maintain the basket assembly configuration.

The GTCC waste canister is essentially identical to the Class 1 TSC, except for the placement of lifting lugs and the placement of a key way within the canister. The GTCC basket is constructed of Type 304 stainless steel and consists

primarily of a cylinder with a 3-inch thick wall closed at the bottom end with a 3-inch thick plate. The cylinder is centered in the GTCC waste canister by 14 Type 304 stainless steel support plates along its length. A 3-inch thick 304 stainless steel separator fixture divides the cylinder into two vertically stacked components, each 77 inches deep with a diameter of 47.8 inches.

The approximate dimensions and weights of the package are as follows:

Overall length (with impact limiters)……..273.3 inches
Overall length (without impact limiters)…….209.3 inches
Impact Limiter Outside diameter……124.0 inches
Outside diameter (without impact limiters)……92.9 inches
Cavity diameter……..…….67.6 inches
Cavity length……192.5 inches
Package lid thickness……..……6.5 inches
Bottom thickness……10.3 inches
Inner shell thickness……..……2.0 inches
Outer shell thickness……..2.75 inches
Gamma shield thickness……2.75 inches
Radial neutron shield thickness……4.50 inches

Transportable Storage Canister

Shell thickness……..0.625 inches
Shell bottom……..……1.75 inches
Shield lid thickness……...7 inches
Structural lid thickness……3 inches
Outer diameter……..……..67 inches
Internal cavity diameter……..……65.8 inches
Internal fuel cavity length, depending on class……163-180 inches
Overall length, depending on class……175-192 inches

Fuel Basket
Basket assembly length, depending on class……..162-180 inches
Basket assembly diameter……..……..65.5 inches
Number of support disks, depending on class……30-41
Number of heat transfer disks, depending on class……17-33

Total weight including cask, basket, impact limiters, fuel, canister with lids, cask lid, and spacers for each fuel class is approximately:

Class 1 (PWR)……251,000 pounds
Class 2 (PWR)……252,000 pounds
Class 3 (PWR)……249,000 pounds
Class 4 (BWR)……256,000 pounds
Class 5 (BWR)……255,000 pounds

b. Physical description of the impact limiters

The package has impact limiters at each end of the package body. The impact limiters consist of a combination of redwood and balsa wood encased in Type 304 stainless steel. The impact limiters limit the g-loads acting on the package

during a transport drop load condition due to crushing of the redwood and balsa wood. The upper and lower impact limiters are bolted to the package body by 16 equally spaced attachment rods with nuts.

c. Design waste volume (contents listed as number of fuel assemblies)

The package is designed to transport four types of contents.

- 24 intact irradiated PWR spent fuel assemblies,
- 56 intact irradiated BWR spent fuel assemblies,
- 24 irradiated intact or damaged PWR fuel assemblies and canistered fuel debris, or
- GTCC waste from the Maine Yankee Reactor. GTCC waste is limited to a maximum weight of 20,000 pounds per package, or 10,000 pounds per compartment.

d. Mode of transportation

The UMS can be transported by rail, truck or boat. Air transport is not authorized.

9. Model No. FuelSolutions™ TS125Transportation Package

The certificate of compliance for the Model No. FuelSolutions™TS125 Transportation Package can be found in ADAMS using Accession No. ML12306A426.

a. Physical description of the packaging

The FuelSolutions™ TS125 Transportation Package (TS-125) consists of the TS125 transportation package and impact limiters, together with a FuelSolutions™ W21 or W74 canister and its contents. The FuelSolutions™ canister and its contents are contained inside the TS125 transportation package cavity. The TS125 transportation package cavity is sized to accommodate one FuelSolutions™ long canister, or alternatively, one FuelSolutions™ short canister with a cavity spacer. The approximate dimensions and weights of the package are as follows:

Package Length.....342.4 inches
Package Outside Diameter.....143.5 inches
Package Length (w/o impact limiters).....210.4 inches
Package Outside Diameter (w/o impact limiters).....94.2 inches
Package Cavity Length.....193.0 inches
Package Cavity Diameter (section at rails).....66.88 inches
Canister Outside Diameter.....66.0 inches
Maximum Long Canister Length.....192.25 inches
Maximum Short Canister Length.....182.25 inches
Package Cavity Spacer Length.....10.0 inches
Max. Package Weight.....285,000.0 lbs
Max. Package Contents Weight (incl. canister and spacer).....85,000.0 lbs

