NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE		PAGES
9235	14	71-9235	USA/9235/B(U)F-96	1	OF	19

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*
NAC International
3930 East Jones Bridge Road, Suite 200
Norcross, Georgia 30092

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION
NAC International, application dated
May 25, 2011.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.(a) Packaging

(1) Model No.: NAC-STC

(2) Description: For descriptive purposes, all dimensions are approximate nominal values. Actual dimensions with tolerances are as indicated on the Drawings.

A steel, lead and polymer (NS4FR) shielded shipping cask for (a) directly loaded irradiated pressurized water reactor (PWR) fuel assemblies, (b) intact, damaged and/or the fuel debris of Yankee Class or Connecticut Yankee irradiated PWR fuel assemblies in a canister, (c) non-fissile, solid radioactive materials (referred to hereafter as Greater Than Class C (GTCC) as defined in 10 CFR Part 61) waste in a canister, and (d) West Valley Demonstration Project (WVDP) High-Level Waste (HLW) canisters in a HLW Overpack. The cask 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
Cask 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 pounds (lbs.).

5.(a)(2) Description (Continued)

Cask body. The cask 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 cask. The bottom end of the cask 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 cask 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 42, 1-½-inch diameter bolts and the outer lid is fastened by 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 cask 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 cask 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 cask.

Impact limiter. The package is equipped at each end with an impact limiter made of redwood and balsa. 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 cask 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 Yankee-multi-purpose canister (MPC) configuration.

Basket and transportable storage canister. The spent fuel contents are transported either directly-loaded (uncanistered) into a stainless steel fuel basket, or within a stainless steel transportable storage canister (TSC). The WVDP-HLW contents are transported in a stainless steel basket inside a transportable canister referred to as the HLW Overpack or WVDP-HLW Overpack.

5.(a)(2) Description (Continued)

Directly-loaded fuel basket. The directly-loaded fuel basket within the cask 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.

Yankee Class MPC and Connecticut Yankee MPC TSC assemblies. The Yankee Class MPC and Connecticut Yankee 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-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.

Yankee Class MPC TSC fuel basket. 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.

Connecticut Yankee MPC fuel basket. The Connecticut Yankee 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

5.(a)(2) Description (Continued)

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.

LaCrosse boiling water reactor multi-purpose canister MPC-LACBWR TSC assembly. The LaCrosse boiling water reactor multi-purpose canister MPC-LACBWR 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.

TSC GTCC basket. 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 cask cavity by two aluminum honeycomb spacers. The spacers, which are enclosed in a Type 6061-T651 aluminum alloy shell, position the canister within the cask 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 cask cavity by one stainless steel spacer located in the bottom of the cask cavity.

WVDP-HLW Overpack and transport inserts. The WVDP-HLW Overpack measures 126.5 in. in length by 70.6 inches in diameter. The WVDP-HLW Overpack consists of three (3) principal components, namely the WVDP-HLW Overpack shell, basket, and closure lid. The HLW Overpack consists of an annular right circular shell closed at one end by a bottom plate. The shell is constructed of 3/8-inch rolled dual certified Type 304/304L stainless steel plate. The edges of the rolled plates are joined with full penetration welds. The dual certified Type 304/304L stainless steel bottom plate is also attached to the shell by using a full penetration weld. The basket is an assembly of five vertical cylindrical cells held by supporting plates, all

5.(a)(2) Description (Continued)

fabricated from 304 stainless steel. The basket's cells position up to five (5) HLW canisters, melter-evacuated canisters, or HLW debris canisters inside the Overpack. For shipments of less than 5 HLW canisters (i.e., partially loaded basket), transport inserts occupy the unused cylindrical cells. The material used for fabricating the transport insert is 304 stainless steel.

Spacer assemblies for WVDP-HLW Overpack. Two spacer assemblies serve for configuration control of the WVDP-HLW Overpack within the NAC-STC package. One spacer is positioned below the HLW Overpack and a second spacer is positioned above the HLW Overpack. Both spacer assemblies are constructed of concentric rings of 304 stainless steel welded to a stainless steel base plate.

5.(a)(3) Drawings

High burnup fuel is not an authorized content for the Model No. NAC-STC. Components and items included in Condition Nos. 5.(a)(3)(i) and 5.(a)(3)(v) related to high burnup fuel are not approved for use. This includes the fuel tube and neutron absorber specifications identified in the notes for the drawings as excluded items.

(i) For the approved contents and quantity of materials specified in Condition No. 5.(b) of this certificate of compliance, the cask is constructed and assembled in accordance with the following Nuclear Assurance Corporation (now NAC International) Drawing Nos.:

423-800, sheets 1-3, Rev. 17P(1) and 17NP(1)
423-802, sheets 1-7, Rev. 21
423-803, sheets 1-2, Rev. 10
423-804, sheets 1-3, Rev. 9
423-805, sheets 1-2, Rev. 7
423-806, Rev. 8
423-807, sheets 1-3, Rev. 4
423-811, sheets 1-2, Rev. 11
423-812, Rev. 6
423-900, Rev. 6
423-209, Rev. 0
423-210, Rev. 0
423-901, Rev. 2

Note:
(1) Excludes components and items related to Assembly No. 97, Note 14, and the reference in Note 1 to Assembly 423-870-98. These three items are specific for high burnup fuel contents.

5.(a)(3) Drawings

(ii) For the directly loaded configuration, the basket is constructed and assembled in accordance with the following Nuclear Assurance Corporation (now NAC International) Drawing Nos.:

423-870, Rev. 5
423-871, Rev. 5
423-872, Rev. 6
423-873, Rev. 2
423-874, Rev. 2
423-875, sheets 1-2, Rev. 7

(iii) For the Yankee Class TSC configuration, the canister, and the fuel and GTCC waste baskets are constructed and assembled in accordance with the following NAC International Drawing Nos.:

455-800, sheets 1-2, Rev. 2
455-801, sheets 1-2, Rev. 4
455-820, sheets 1-2, Rev. 3
455-870, Rev. 5
455-871, sheets 1-2, Rev. 8
455-871, sheets 1-3, Rev. 7P2[1]
455-872, sheets 1-2, Rev. 12
455-872, sheets 1-2, Rev. 11P1[1]
455-873, Rev. 4
455-881, sheets 1-3, Rev. 8
455-887, sheets 1-3, Rev. 4
455-901, Rev. 0P0[1]
455-888, sheets 1-2, Rev. 8
455-891, sheets 1-2, Rev. 1
455-891, sheets 1-3, Rev. 2P0[1]
455-892, sheets 1-2, Rev. 3
455-892, sheets 1-3, Rev. 3P0[1]
455-893, Rev. 3
455-894, Rev. 2
455-895, sheets 1-2, Rev. 5
455-895, sheets 1-2, Rev. 5P0[1]
455-902, sheets 1-5, Rev. 0P4[1]
455-919, Rev. 2

(iv) For the Yankee Class TSC configuration, RFAs are constructed and assembled in accordance with the following Yankee Atomic Electric Company Drawing Nos.:

YR-00-060, Rev. D3
YR-00-061, Rev. D4
YR-00-062, sheet 1, Rev. D4
YR-00-062, sheet 2, Rev. D2
YR-00-062, sheet 3, Rev. D1
YR-00-063, Rev. D4
YR-00-064, Rev. D4
YR-00-065, Rev. D2
YR-00-066, sheet 1, Rev. D5
YR-00-066, sheet 2, Rev. D3

[1] Drawing defines the alternate configuration that accommodates the Yankee-MPC damaged fuel can.