The TS125 transportation package body is an assembly composed of stainless steel components which include an inner shell, an outer shell, a top ring forging, a closure lid with a seal test port and a cavity vent port, a bottom plate forging, and a cavity drain port. The inner and outer shells are welded to the bottom plate forging and the top ring forging. The package body also includes an annular lead gamma shield; an annular neutron shield with package tie-down rings, support angles, and jacket; a bottom end neutron shield with a support ring and jacket; a longitudinal shear block; and lifting trunnion mounting bosses. The inner and outer shells form the annular cavity for the lead gamma shield. The outer shell and the neutron shield jacket form the annular cavity for the solid neutron shield. The neutron shield support angles facilitate heat rejection through the solid neutron shielding material to the outer surface of the package body. The package closure lid includes a thick recessed plate with two concentric “Helicoflex” silver-jacketed metallic O-ring seals, the cavity vent port, and the seal test port. The closure lid is secured to the package body during transport with sixty, 2-inch-diameter closure bolts. The vent and drain ports are closed by a plug assembly to maintain containment integrity during transportation.

The transportation package’s containment boundary consists of: the inner cylindrical shell, the bottom plate forging (which forms the bottom closure of the package), the top ring forging and sealing surfaces, the closure lid and sealing surfaces, the welds associated with the above components, the closure bolts, the innermost closure lid O-ring seal, the cavity vent port seal gland and O-ring seal, and the cavity drain port seal gland and O-ring seal. The structural components of the transportation package are made of high-strength austenitic stainless steel. The gamma shielding is made of lead and is completely enclosed within the annular region between the inner and outer steel shells. The neutron shielding is solid hydrogenous material that is completely enclosed within the annular region between the package outer shell and neutron shield jacket with tie-down rings at each end.

A FuelSolutions™ canister consists of a steel shell assembly and an internal basket assembly. The shell assembly maintains a helium atmosphere for transport conditions. Credit is not taken for containment provided by the canister shell for transport conditions. The shell assembly also provides radiological shielding in both the radial and axial directions. The internal basket assembly provides geometric spacing, structural support, and criticality control for the spent fuel assemblies for transport conditions. There are two classes of W21 canisters (W21T and W21M) differing primarily in materials of construction. Each W21 canister class includes four different canister types, as follows. The W21T canister class includes a:

- long canister with lead shield plugs (W21T-LL),
- long canister with carbon steel shield plugs (W21T-LS),
- short canister with lead shield plugs (W21T-SL), and
- short canister with carbon steel shield plugs (W21T-SS).

The W21M canister class includes a:

- long canister with depleted uranium shield plugs (W 21M-LD),
- long canister with carbon steel shield plugs (W21M-LS),

- short canister with depleted uranium shield plugs (W21M-SD), and
- short canister with carbon steel shield plugs (W21M-SS).

There are also two classes of W74 canisters (W74T and W74M), differing primarily in materials of construction. Both the W74T and W74M canister classes include only a long canister with carbon steel shield plugs.

A FuelSolutions™ canister shell assembly consists of a steel cylindrical shell, bottom end closure, bottom shield plug, bottom shell extension, bottom outer plate, top shield plug, top inner closure plate, and top outer closure plate. The closure plates at the top and bottom are welded to the cylindrical shell. All structural components of the canister shell assembly are constructed of austenitic stainless steel, with the exception of the shield plugs. The shield plug materials may be composed of lead, depleted uranium or carbon steel, depending upon the specific canister variant. To prevent any corrosion, galvanic, or chemical reactions between the shield plug materials and the package environment or contents, the shield materials are isolated from the environment and package interior. The lower shield plugs are encased within stainless steel. The upper shield plugs that are made of lead or depleted uranium are encased in stainless steel. The carbon steel upper shield plug is electroless nickel-plated.

A FuelSolutions™ W21 canister basket assembly consists of 21 guide tubes that are positioned and supported by a series of circular spacer plates, which are in turn positioned and supported by support rod assemblies. The W21 guide tubes include neutron absorber sheets on all four sides.