5.(a)(3) Drawings (Continued)

(v) The Balsa Impact Limiters are constructed and assembled in accordance with the following NAC International Drawing Nos.:

423-257, Rev. 2
423-258, Rev. 2
423-843, Rev. 5(1)
423-859, Rev. 0

Note:
(1) Approval of drawing No. 423-843, Rev. 5, excludes components and items related to Assembly No. 91. Assembly No. 91 is specific for high burnup fuel contents.

(vi) For the Connecticut Yankee TSC configuration, the canister and the fuel and GTCC waste baskets are constructed and assembled in accordance with the following NAC International Drawing Nos.:

414-801, sheets 1-2, Rev. 2
414-820, Rev.0
414-870, Rev.3
414-871, sheets 1-2, Rev.6
414-872, sheets 1-3, Rev.6
414-887, sheets1-4, Rev. 4
414-889, sheets 1-3, Rev. 7
414-891, Rev. 3
414-892, sheets 1-3, Rev. 3
414-873, Rev.2
414-874, Rev.0
414-875, Rev.0
414-881, sheets 1-2, Rev. 4
414-882, sheets 1-2, Rev.4
414-893, sheets 1-2, Rev. 3
414-894, Rev. 0
414-895, sheets 1-2, Rev. 4

(vii) For the Connecticut Yankee TSC configuration, DFCs and RFAs are constructed and assembled in accordance with the following NAC International Drawing Nos.:

414-901, Rev. 1
414-902, sheets 1-3, Rev. 3
414-903, sheets 1-2, Rev. 1
414-904, sheets 1-3, Rev. 0

(viii) For the Dairyland Power Cooperative LaCrosse BWR transport package and TSC configuration, the TSC, fuel basket, and DFCs are constructed and assembled in accordance with the following NAC International Drawing Nos.:

630045-800, sheets 1-2, Rev. 0
630045-870, Rev. 2
630045-872, sheets 1-2, Rev. 1
630045-877, Rev. 1
630045-881, sheets 1-2, Rev. 1
630045-894, Rev. 1
630045-901, Rev. 0
630045-820, Rev. 0
630045-871, sheets 1-4, Rev. 2
630045-873, Rev. 1
630045-878, Rev. 1
630045-893, Rev. 1
630045-895, sheets 1-3, Rev. 1
630045-902, sheets 1-2, Rev. 1

5.(a)(3) Drawings (Continued)

(ix) For the West Valley Demonstration Project High-Level Waste, the HLW Overpack (shell, basket, and closure lid), overpack spacers, and transport inserts are constructed and assembled in accordance with the following NAC International Drawing Nos.:

630087-501, sheets 1-2, Rev. 1
630087-504, Rev. 0
630087-505, Rev. 0
630087-510, Rev. 1
630087-511, Rev. 1
630087-512, Rev. 1
630087-513, sheets 1-3, Rev. 1
630087-514, Rev. 0

5.(b) Contents

(1) Type and form of material

(i) Irradiated PWR fuel assemblies with uranium oxide pellets. Each fuel assembly may have a maximum burnup of 45 GWD/MTU. The minimum fuel cool time is defined in the Fuel Cool Time Table, below. The maximum heat load per assembly is 850 watts. Prior to irradiation, the fuel assemblies must be within the following dimensions and specifications:

5.(b)(1)(i) Contents - Type and Form of Material - Irradiated PWR fuel assemblies (Continued)

Assembly Type	14x14	15x15	16x16	17x17	17x17 (OFA)	Framatome-Cogema 17x17
Cladding Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirconium Alloy
Maximum Initial Uranium Content (kg/assembly)	407	469	402.5	464	426	464
Maximum Initial Enrichment (wt% ^{235}U)	4.2	4.2	4.2	4.2	4.2	4.5
Minimum Initial Enrichment (wt% ^{235}U)	1.7	1.7	1.7	1.7	1.7	1.7
Assembly Cross- Section (inches)	7.76 to 8.11	8.20 to 8.54	8.10 to 8.14	8.43 to 8.54	8.43	8.425 to 8.518
Number of Fuel Rods per Assembly	176 to 179	204 to 216	236	264	264	264(1)
Fuel Rod OD (inch)	0.422 to 0.440	0.418 to 0.430	0.382	0.374 to 0.379	0.360	0.3714 to 0.3740
Minimum Cladding Thickness (inch)	0.023	0.024	0.025	0.023	0.023	0.0204
Pellet Diameter (inch)	0.344 to 0.377	0.358 to 0.390	0.325	0.3225 to 0.3232	0.3088	0.3224 to 0.3230
Maximum Active Fuel Length (inches)	146	144	137	144	144	144.25

Note:
(1) Fuel rod positions may also be occupied by solid poison shim rods or solid zirconium alloy or stainless steel fill rods that displace an amount of water greater than or equal to that displaced by the original fuel rod(s).

5.(b)(1)(i) Contents - Type and Form of Material - Irradiated PWR fuel assemblies (Continued)

FUEL COOL TIME TABLE
Minimum Fuel Cool Time in Years

	Fuel Assembly Burnup (BU)															
Uranium Enrichment (wt% ^{235}U)	**BU ≤ 30 GWD/MTU**				**30 < BU ≤ 35 GWD/MTU**				**35 < BU ≤ 40 GWD/MTU**				**40 < BU ≤ 45 GWD/MTU**			
Fuel Type	14x14	15x15	16x16	17x17	14x14	15x15	16x16	17x17	14x14	15x15	16x16	17x17	14x14	15x15	16x16	17x17
1.7≤E<1.9	8	7	6	7	10	10	7	9	--	--	--	--	--	--	--	--
1.9≤E<2.1	7	7	5	7	9	9	7	8	12	13	9	11	--	--	--	--
2.1≤E<2.3	7	7	5	6	9	8	6	8	11	11	8	10	--	--	--	--
2.3≤E<2.5	6	6	5	6	8	8	6	7	10	10	8	9	14	15	12	14
2.5≤E<2.7	6	6	5	6	8	7	6	7	10	9	7	9	13	14	10	12
2.7≤E<2.9	6	6	5	5	7	7	5	6	9	9	7	8	12	12	9	11
2.9≤E<3.1	6	5	5	5	7	7	5	6	9	8	6	8	11	11	8	10
3.1≤E<3.3	5	5	5	5	7	6	5	6	8	8	6	7	10	10	8	9
3.3≤E<3.5	5	5	5	5	6	6	5	6	8	7	6	7	10	10	7	9
3.5≤E<3.7	5	5	5	5	6	6	5	6	7	7	6	7	9	9	7	9
3.7≤E<3.9	5	5	5	5	6	6	5	6	7	7	6	7	9	9	7	9
3.9≤E<4.1	5	5	5	5	6	6	5	6	7	7	6	7	8	9	7	9
4.1≤E≤4.2	5	5	5	5	5	6	5	6	6	7	6	7	8	8	7	9
4.2<E<4.3	--	--	--	5(1)	--	--	--	6(1)	--	--	--	7(1)	--	--	--	9(1)
4.3≤E≤4.5	--	--	--	5(1)	--	--	--	6(1)	--	--	--	7(1)	--	--	--	8(1)

Note:
(1) Framatome-Cogema 17x17 fuel only.