The W74 canister includes two stackable basket assemblies with a capacity to accommodate up to 64 Big Rock Point fuel assemblies. Each basket includes 37 cell locations, with the center five cell locations mechanically blocked to prevent fuel loading in these locations. The W74 basket assembly consists of a series of circular spacer plates that are positioned and supported by four support tubes that run through the spacer plates and support sleeves between the spacer plates. Each basket cell location, with the exception of the four support tubes and the five blocked-out center cells, contain a guide tube assembly. The W74 guide tube assemblies include borated stainless steel neutron absorber sheets on either one side or two opposite sides. The guide tubes are arranged in the basket to position at least one poison sheet between adjacent fuel assemblies, with the exception of intact fuel assemblies placed in the support tubes.

In the W74 basket, damaged fuel is placed in damaged fuel cans that are accommodated in the support tube cell locations. The W74 damaged fuel cans are similar to the W74 guide tubes, but include a screened bottom end, a screened removal lid, and borated stainless steel neutron absorber sheets on all four sides.

b. Physical description of the impact limiters

The FuelSolutions™ TS125 Transportation Package has identical energy-absorbing impact limiters at both ends. Each impact limiter assembly consists of

crushable aluminum honeycomb energy-absorbing core segments that are encased in a sealed stainless steel shell. In addition to confining the aluminum honeycomb core segments in the event of a free drop, the impact limiter shell protects the aluminum honeycomb material from the weather. Both the top and bottom impact limiters are attached to the transportation package body tie-down rings with twelve, 1-inch-diameter bolts. A tamper-indicating device is provided which connects each impact limiter to the transportation package to assure that the package has not been opened by unauthorized personnel during transport.

c. Design waste volume (contents listed as number of fuel assemblies)

- 21 PWR spent fuel assemblies, or
- 64 Big Rock Point (BRP) SNF assemblies without channels, including intact, partial, and damaged uranium dioxide (UO_2) and MOX fuel assemblies.

d. Mode of transportation

The FuelSolutions™ TS125 can be transported by truck, boat, or rail. Air transport is not authorized.

10. Model No. TN-68 Transport Package

The certificate of compliance for the Model No. TN-68 Transport Package can be found in ADAMS using Accession No. ML14070A314.

a. Physical description of the packaging

The TN-68 is predominantly a steel package that is used to transport up to 68 intact BWR fuel assemblies with or without channels. The overall dimensions of the package are 271 inches long and 144 inches in diameter with the impact limiters installed.

The package generally consists of four components, the fuel basket assembly, a containment vessel within a forged steel package body, a radial neutron shield, and impact limiters.

The basket assembly locates and supports the fuel assemblies, transfers heat to the package body wall and provides neutron absorption to satisfy sub-criticality requirements. The basket structure consists of an assembly of stainless steel cells, joined by fusion welding of 1.75-inch-wide stainless steel plates. Above and below the plates are slotted borated aluminum (or boron carbide/aluminum) metal matrix composite neutron poison plates which form an egg-crate structure. This construction forms a honey-comb like structure of cell liners which provides compartments for 68 fuel assemblies. The nominal dimensions of each cell are 6.0 inches by 6.0 inches.

A thick-walled (6.0 inch), forged steel package body for gamma shielding surrounds the containment vessel, by an independent shell and bottom plate of carbon steel. The gamma shield completely surrounds the containment vessel

inner shell and bottom closure. The thickness of the bottom of the package body is 8.25 inches. A 4.5 inch thick steel gamma shield is also welded to the inside of the containment lid.

The approximate dimensions and weights of the package are as follows:
Overall length (with impact limiters, in)…….271
Overall length (without impact limiters, in)……197
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
Maximum weight of package (pounds)……..272,000
Maximum weight of BWR fuel contents (pounds)……..47,900
Maximum weight of impact limiters and attachments (pounds)……32,000

The maximum contents weight is 75,600 pounds. The maximum weight of the irradiated fuel contents is 47,900 pounds.

b. Physical description of the impact limiters

The package has impact limiters at each end of the package body. The impact limiters consist of balsa wood and redwood blocks, encased in sealed stainless steel shells that maintain the wood in a dry atmosphere and provide wood confinement when crushed during a free drop. The impact limiters have internal radial gussets for added strength and confinement. The impact limiters are attaching to each other using 13 tie rods and to the package by eight bolts attaching to brackets welded to the outer shell in eight locations (four bolting locations per impact limiter).

c. Design waste volume (contents listed as number of fuel assemblies)

68 unconsolidated intact irradiated GE BWR fuel assemblies with zircalloy cladding.

d. Mode of transportation

The TN-68 can be transported by truck, rail, or boat. Air transport is not authorized.

11. Model No. NUHOMS®-MP197 or NUHOMS®-MP197HB

The certificate of compliance for the Model No. NUHOMS®-MP197 or NUHOMS®-MP197HB can be found in ADAMS using Accession No. ML14114A099.

a. Physical description of the packaging

The NUHOMS®-MP197 package consists of two models: the MP197 and MP197HB.

The NUHOMS®-MP197 packaging, used for the transport of the NUHOMS®-61BT DSC, is fabricated primarily of stainless steel. Non-stainless steel items include the lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the neutron shield, and carbon steel closure bolts. The body of the packaging consists of a 1.25-inch-thick, 68-inch inside diameter, stainless steel inner (containment) shell and a 2.5-inch-thick, 82-inch outside diameter stainless steel structural shell, without impact limiters, which sandwich the 3.25-inch-thick cast lead shielding.

The packaging is 208 inches long and has an outer diameter of 91.5 inches. The weight of the packaging body is 148,840 pounds including about 10,000 pounds of neutron shield and 60,000 pounds of cast lead.

The containment system consists of the inner shell, a 6.50-inch-thick bottom plate, a 2.5-inch-thick radioactive material access closure with a 24-inch-diameter, a top closure flange, a 4.5-inch-thick top closure lid with closure bolts, drain port closures and bolts, and double O-ring seals for each penetration. The packaging cavity is pressurized to above atmospheric pressure with an inert gas, helium. Shielding is provided by 4 inches of stainless steel, 3.25 inches of lead, and 4.5 inches of neutron shielding. Four removable trunnions are provided for handling and lifting of the package.

The DSC allows the transfer of spent fuel assemblies, into or out of a storage module, a dry transfer facility, or a pool as a unit. The DSC also provides additional axial biological shielding during handling and transport. The DSC consists of a stainless steel shell, with an outside diameter of 67 inches and an external length of 200 inches, and of a basket assembly designed to accommodate 61 intact BWR fuel assemblies, with or without fuel channels.

The basket structure consists of a welded assembly of stainless steel tubes (fuel compartments) separated by poison plates and surrounded by larger stainless steel boxes and support rails. The poison plates, constructed from borated aluminum, provide criticality control and a heat conduction path from the fuel assemblies to the canister wall. No credit is given to the DSC as a containment boundary.

The MP197HB packaging is a modified version of the MP197 packaging described above, fabricated primarily of nickel-alloy steel. Other materials include the cast lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the resin neutron shield, and the carbon steel closure bolts. Socket-headed cap screws (bolts) are used to secure the lid to the package body and the radioactive material access

closure plate to the bottom of the package. The body of the packaging consists of a nickel-alloy steel inner shell, 1.25-inch-thick with a 70.5-inch inside diameter, and a nickel-alloy steel outer shell, 2.75-inch-thick with an 84.5-inch outside diameter, which sandwich the 3-inch-thick cast lead shielding material.

The packaging is 271.25 inch long with a diameter of 126 inches, when both impact limiters are installed. The packaging diameter, including the radial neutron shield, is 97.75 inches without the fins or 104.25 inches with the fins. The fins are an optional feature for heat loads less than or equal to 26 kW. The packaging cavity is 199.25 inches long and 70.5 inches in diameter without the internal sleeve (discussed below) or 68 inches in diameter with the sleeve.

The MP197HB uses an internal aluminum sleeve for smaller diameter DSCs and secondary containers. The inner sleeve is designed with slots to accommodate the existing rails inside the packaging and to provide rails inside the sleeve on which the smaller diameter DSCs or secondary containers slide during horizontal loading or unloading of the package.

The gross weight of the loaded package is 152 tons including a maximum payload of 56 tons. Four removable trunnions, attached to the package body, are provided for lifting and handling operations, including rotation of the packaging between the horizontal and vertical orientations.

The package containment boundary consists of the inner shell, a 6.5-inch-thick bottom plate with a 28.88-inch-diameter, a 2.5-inch-thick radioactive material access closure plate with seal and bolts, a package body flange, a 4.5-inc- thick lid with seal and bolts, vent and drain ports with closures bolts and seals, and all containment welds.

An inert atmosphere (helium) is maintained in the package cavity. Shielding is provided by approximately 4 inches of steel, 3 inches of lead and 6.25 inches of neutron shielding assembly.

To accommodate the NUHOMS®-69BTH DSC with heat loads greater than 26 kW, removable external fins are provided for the packaging.