5.(b)(1) Contents - Type and Form of Material (Continued)

(ii) Irradiated intact Yankee Class PWR fuel assemblies or RFAs within the TSC. The maximum initial fuel pin pressure is 315 psig. The fuel assemblies consist of uranium oxide pellets with the specifications, based on design nominal or operating history record values, listed below:

Assembly Manufacturer/Type	UN 16x16	CE [1] 16x16	West. 18x18	Exxon [2] 16x16	Yankee RFA	Yankee DFC
Cladding Material	Zircaloy	Zircaloy	SS	Zircaloy	Zirc/SS	Zirc/SS
Maximum Number of Rods per Assembly	237	231	305	231	64	305
Maximum Initial Uranium Content (kg/assembly)	246	240	287	240	70	287
Maximum Initial Enrichment (wt% ^{235}U)	4.0	3.9	4.94	4.0	4.94	4.97 [3]
Minimum Initial Enrichment (wt% ^{235}U)	4.0	3.7	4.94	3.5	3.5	3.5 [3]
Maximum Assembly Weight (lbs)	≤ 950	≤ 950	≤ 950	≤ 950	≤ 950	≤ 950
Maximum Burnup (MWD/MTU)	32,000	36,000	32,000	36,000	36,000	36,000
Maximum Decay Heat per Assembly (kW)	0.28	0.347	0.28	0.34	0.11	0.347
Minimum Cool Time (yrs)	11.0	8.1	22.0	10.0	8.0	8.0
Maximum Active Fuel Length (in)	91	91	92	91	92	N/A

Notes:

1. Combustion Engineering (CE) fuel with a maximum burnup of 32,000 MWD/MTU, a minimum enrichment of 3.5 wt. % ^{235}U, a minimum cool time of 8.0 years, and a maximum decay heat per assembly of 0.304 kW is authorized.
2. Exxon assemblies with stainless steel in-core hardware shall be cooled a minimum of 16.0 years with a maximum decay heat per assembly of 0.269 kW.
3. Stated enrichments are nominal values (fabrication tolerances are not included).

5.(b)(1) Contents - Type and Form of Material (Continued)

(iii) Solid, irradiated, and contaminated hardware and solid, particulate debris (dross) or filter media placed in a GTCC waste container, provided the quantity of fissile material does not exceed a Type A quantity, and does not exceed the mass limits of 10 CFR 71.15.

(iv) Irradiated intact and damaged Connecticut Yankee (CY) Class PWR fuel assemblies (including optional stainless steel rods inserted into the CY intact and damaged fuel assembly reactor control cluster assembly (RCCA) guide tubes that do not contain RCCAs), RFAs, or DFCs within the TSC. The maximum initial fuel pin pressure is 475 psig. The fuel assemblies consist of uranium oxide pellets with the specifications, based on design nominal or operating history record values, listed below:

Assembly Manufacturer/Type	PWR [1] 15x15	PWR [2] 15x15	PWR [3]	CY-MPC RFA [4]	CY-MPC DFC [5]
Cladding Material	SS	Zircaloy	Zircaloy	Zirc/SS	Zirc/SS
Maximum Number of Assemblies	26	26	24	4	4
Maximum Initial Uranium Content (kg/assembly)	433.7	397.1	390	212	433.7
Maximum Initial Enrichment (wt% ^{235}U)	4.03	3.93	4.61	4.61[6]	4.61[6]
Minimum Initial Enrichment (wt% ^{235}U)	3.0	2.95	2.95	2.95	2.95
Maximum Assembly Weight (lbs)	≤ 1,500	≤ 1,500	≤ 1,500	≤ 1,600	≤ 1,600
Maximum Burnup (MWD/MTU)	38,000	43,000	43,000	43,000	43,000
Maximum Decay Heat per Assembly (kW)	0.654	0.654	0.654	0.321	0.654
Minimum Cool Time (yrs)	10.0	10.0	10.0	10.0	10.0
Maximum Active Fuel Length (in)	121.8	121.35	120.6	121.8	121.8

Notes:
1. Stainless steel assemblies manufactured by Westinghouse Electric Co., Babcock & Wilcox Fuel Co., Gulf Gen. Atomics, Gulf Nuclear Fuel, & Nuclear Materials & Man. Co.
2. Zircaloy spent fuel assemblies manufactured by Gulf Gen. Atomics, Gulf Nuclear Fuel, & Nuclear Materials & Man. Co., and Babcock & Wilcox Fuel Co.
3. Westinghouse Vantage 5H zircaloy clad spent fuel assemblies have an initial uranium enrichment > 3.93 % wt. U^{235}.
4. Reconfigured Fuel Assemblies (RFA) must be loaded in one of the 4 oversize fuel loading positions.
5. Damaged Fuel Cans (DFC) must be loaded in one of the 4 oversize fuel loading positions.
6. Enrichment of the fuel within each DFC or RFA is limited to that of the basket configuration in which it is loaded.

5.(b)(1) Contents - Type and Form of Material (Continued)

(v) Irradiated undamaged and damaged Dairyland Power Cooperative LACBWR fuel assemblies based on design nominal or operating history record values listed below. Fuel assemblies may contain zirconium alloy shroud compaction debris.

Parameter	Units	Allis Chalmers	Exxon
Number of Assemblies per Canister[1]	---	32	68
Maximum Assembly Weight[6]	lbs	400	400
Assembly Length	In	103	103
Fuel Rod Cladding	---	Stainless Steel	Stainless Steel
Maximum Initial Uranium Mass[2]	kgU	121.4	111.9
Maximum Initial Enrichment	wt% ^{235}U	3.64/3.94[5]	3.71[3]
Minimum Initial Enrichment	wt% ^{235}U	3.6	3.6
Maximum Burnup	MWd/MTU	22,000	21,000
Maximum Assembly Decay Heat	W	63	62
Minimum Cool Time	Yr	28	23
Assembly Array Configuration	---	10X10	10X10
Number of Fuel Rods	---	100	96
Maximum Active Fuel Length	in	83	83
Rod Pitch	in	0.565	0.557
Rod Diameter	in	0.396	0.394
Pellet Diameter	in	0.350	0.343
Clad Thickness	in	0.020	0.0220
Number of Inert Rods[4]	---	0	4
Inert Rod OD	in	N/A	0.3940

1. Maximum 68 assemblies per canister. Allis Chalmers fuel is restricted to Damaged Fuel Cans (DFCs). Therefore, Allis Chalmers fuel is limited to 32 assemblies per canister.
2. DFCs have been evaluated for 2% additional fuel rod mass.
3. Represents planar average enrichment.
4. Inert rods comprised of stainless steel clad tube containing zirconium alloy slug. Inert rods not required for fuel assemblies located in DFC.
5. Two Allis Chalmers fuel types: Type 1 at an enrichment of 3.64 wt% ^{235}U and Type 2 at 3.94 wt% ^{235}U.
6. Not including weight of DFC. DFCs may contain optional inner container subject to maximum weight and fissile material limits in this table.