The DSC consists of a stainless steel shell and a basket assembly. The DSC basket assembly provides criticality control and contains a storage position for each fuel assembly.

There are nine DSC designs and a radioactive waste canister authorized for transport in the NUHOMS®-MP197HB packaging. The packaging cavity is designed to accommodate the larger 69.8-inch-diameter DSCs (32PTH, 32PTH1, 37PTH, and 69BTH DSC). To accommodate the smaller 67.3-inch-diameter DSCs (24PT4, 24PTH, 32PT, 61BT, and 61BTH DSC) or secondary container (RWC), an aluminum inner sleeve is provided. To accommodate the varying lengths of the DSCs and secondary containers, stainless steel or aluminum spacers are provided to limit axial movement of the payload.

Spacers are to be installed in the MP197HB overpack or DSC cavity, if necessary, to limit the axial gaps between the components.

The maximum weight of the payload (DSC including the fuel) is limited to 56 tons.

b. Physical description of the impact limiters

The two impact limiters, consisting of a laminate of balsa wood and redwood encased in stainless steel shells, are attached to the top (front) and bottom (rear) of the packaging by 12 bolts. The impact limiters are provided with seven fusible plugs that are designed to melt during a fire accident, thereby relieving excessive internal pressure. Each impact limiter has two hoist rings for handling. The hoist rings are threaded into the impact limiter shell. During transportation, the impact limiter hoist rings are removed. An aluminum thermal shield is added to the bottom impact limiter to reduce the impact limiter wood temperature. The weight of the impact limiters, the thermal shield, and attachment bolts, is approximately 28,000 lbs. Additionally, a personnel barrier is mounted to the transportation frame to prevent access to the body of the package during transport.

c. Design waste volume (contents listed as number of fuel assemblies)

61 intact standard BWR fuel assemblies with or without fuel channels

d. Mode of transportation

The NUHOMS®-MP197 and NUHOMS®-MP197HB can be transported by rail, truck, or boat. Transport by air is not authorized.

12. Model No. TN-40

The certificate of compliance for the Model No. TN-40 can be found in ADAMS using Accession No. ML14070A388.

a. Physical description of the packaging

The TN-40 is designed to transport up to 40 PWR spent nuclear fuel assemblies discharged from the Prairie Island Nuclear Generating Plant. These assemblies have been stored prior to shipment in the TN-40 package used as a dry storage cask at the Prairie Island Nuclear Generating Plant. These 29 loaded packages are authorized for single use. The TN-40 packaging consists of a basket assembly, a containment vessel, a package body which also functions as the gamma shield and neutron shield, and impact limiters. A transport frame, which is not part of the packaging, is used for tie-down purposes. The containment vessel components consist of the inner shell and bottom inner plate, shell flange, lid outer plate, lid bolts, penetration cover plates and bolts (vent and drain), and the inner metallic seals of the lid seal and the vent and drain seals. The containment vessel prevents leakage of radioactive material from the package cavity. It also maintains an inert atmosphere (helium) in the package cavity. The

overall containment vessel length is approximately 170.5 inches with a wall thickness of 1.5 inches. The cylindrical package cavity has a nominal diameter of 72.0 inches and a length of 163 inches.

Double metallic seals are used for the lid closure. To preclude air in-leakage, the package cavity is pressurized with helium to above atmospheric pressure. The package cavity is accessed via draining and venting ports. Double metallic seals are utilized to seal these two lid penetrations. The over-pressure port provides access to the volumes between the double seals in the lid and cover plates for leak testing purposes. The over-pressure port cover is not part of the containment boundary. The carbon steel packaging body, which also functions as the gamma shielding, is around the inner shell and the bottom inner plate of the containment vessel. The 8.0 inch and 8.75 inch gamma shield completely surround the containment vessel shell and bottom plate, respectively. A 6.0-inch-thick shield plate is also welded to the inside of the 4.5-inch-thick lid outer plate. Radial neutron shielding is provided by a borated polyester resin compound surrounding the gamma shield shell. The total radial thickness of the resin and aluminum is 4.50 inches. The array of resin-filled containers is enclosed within a 0.50-inch-thick outer steel shell. The aluminum container walls also provide a path for heat transfer from the gamma shield shell to the outer shell. A pressure relief valve is mounted on top of the resin enclosure to limit the possible internal pressure increase under hypothetical accident conditions. The basket structure consists of an assembly of stainless steel cells joined by a fusion welding process and separated by aluminum and poison plates, which form a sandwich panel. The panel consists of two aluminum plates separated by a poison plate. The aluminum plates provide the heat conduction paths from the fuel assemblies to the package inner plate. The poison material provides the necessary criticality control. The opening of the cells is 8.05 inches by 8.05 inches which provides a minimum of 1/8 inch clearance around the fuel assemblies. The overall basket length (160.0 inches) is less than the package cavity length to allow for thermal expansion and fuel assembly handling.

The nominal external dimensions, with impact limiters, are 261 inches long by 144 inches wide. The total weight of the package is 271,500 lbs.

b. Physical description of the impact limiters

The impact limiters consist of balsa wood and redwood blocks encased in stainless steel plates. The impact limiters have an outside diameter of 144 inches, and an inside diameter of 92 inches to accommodate the package ends. The bottom limiter is notched to fit over the lower trunnions. The impact limiters are attached to each other using tie rods. The impact limiters are also attached to the outer shell of the package with bolts. Each impact limiter is provided with fusible plugs that are designed to melt during a fire accident, thereby relieving excessive internal pressure. Each impact limiter has lifting lugs for handling, and support angles for holding the impact limiter in a vertical position during storage. An aluminum spacer is placed on the package lid prior to mounting the top impact limiter to provide a smooth contact surface between the lid and the top impact limiter.

c. Design waste volume (contents listed as number of fuel assemblies)

40 PWR spent nuclear fuel assemblies.

d. Mode of transportation

TheTN-40 can be transported by truck, rail, or boat. Air transport is not authorized.

13. Model No. HI-STAR 180

The certificate of compliance for the Model No. HI-STAR 180 can be found in ADAMS using Accession No. ML14281A559.

a. Physical description of the packaging

The HI-STAR 180 package is designed for transportation of undamaged irradiated uranium dioxide ($UO_{2)}$ and MOX fuel assemblies. The fuel basket provides criticality control and the packaging body provides the containment boundary, helium retention boundary, moderator exclusion barrier, gamma and neutron radiation shielding, and heat rejection capability. The outer diameter of the HI-STAR 180 packaging is approximately 2700 mm without impact limiters and approximately 3250 mm with impact limiters. The maximum gross weight of the loaded HI-STAR 180 package is 140 metric tons.

Metamic-HT, a metal matrix composite of aluminum and boron carbide, is the principal constituent material of the fuel basket, both as structural material and neutron absorber material. Two interchangeable fuel basket models, designated F-32 and F-37, contain either 32 or 37 PWR fuel assemblies respectively, in regionalized and uniform loading patterns. The fuel basket features a honeycomb structure and flux traps between some but not all cells. The cylindrical steel shell containment system is welded to a bottom steel baseplate and a top steel forging machined to receive two independent steel closure lids, with each lid being individually designated as a containment boundary component. The outer surface of the package inner shell is buttressed with a monolithic shield cylinder for gamma and neutron shielding. Each closure lid features a dual metallic self-energizing seal system designed to ensure its containment and moderator exclusion functions. For this package, the inner closure lid inner seal and the inner closure lid vent/drain port cover inner seals are the containment boundary components on the inner lid; the outer closure lid inner seal and the outer closure lid access port plug seal are the containment boundary components on the outer lid.

b. Physical description of the impact limiters

The HI-STAR 180 package is fitted with two impact limiters fabricated of aluminum honeycomb crush material completely enclosed by an all-welded austenitic stainless steel skin. Both impact limiters are attached to the package with 16 bolts.

c. Design waste volume (contents listed as number of fuel assemblies)

32 or 37 PWR fuel assemblies depending on the basket used.

d. Mode of transportation

The HI-STAR 180 can be transported by truck, rail, or boat. Air transport is not authorized.

14. Model No. HI-STAR 60

The certificate of compliance for the Model No. HI-STAR 60 can be found in ADAMS using Accession No. ML14127A092.

a. Physical description of the packaging

The HI-STAR 60 packaging is designed for transportation of irradiated nuclear fuel assemblies. The fuel basket provides criticality control and the package provides the containment boundary, helium retention boundary, gamma and neutron radiation shielding, and heat rejection capability. The outer diameter of the HI-STAR 60 package is approximately 1924 mm without impact limiters and approximately 2864 mm with impact limiters. The maximum gross weight of the loaded HI-STAR 60 package, as presented for transportation, is 74.4 metric tons.