5.(b)(1) Contents - Type and Form of Material (Continued)

(vi) West Valley Demonstration Project (WVDP) High Level Waste (HLW) stainless steel canisters containing HLW vitrified in borosilicate glass. A WVDP-HLW Overpack may contain HLW canisters, melter-evacuated canisters partially filled with HLW glass or HLW debris. The contents of a package containing the WVDP-HLW are limited to up five HLW canisters, up to two evacuated canisters and one debris canister, in any combination. All canisters are closed with a permanent welded closure, and have a nominal height of ≤ 118 inches and an outside diameter of ≤ 24 inches, approximately. The heat load shall be ≤ 0.300 kW per HLW canister. The maximum gross weight allowed per canister is 5,500 lbs. The following are the applicable design limits for the HLW:

WVDP-HLW Canisters	
Maximum HLW Mass (kg)	2,200
Maximum Ci Content HLW	
^{137}Cs	42,000
^{137m}Ba	40,000
^{90}Sr	23,000
^{90}Y	23,000
^{60}Co	0.2

The quantity of fissile material in the WVDP-HLW Overpack shall not exceed the limits of 10 CFR 71.15.

5.(b)(2) Maximum quantity of material per package

(i) For the contents described in Item 5.(b)(1)(i): 26 PWR fuel assemblies with a maximum total weight of 39,650 lbs. and a maximum decay heat not to exceed 22.1 kW per package.

(ii) For the contents described in Item 5.(b)(1)(ii): Up to 36 intact fuel assemblies to the maximum content weight limit of 30,600 lbs. with a maximum decay heat of 12.5 kW per package. Intact fuel assemblies shall not contain empty fuel rod positions and any missing rods shall be replaced by a solid Zircaloy or stainless steel rod that displaces an equal amount of water as the original fuel rod. Mixing of intact fuel assembly types is authorized.

(iii) For intact fuel rods, damaged fuel rods and fuel debris of the type described in Item 5.(b)(1)(ii): up to 36 RFAs, each with a maximum equivalent of 64 full length Yankee Class fuel rods and within fuel tubes. Mixing of directly loaded intact assemblies and damaged fuel (within RFAs) is authorized. The total weight of damaged fuel within RFAs or mixed damaged RFA and intact assemblies shall not exceed 30,600 lbs. with a maximum decay heat of 12.5 kW per package.

5.(b)(2) Maximum quantity of material per package (Continued)

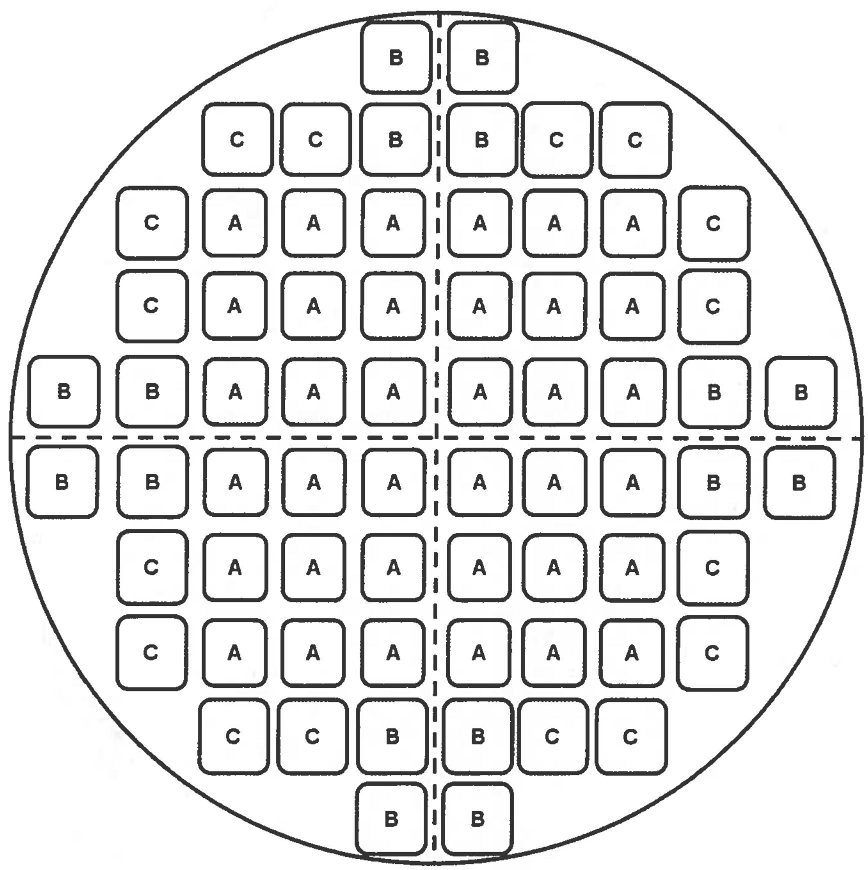
(iv) For the contents described in Item 5.(b)(1)(iii): for Connecticut Yankee GTCC waste up to 24 containers of GTCC waste. The total cobalt-60 activity shall not exceed 196,000 curies. The total weight of the waste containers shall not exceed 18,743 lbs. with a maximum decay heat of 5.0 kW. For all others, up to 24 containers of GTCC waste. The total cobalt-60 activity shall not exceed 125,000 curies. The total weight of the waste and containers shall not exceed 12,340 lbs. with a maximum decay heat of 2.9 kW.

(v) For the contents described in Item 5.(b)(1)(iv): up to 26 Connecticut Yankee fuel assemblies, RFAs or damaged fuel in CY-MPC DFCs for stainless steel clad assemblies enriched up to 4.03 wt. percent and Zirc-clad assemblies enriched up to 3.93 wt. percent. Westinghouse Vantage 5H fuel and other Zirc-clad assemblies enriched up to 4.61 wt. percent must be installed in the 24-assembly basket, which may also hold other Connecticut Yankee fuel types. 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. The total weight of damaged fuel within RFAs or mixed damaged RFAs and intact assemblies shall not exceed 35,100 lbs. with a maximum decay heat of 0.654 kW per assembly for a canister of 26 assemblies. A maximum decay heat of 0.321 kW per assembly for Connecticut Yankee RFAs and of 0.654 kW per canister for the Connecticut Yankee DFCs is authorized.

(vi) For the contents described in 5.(b)(1)(v): Up to 68 LACBWR assemblies, including up to 32 damaged fuel assemblies contained in DFCs, may be transported in the MPC-LACBWR TSCs.

5.(b)(2)(vi) Maximum quantity of material per package (Continued)

Total weight of contents within the MPC-LACBWR TSC is 28,870 lbs., including the weight of 32 DFCs. The maximum decay heat is 4.5 kW per package. LACBWR undamaged fuel assemblies and LACBWR DFCs must be loaded in accordance with the following loading pattern:



Slot A: Undamaged Exxon fuel maximum planar average enrichment 3.71 wt% ^{235}U.