Fuel Basket

The fuel basket, designated F-12 for the transport of 12 pressurized water reactor (PWR) fuel assemblies, is a fully welded, stainless steel, honeycomb structure and features flux traps between some but not all cells.

Fuel Impact Attenuators

Fuel impact attenuators are spacers designed to limit internal gaps between the fuel assembly end-fittings and the internal surfaces of the package. fuel impact attenuators also mitigate the g-loads on the fuel assemblies due to secondary internal impact.

Package

The HI-STAR 60 package is a multi-layer steel cylinder with a welded base-plate and bolted lid (closure plate). The inner shell of the package forms an internal cylindrical cavity for housing the basket. The outer surface of the package inner shell is buttressed with intermediate steel shells for radiation shielding. The package closure plate incorporates a dual O-ring design to ensure its containment function. The containment system consists of the package inner shell, bottom plate, top flange, top closure plate, top closure inner O-ring seal, vent port plug and seal, and drain port plug and seal.

Fastener Strain Limiters

Fastener strain limiters are collapsible devices designed to limit the axial stress imparted to the impact limiter attachment bolts.

b. Physical description of the impact limiters

The HI-STAR 60 package is fitted with two impact limiters fabricated of aluminum honeycomb crush material completely enclosed by an all-welded austenitic stainless steel skin. The two impact limiters are attached to the package with eight bolts at the top and bottom, respectively. The outer diameter of the HI-STAR 60 package is approximately 2864 mm with impact limiters. The length of the HI-STAR 60 increases by 2932 mm with impact limiters.

c. Design waste volume

12 PWR spent fuel assemblies.

d. Mode of transportation

The HI-STAR 60 can be transported by truck, boat, or rail. Air transport is not authorized.

15. Model No. BEA Research Reactor (BRR) Package

The certificate of compliance for the Model No. BEA Research Reactor (BRR) Package can be found in ADAMS using Accession No. ML15021A076.

a. Physical description of the packaging

A package used to transport fuel elements that have been irradiated in various test and research reactors. The package is comprised of a lead–shielded cask body, payload basket, an upper shield plug, a closure lid, upper and lower impact limiters, and utilizes ASTM Type 304 stainless steel as its primary structural material. The cask is a right circular cylinder 77.1 inches long and 38 inches in diameter, not including the impact limiter attachments and the thermal shield. Lead shielding is located between two circular shells, in the lower end structure, and in the shield plug. The payload cavity has a diameter of 16 inches and a length of 54 inches.

There are four baskets used with the package, one for each type of fuel transported. The baskets are made from welded construction using ASTM Type 304 stainless steel in plate, bar, pipe, and tubular forms. Each basket has a diameter of 15.63 inches and a length of 53.45 inches, and features a number of cavities that fit the size and shape of the fuel.

The package is designed to be transported as one package per conveyance, with its longitudinal axis vertical, by highway truck or by rail in exclusive use. When loaded and prepared for transport, the package is 119.5 inches long, 78 inches in diameter (over the impact limiters), and weighs 32,000 lb.

b. Physical description of the impact limiters

Impact limiters are attached to each end, having essentially identical design. Each limiter is 78 inches in diameter and 34.6 inches long overall, with a conical section 15 inches long towards the outer end. The impact limiter design consists of ASTM Type 304 stainless steel shells and approximately 9 lb/ft^3 polyurethane foam.

c. Design waste volume (contents listed as number of fuel assemblies)

- 8 irradiated Missouri University Research Reactor, Massachusetts Institute of Technology Nuclear Research Reactor (MITR-II), or Advanced Test Reactor, fuel elements, or
- 19 irradiated TRIGA fuel elements.

d. Mode of transportation

The BEA Research Reactor package can be transported by truck, rail or boat. Transport by air is not authorized.