Slot B: Undamaged or damaged Exxon fuel maximum planar average enrichment 3.71 wt% ^{235}U, up to four slots maximum, B and C combined. Damaged Allis Chalmers fuel maximum enrichment 3.64 wt% ^{235}U.

Slot C: Undamaged or damaged Exxon fuel maximum planar average enrichment 3.71 wt% ^{235}U, up to four slots maximum, B and C combined. Damaged Allis Chalmers fuel maximum enrichment 3.94 wt% ^{235}U.

LACBWR DFCs are allowed to contain an additional 2% fissile material to account for loose pellets, not necessarily associated with the as-built fuel assembly.

NOTE: The above sketch is not to scale. It is a depiction of the loading pattern.

5.(b)(2) Maximum quantity of material per package (Continued)

(vii) For the contents Described in 5.(b)(1)(vi): Up to five (5) HLW canisters may be transported in the WVDP-HLW Overpack, including melter-evacuated canisters partially filled with HLW glass or canisters with HLW debris. A single WVDP-HLW Overpack is limited to a load of up to five (5) HLW canisters, two (2) melter-evacuated canisters, and one (1) HLW debris canister, in any combination. For a WVDP-HLW Overpack loaded with less than 5 canisters, a transport insert shall be loaded in all empty basket cell locations.

The NAC-STC content weight shall be ≤ 45,800 lbs. in the WVDP-HLW Overpack configuration. The WVDP-HLW Overpack heat load shall be ≤ 1.5 kW. Top and bottom spacers are used for axial positioning of the WVDP-HLW Overpack within the NAC-STC cavity.

5.(c) Criticality Safety Index (CSI):

(1) CSI=0.0 for contents described in 5.(b)(1)(i), 5.(b)(1)(ii), 5.(b)(1)(iii), 5.(b)(1)(iv) (i.e., Yankee Class and CY Fuel and GTCC Waste), and 5.(b)(1)(vi).

(2) CSI=100 for contents described in 5.(b)(1)(v) (i.e., LACBWR fuel).

6. Known or suspected damaged fuel assemblies or rods (fuel with cladding defects greater than pin holes and hairline cracks) are not authorized, except as described in Item 5.(b)(2)(iii).

7. For contents placed in a GTCC waste container and described in Item 5.(b)(1)(iii), and which contain organic substances which could radiolytically generate combustible gases, a determination must be made by tests and measurements or by analysis that the following criteria are met over a period of time that is twice the expected shipment time:

The hydrogen generated must be limited to a molar quantity that would be no more than 4% by volume (or equivalent limits for other inflammable gases) of the TSC gas void if present at STP (i.e., no more than 0.063 g-moles/ft^3 at 14.7 psia and 70°F). For determinations performed by analysis, the amount of hydrogen generated since the time that the TSC was sealed shall be considered.

8. For damaged fuel rods and fuel debris of the quantity described in Item 5.(b)(2)(iii) and 5.(b)(2)(v): if the total damaged fuel plutonium content of a package is greater than 20 Ci, all damaged fuel shall be enclosed in a TSC which has been leak tested at the time of closure. For the Yankee Class TSC the leak test shall have a test sensitivity of at least 4.0×10^{-8} cm^3/sec (helium) and shown to have a leak rate no greater than 8.0×10^{-8} cm^3/sec (helium). For the Connecticut Class TSC the leak test shall have a test sensitivity of at least 1.0×10^{-7} cm^3/sec (helium) and shown to have a leak rate no greater than 2.0×10^{-7} cm^3/sec (helium).

9. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) The package must be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7 of the application, as supplemented, with exception to Operating procedures related to high burnup fuel content, which is not approved as authorized contents for the Model No. NAC-STC.

(b) Each packaging must be acceptance tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Chapter 8 of the application, as supplemented, except that:

(1) the thermal testing of the package (including the thermal acceptance test and periodic thermal tests) must be performed as described in NAC-STC Safety Analysis Report, and

(2) the acceptance testing and maintenance related to the high burnup fuel content as well as the use of Viton O-rings to meet the leaktight acceptance criterion are not approved, since high burnup fuel is not approved as authorized contents for the Model No. NAC-STC. For directly-loaded baskets, neutron absorber tests must follow the requirements of Section 8.1.7 of the application, which also limits the absorber materials to Boral and TalBor and only allows for crediting of 75% of the absorber's boron-10 content.

(c) For packaging Serial Numbers STC-1 and STC-2, only one of these two packagings must be subjected to the thermal acceptance test as described in Section 8.1.6 of the NAC-STC Safety Analysis Report.

10. Prior to transport by rail, the Association of American Railroads must have evaluated and approved the railcar and the system used to support and secure the package during transport.

11. Prior to marine or barge transport, the National Cargo Bureau, Inc., must have evaluated and approved the system used to support and secure the package to the barge or vessel, and must have certified that package stowage is in accordance with the regulations of the Commandant, United States Coast Guard.

12. Transport by air is not authorized.

13. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

14. Expiration date: May 31, 2019.

REFERENCES

NAC International application dated: May 25, 2011.

NAC International supplement dated: November 26, 2013, April 24, 2014, August 29, 2014, June 5, 2015, August 12, 2015, and October 15, 2015.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Steve Ruffin, Acting Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: February 17, 2016

SAFETY EVALUATION REPORT

Docket No. 71-9235
Model No. NAC-STC
Certificate of Compliance No. 71-9235
Revision 14

Enclosure 2

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ABBREVIATIONS

°F	degree(s) Fahrenheit
^{137}Cs	cesium-137
^{137m}Ba	barium-137m
3-D	three-dimensional
^{60}Co	cobalt-60
^{90}Sr	strontium-90
^{90}Y	yttrium-90
ADAMS	Agencywide Documents Access and Management System
Al_2O_3	alumina
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
atm	atmosphere(s)
B&PV	boiler and pressure vessel
CFR	Code of Federal Regulations
cm^3/s	cubic centimeter(s) per second
CoC	certificate(s) of compliance
CY	Connecticut Yankee
FEA	finite element analysis/analyses
ft	foot/feet
g	acceleration due to gravity
g	gram(s)
g/cm^3	gram(s) per cubic centimeter
GTCC	greater than Class C
Gy	gray(s)
HAC	hypothetical accident conditions
HLW	high-level waste
in.	inch(es)
in^2	square inch(es)
kg	kilogram(s)
ksi	kilopound(s) per square inch
kW	kilowatt(s)
lb	pound(s)
m	meter(s)
MCNP	Monte Carlo N-Particle Transport Code
MPC	multipurpose canister
mrem/hr	millirem(s) per hour
NCT	normal condition(s) of transport
NDT	nondestructive testing
psi	pound(s) per square inch
psig	pound(s) per square inch, gauge
PTFE	polytetrafluoroethylene
PWR	pressurized water reactor
rad	radiation absorbed dose(s)
SAR	safety analysis report
SER	safety evaluation report
SiO_2	silica

SS	stainless steel
TSC	transportable storage canister
WVDP	West Valley Demonstration Project

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SAFETY EVALUATION REPORT

Docket No. 71-9235
Model No. NAC-STC
Certificate of Compliance No. 71-9235
Revision 14

SUMMARY

By letter dated November 26, 2013, as supplemented on April 24, 2014, August 29, 2014, June 5, 2015, August 12, 2015, September 11, 2015, and October 15, 2015, NAC International Inc. (NAC or the applicant), requested to revise the certificate of compliance (CoC) for the Model No. NAC-STC (NAC-STC) transport package. The application proposed to modify the NAC-STC package to authorize the following contents (in separate shipments and distinctive designs):

(1) West Valley Demonstration Project (WVDP) vitrified high-level waste (HLW) (WVDP-HLW) in welded canisters
(2) Directly-loaded uncanistered high burnup pressurized water reactor 17x17 (PWR 17x17) fuel

The staff evaluated the changes proposed by the applicant. Due to unresolved issues with the proposed high burnup fuel contents, the staff is limiting its approval and the discussion in this safety evaluation report (SER) to only changes associated with the proposed WVDP-HLW contents. The staff informed the applicant about these unresolved issues in a letter dated November 24, 2015 [Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML15328A484].

The applicant proposed modifications to the neutron absorber materials and qualification, and the dimensions of the fuel tube and neutron absorber plates for the directly-loaded fuel basket. These modifications are pertinent to the proposed high burnup fuel contents and therefore not discussed in this safety evaluation report. The applicant also proposed changes to the allowable Viton O-rings. Since there are still unresolved issues related to the containment evaluation of the revised Viton O-rings, the staff is only approving the use of these O-rings in non-containment seals.

The proposed packaging for transport of the WVDP-HLW contents consists of an overpack assembly, transport spacers, and overpack spacer assemblies. The application did not include revisions to the previously-approved NAC-STC package, including its shielding materials. The previously-approved design will be used in conjunction with the new packaging components described in the application for the WVDP-HLW contents. During transport of the WVDP-HLW content, the NAC-STC cask body and closure continues to provide the containment boundary. The package is designed to be transported singly and horizontally by ground or by water as an exclusive use shipment.

The WVDP-HLW contents include 275 welded-sealed HLW canisters, two (2) melter-evacuated canisters partially filled with glass and one (1) HLW debris canister. The NAC-STC package allows for a heat load up to 1.5 kilowatts (kW) for the WVDP-HLW contents under normal conditions of transport (NCT) and hypothetical accident conditions (HAC). The package further provides a leaktight containment for the WVDP-HLW contents.

The staff used the guidance in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," to perform the review of the proposed WVDP-HLW contents and the associated package changes. Based on the statements and representations in the application, as supplemented, and the conditions listed in the following chapters, the staff concludes that the package meets the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, "Packaging and Transportation of Radioactive Material."

1.0 GENERAL INFORMATION

1.1 Packaging

The components described in this SER are specific to this applicant's request for authorizing the WVDP-HLW and debris as authorized contents for the Model No. NAC-STC package. This section briefly describes these items as well as the components required for ensuring the safe transport of the proposed contents described in the application, as supplemented.

Sections 1.1, 1.2.1, and 1.2.1.2 of the application provide a description of the new packaging components for the WVDP-HLW contents, specifically the HLW Overpack assembly, transport spacers, and overpack spacer assemblies. The application does not include any revisions to the previously-approved Model No. NAC-STC package, excluding the proposed use of alternate Viton O-rings. The previously-approved package design will be used in conjunction with the new packaging components described in the application for the WVDP-HLW contents. During transport of the WVDP-HLW contents, the Model No. NAC-STC cask body and closure continues to provide the containment boundary. Therefore, the applicant did not propose changes to the primary containment of the Model No. NAC-STC package in this request.

The package also has impact limiters to be used when transporting the WVDP-HLW contents. The impact limiters are located at each end of the package. These consist of either redwood or balsa wood. Both woods have already been approved for use with the Model No. NAC-STC. The applicant provided a structural evaluation considering the WVDP-HLW contents in Section 2.12.6 of the application.

Per Tables 1.2-1 and 2.12.2-1 of the application, once loaded with the WVDP-HLW contents and ready for transport, the Model No. NAC-STC package is 193 inches tall, 99 inches in diameter (across corners), and weighs a maximum of 236,000 pounds (lb).

1.1.1 HLW Overpack

For the STC-WVDP configuration, the main component is the HLW Overpack (i.e., WVDP-HLW Overpack). The HLW Overpack is generally similar to the multipurpose canisters (MPCs) that are currently approved for use with the package, but with a basket that is suited to the proposed WVDP-HLW contents. The HLW Overpack is designed to contain up to five (5) HLW canisters, evacuated canisters, or HLW debris canisters. In cases where the overpack is only partially loaded (i.e., less than 5 canisters), a transport insert shall be loaded into the unused basket locations. The transport insert is fabricated from 304 stainless steel.

The principal components of the HLW Overpack are the following:

- the HLW Overpack shell,
- spacers,
- the basket
- the closure lid

The HLW Overpack is not designed to be a separate leak tight containment for the HLW canisters since the Model No. NAC-STC cask body and closure provides the transport containment boundary. Since the HLW Overpack is not a containment boundary, it is designed to meet the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (ASME B&PV) Code, Section VIII, Division 2, requirements. The nominal inner and outside diameters of the HLW Overpack are 69.8 in. and 70.6 in., respectively. The overall external length of the HLW Overpack is 126.5 in., the inside depth is 124.5 in., and the bottom plate is 2.0 in. thick.

This section briefly describes these items as well as the components required for ensuring the safe transport of the proposed contents in the Model No. NAC-STC.

1.1.1.1 HLW Overpack Shell

The HLW Overpack consists of an annular right-circular shell closed at one end by a bottom plate. The annular right-circular shell is constructed of 3/8-inch rolled dual-certified 304/304L stainless steel (SS) plate. The edges of the rolled plates are joined with full penetration welds. The shell is further closed at one end by a dual-certified 304/304L bottom plate, which is attached to the shell by a full penetration weld. The shell is constructed in accordance with ASME B&PV Code, Section VIII, Division 2.

1.1.1.2 HLW Overpack Spacer Assemblies

The Model No. NAC-STC transportation package includes two spacer assemblies for configuration control of the HLW Overpack within the package cavity:

(a) one below the HLW Overpack
(b) the second above the HLW Overpack

The spacer assemblies serve to maintain the axial location of the HLW Overpack within the Model No. NAC-STC transport package.

Both spacer assemblies are constructed with six concentric rings of 3/8-inch-thick Type 304 SS welded to an SS base plate. The top spacer is 23.1 in. long with a diameter of 70.6 in. The bottom spacer is 14.7 in. long with a diameter of 70.6 in. The applicant designed the top and bottom spacers per ASME B&PV Code, Section III, Subsection NF, requirements and evaluated them for normal conditions and hypothetical accident conditions of transport, since the function of the spacers is to maintain configuration control of the HLW Overpack in the Model No. NAC-STC transport package.

Sections 2.12 and 3.7.4.1.1 of the application include the mechanical and thermal material properties, respectively, used for the evaluation of the overpack's spacer assemblies. These properties are the same as those of the spacer assemblies used with the other MPCs in the package and described in Revision 17 of the application for the Model No. NAC-STC, which corresponds to Revision 13 of the CoC for the Model No. NAC-STC.