16. Model No. TN-LC

The certificate of compliance for the Model No. TN-LC can be found in ADAMS using Accession No. Accession No. ML14119A201.

a. Physical description of the packaging

The packaging, designed for transport of irradiated test, research, and commercial reactor fuel in either a closed transport vehicle or an International Standards Organization container, consists of a payload basket, a shielded body, a shielded closure lid and top and bottom impact limiters. The packaging body is a right circular cylinder, approximately 197.5 inches long and 30 inches in diameter, composed of top and bottom end flange forgings connected by inner and outer shells. Lead shielding, made of ASTM B29 copper lead, is placed between the two cylindrical shells, in the bottom end assembly, and in the lid. Neutron shielding, composed of a borated resin compound inserted into twenty aluminum shield boxes, is set between the outer shell and a 0.25 inch-thick Type 304 stainless steel outer sheet. Two removable trunnions are bolted to the packaging body using eight 1-8 Unified National Coarse (UNC) Thread bolts for each trunnion. Two pocket trunnions in the bottom flange, used for rotating the package, may also be used for horizontal package lifting.

Four basket designs are provided for transport of BWR, PWR, MOX, Evolutionary Pressurized Reactor (EPR), National Research Universal Reactor (NRU), National Research Experimental Reactor (NRX), MTR, and TRIGA fuel assemblies, fuel elements or fuel rods.

The packaging may be loaded or unloaded either in a pool or a hot cell environment. The spent fuel payload is shipped dry in a helium atmosphere.

Nominal weights and dimensions are as follows:
Overall length with impact limiters……..230 inches
Overall length without impact limiters……197.50 inches
Cavity length (minimum)……..182.50 inches
Cavity inner diameter……..……18 inches
Lid thickness……..7.50 inches
Weight of contents……..7,100 lbs
Weight of lid……1,000 lbs
Weight of impact limiters……3,000 lbs
Total loaded weight of the package……51,000 lbs

b. Physical description of the impact limiters

Impact limiters, with an approximate outside diameter of 66 inches and height of 22.75 inches, consisting of balsa and redwood blocks encased in stainless steel shells, are attached to each end of the packaging during shipment, each with eight 1-8UNC bolts.

c. Design waste volume (contents listed as number of fuel assemblies)

- Up to 26 NRU or NRX assemblies,
- 54 intact or damaged MTR fuel elements,
- 180 intact TRIGA fuel elements/assemblies,
- 1 intact PWR or BWR fuel assembly, or
- Up to 25 intact PWR (including MOX and EPR) or BWR fuel rods in a pin can.

d. Mode of transportation

The TN-LC can be transported by truck, boat, or rail. Air transport is not authorized.

17. Model No. HI-STAR 180D

The certificate of compliance for the Model No. HI-STAR 180D can be found in ADAMS using Accession No. ML14255A491.

a. Physical description of the packaging

The HI-STAR 180D package is designed for transportation of undamaged irradiated uranium oxide (UO_2) fuel assemblies. The fuel basket provides criticality control and the packaging body provides the containment boundary, helium retention boundary, moderator exclusion barrier, gamma and neutron radiation shielding, and heat rejection capability. The outer diameter of the HI-STAR 180D packaging is approximately 2712 mm without impact limiters and approximately 3250 mm with impact limiters. The maximum gross weight of the loaded HI-STAR 180D package is 125 Metric Tons.

Fuel Basket

Metamic-HT, a metal matrix composite of aluminum and boron carbide, is the principal constituent material of the fuel basket, both as structural material and neutron absorber material. Two interchangeable fuel basket models, designated F-32 and F-37, contain either 32 or 37 pressurized water reactor (PWR) fuel assemblies respectively, in regionalized and uniform loading patterns. The fuel basket features flux traps between some, but not all, cells.

Packaging Body

The cylindrical steel shell containment system is welded to a bottom steel baseplate and a top steel forging machined to receive two independent steel closure lids, with each lid being individually designated as a containment boundary component. The outer surface of the cask inner shell is buttressed with a monolithic shield cylinder for gamma and neutron shielding. Each closure lid features a dual metallic self-energizing seal system designed to ensure its containment and moderator exclusion functions. For this package, the inner closure lid inner seal and the inner closure lid vent/drain port cover inner seals are the containment boundary components on the inner lid; the outer closure lid inner seal and the outer closure lid access port plug seal are the containment boundary components on the outer lid.

b. Physical description of the impact limiters:

The HI-STAR 180D package is fitted with two impact limiters fabricated of aluminum crush material completely enclosed by an all-welded austenitic stainless steel skin. Both impact limiters are attached to the body of the packaging with 16 bolts.

c. Design waste volume (contents listed as number of fuel assemblies)

32 or 37 PWR fuel assemblies in the F-32 or F-37 basket, respectively.

d. Mode of transportation

The HI-STAR 180D can be transported by truck, rail, or boat. Air transport is not authorized.