1.1.1.3 HLW Basket

A basket is used to position the HLW canisters or transport inserts inside the overpack. The basket is an assembly of five vertical cylindrical cells held by supporting plates, all fabricated from 304 SS. The basket is 119.75 in. tall and has an outer diameter of 70.56 in. to allow it to fit inside the overpack. The application does not assign any structural credit to the basket.

The basket for the WVDP vitrified HLW consists of the following components:

(a) five loading tubes with support plates
(b) a top shield disk, and
(c) a bottom plate.

The basket serves to accommodate up to five HLW canisters, including melter-evacuated HLW canisters partially filled with HLW glass or debris. Empty cells shall have a transport insert loaded.

1.1.1.4 <u>Closure Lid</u>

Following loading of the basket and WVDP-HLW contents or transport inserts, the overpack assembly is closed at the top by a closure lid welded to the overpack shell. The closure lid is a 4-inch-thick Type 304/304L SS plate or forging. The closure lid does not have any penetrations. It is joined to the HLW Overpack shell using a partial penetration weld. The closure lid weld is inspected in accordance with ASME B&PV Code Section V.

The user will load the previously-dried HLW canisters into the HLW Overpack in a dry environment. Therefore, the overpack does not require draining, vacuum drying, or gas backfilling. The closure lid has two sets of threaded holes, one for the handling of the closure lid and the second set for lifting the closed HLW Overpack from the vertical storage cask to the Model No. NAC-STC package for offsite transport. A removable lifting fixture, threaded in the closure lid, serves to lift the closure lid and fully welded HLW Overpack.

1.2 Drawings

The staff reviewed the design drawings related to the proposed WVDP-HLW content. It is important to note that the staff did not approve changes to drawings and/or portions of the drawings including components, references, or fuel load configurations related to the direct load of uncanistered high burnup fuel. For this reason, Appendix A includes a cross-walk of the staff's evaluation related to some of the drawings submitted by the applicant as part of Revision 14 of the CoC for the Model No. NAC-STC. Appendix A only includes drawings applicable to both proposed contents or only to the direct load of uncanistered high burnup fuel. The staff finds the drawings solely related to the WVDP-HLW content acceptable (Table 1); therefore, these drawings are not included in Appendix A.

Table 1 below includes a summary of the approved drawings and corresponding revisions along with those items in the drawings that the staff is excluding from approval. The conditions on the CoC reflect the approved licensing drawings, including identification of items that are excluded from approval. In some drawings, the staff simply excluded specific assemblies identified in the drawings related to directly-loaded uncanistered high burnup fuel, since the drawing's bill of materials shows only those specific assemblies used for the unapproved item(s).

Table 1. List of Approved Drawings for the Model No. NAC-STC

	Drawing No.	Items Excluded from Approval
West Valley Demonstration Project High-Level Waste Content	630087-501, sheets 1-2, Rev. 1	None
	630087-504, Rev. 0	None
	630087-505, Rev. 0	None
	630087-510, Rev. 1	None
	630087-514, Rev. 0	None
	630087-511, Rev. 1	None
	630087-512, Rev. 1	None
	630087-513, sheets 1-3, Rev. 1	None
NAC-STC Package Body (Cask Body)	423-800, sheets 1-3, Rev. 17P and 17NP	Assembly 97, Note 1 reference to Assembly 423-870-98, and Note 14.
	423-803, sheets 1-2, Rev. 10	None
	423-806, Rev. 8	
	423-807, sheets 1-3, Rev. 4	
Direct Load Configuration	423-805, sheets 1-2, Rev. 7	None
	423-875, sheets 1-2, Rev. 7	All changes corresponding to Revisions 8 to 11 of Drawing No. 423-875.
	423-870, Rev. 5	All changes corresponding to Revision 6 of Drawing No. 423-870.
	423-900, Rev. 6	All changes corresponding to Revision 7 of Drawing No. 423-900.
Balsa Impact Limiters	423-843, Rev. 5	Assembly 91 and Item 18.

1.3 Contents

All approved contents discussed in this safety evaluation report (SER) are referred to as the HLW contents or the WVDP-HLW contents. The applicant defines the contents as either Type 304L SS canisters filled with HLW vitrified in borosilicate glass, Type 304L SS melter-evacuated canisters partially filled with glass, and/or a Type 304L SS canister filled with HLW debris. The applicant defines debris as containing:

a. borosilicate glass and radioactive waste material within the glass matrix
b. melter inserts which have a refractory material (Alfibond 2800). Alfibond 2800 is a nonorganic insulator composed of alumina (Al_2O_3) and silica (SiO_2). No organic material is present in the insulator.

All canisters are closed with a permanent welded closure, and have a nominal height of less than or equal to 118 (≤ 118) in. and an outside diameter of ≤ 24 in., approximately. The maximum gross weight allowed per canister is 5,500 lb. The heat load shall be ≤ 0.300 kW per

HLW canister. The melter-evacuated canisters and HLW debris canisters are bounded by the weight and radioactive content of the HLW canisters (i.e., WVDP-HLW canisters) evaluated in the application. As requested by the applicant, the approved contents of a package containing the WVDP-HLW are limited to up to two evacuated canisters and one debris canister. Table 2 below identifies applicable design limits for the HLW.

Table 2. Weight and Possible Isotopes Inside the WVDP-HLW Canisters

Maximum HLW Mass (kg)—WVDP-HLW Canisters	2,200/canister
Maximum Content in WVDP-HLW Evaluated (Curies)	
^{137}Cs	42,000
^{137m}Ba	40,000
^{90}Sr	23,000
^{90}Y	23,000
^{60}Co	0.2

For a HLW Overpack loaded with less than five canisters, the user loads a transport insert in each empty cell located in the basket. The NAC-STC content weight shall be less than or equal to 45,800 lb in this configuration (i.e., STC-WVDP configuration). The STC-WVDP configuration heat load shall be less than or equal to 1.5 kW. Top and bottom spacers are required for axial positioning in the STC-WVDP configuration with the NAC-STC package cavity.

The staff reviewed the description of the contents and concludes that it meets the requirements of 10 CFR Part 71.

2.0 STRUCTURAL EVALUATION

The purpose of this evaluation is to verify that the Model No. NAC-STC packaging, as modified for transporting the WVDP-HLW contents, has adequate structural capability to demonstrate the package performance for meeting the requirements of 10 CFR Part 71. This demonstration involves primarily two aspects:

(1) the performance of the cask body, including its lids, under the inertial forces and thermal loadings associated with the HLW Overpack content, and
(2) the structural capability of the HLW Overpack for positioning the content in the analyzed configuration within the package cavity.

The applicant needs to demonstrate that the package would maintain its analyzed configurations during NCT.

2.1 Description of the Structural Design

2.1.1 Design Features

The HLW Overpack consists of a cylindrical shell with a welded bottom plate and a closure lid. In Section 1.1.1 of this SER, the staff included a brief description of the HLW Overpack and its main components, including the overpack spacers. This configuration includes two spacer assemblies, one below and one above the overpack for its positioning within the cavity of the Model No. NAC-STC package. The applicant noted that the design of the overpack is not for a leaktight component.

Section 2.12.1 of the application describes the function of the HLW Overpack, which is to retain up to five HLW canisters in a five-cell basket for transporting the WVDP-HLW content within the previously certified Model No. NAC-STC package design. The basket serves for spacing the HLW canisters during the dry loading of the overpack. The applicant did not take credit of this component in the structural analysis. The applicant took credit for the shell and top and bottom spacers of the overpack in the structural analysis.

The top and bottom spacers maintain the overpack in the proper axial location inside the package cavity. Drawing Nos. 630087-504 and -505 of the application include design details of the bottom and top spacers, respectively. The function of the spacers is to ensure that the HLW Overpack is in the proper axial location inside the package cavity. The staff reviewed a previously approved single spacer configuration for the Connecticut Yankee MPC (CY-MPC) and found identical design features, except for a different height of 12.7 in. The staff also reviewed Table 2.12.2-1 of the application and noted that the package center-of-gravity is identical to all previously approved transportation configurations, including the CY-MPC.

Based on the information provided by the applicant, the staff finds acceptable the description of design features for the spacers and consistent with the guidance provided in NUREG-1609.

Table 3. Calculated of the End-Drop and Top-Drop Decelerations for the NAC-STC WVDP-HLW Contents (Section 2.12.6.7.4 of the application)

Content, package, and balsa impact limiter weight	236,000 lb
end-drop decelerations	44.2g
top-drop decelerations	51.9g

2.1.2 General Considerations for Structural Evaluation of Package

In Section 2.12.6 of the application, the applicant provides a summary description of the approach used for evaluating the structural integrity of the STC-WVDP configuration. The applicant's approach is based on comparing the effects of the package drop inertia and thermal loadings on the packaging components for transporting the HLW Overpack to those for the Yankee-MPC. Table 4 includes the parameters used by the applicant for evaluating the structural integrity of the HLW Overpack.

Table 4. Parameters Considered for the Structural Evaluation of the HLW Overpack as Proposed Contents for the Model No. NAC-STC

	Yankee-MPC	HLW Overpack
Location of the center of gravity[a]	165 in.	
Actual canister weight	55,590 lb	41,825 lb
Lid weight	8,800 lb	4,400 lb
Design weight	260,000 lb	236,000 lb
Heat load	1.5 kW	12 kW
30-ft end-drop	39.9g	44.2g
30-ft side-drop events	48.5g	51.9g
Content weight	67,195 lb	45,800 lb
[a] The HLW Overpack is 4 in. longer than the Yankee-MPC canister.		

End-Drop

The applicant noted in Section 2.12.6.7.4.1 of the application that the lower STC-WVDP package design weight of 236,000 lb, which is less than the Yankee-MPC design weight of 260,000 lb, resulted in relatively higher package decelerations. The applicant noted that the package closure lids are the package components with the smallest design weights. This assumption was the basis for only considering the lid assembly in the structural evaluation for the end-drop. Also, by comparing the content weight of 45,800 lb for the STC-WVDP to that of 67,195 lb for the Yankee-MPC configuration, the applicant stated the following:

> [T]he inertial loading applied to the closure lid associated with the total package weight configuration of 260,000 lbs. is bounding by more than 30% over the loading associated with the STC-WVDP configuration.

Side-Drop

Similarly, the applicant evaluated the performance of the package body for the side-drop event by comparing the inertia forces exerted on the package body shell and the closure lids. As a result, the applicant stated the following:

[T]he inertial loading applied to the cask shells associated with the total cask weight configuration of 260,000 lbs. is bounding by more than 25% over the loading associated with the STC-WVDP configuration.

The staff reviewed the approach used by the applicant to evaluate the end-drop and the side-drop by comparing previously approved package body evaluation results for evaluating the STC-WVDP configuration. The staff finds the approach acceptable because it followed a commonly used practice of similarity analysis, which compares relevant design attributes, such as applicable inertia forces, between two packages of close resemblance to demonstrate a satisfactory structural performance.

2.1.2.1 Finite Element Analysis Models

Section 2.12.6.12.2 of the application presented details of the finite element analysis (FEA) models for the FEA structural evaluation of the overpack by analysis.

(a) ***End-Drop Analysis***—For the end-drop analysis, the applicant used SOLID45 elements for a three-dimensional (3-D) half-symmetry model, which is constrained vertically either at the bottom or the top to simulate the bottom or top-end drop condition.

(b) ***Side-Drop Analysis***—For the side-drop analysis, the applicant modified the same model to include the inner liner of the Model No. NAC-STC package and contact elements to simulate the interaction between the two circular surfaces with slightly different curvature. The applicant also described the attributes for the FEA models used for evaluating effects of internal pressure and thermal stress on the overpack structural performance.

The staff reviewed the modeling approaches and finds these acceptable because the applicant used previously approved (and applicable) canister configurations, including elements selection, and use of contact element to simulate interaction between the overpack shell assembly and the Model No. NAC-STC package.

2.1.3 Design Criteria

2.1.3.1 Codes and Standards

The applicant mentions in Section 2.12.1.2 of the application that the Model No. NAC-STC containment design remains unchanged when transporting the HLW Overpack. For the overpack design, the applicant used the ASME B&PV Code, Section VIII, Division 2, criteria for the stress evaluation, as specified in Table 2.12.6.12-1 of the application. The staff considered provisions in NUREG/CR-3854, "Fabrication Criteria for Shipping Containers," in its review, which is cited in NUREG-1609 for applicable codes and standards for shipping package design and fabrication. The staff determined the use of the subject criteria met the intent of NUREG-1609 guidance. Hence, the staff finds acceptable the design-by-analysis approach the applicant used for the stress evaluation of the overpack components.

The applicant designed the top and bottom spacers per the ASME B&PV Code, Section III, Subsection NF, criteria. The staff finds the criteria acceptable because, similar to the CY-MPC, the spacers are configured as structural supports for the overpack to maintain its analyzed location within the cavity of the package subject to the NCT tests and conditions.

The overpack and spacers are made of Type 304/304L SS. The applicant noted that these components do not undergo a ductile-to-brittle transition above -40 °C (-40 °F) and, therefore, brittle fracture is not a design concern. The staff finds the assessment by the applicant acceptable, since the applicant followed a well-established approach, which recognizes the lack of brittle failure tendency for the SS, under the conditions of transport for the WVDP-HLW contents.

2.1.3.2 Loads and Load Combinations

The applicant did not make modifications to the package body or lids. The applicant continued considering the necessary loads and load combinations per Regulatory Guide 7.8, "Load Combinations for the Structural Analysis of Shipping Casks for Radioactive Material," for evaluating other packaging components, including the impact limiters and the HLW Overpack.

2.1.4 Weights and Centers of Gravity

Table 2.12.2-1 of the application includes a summary of the weights and the location of the centers of gravity of the major components for the STC-WVDP transport configuration. The maximum weight of the loaded package is 236,600 lb, including the impact limiters. The center of gravity of this load measures at 96 in. above the bottom outer surface of package body. The applicant considered similar package weight and center-of-gravity details for calculating the package component deceleration inertia g-loads.

The staff confirmed that the location of the package center of gravity is identical to all previously approved transportation configurations, including the CY-MPC, as discussed in Section 2.1.2 of this SER. The staff finds the applicant's evaluation of the weights and centers of gravity acceptable.

2.2 Mechanical Properties of Materials

Section 2.3 of the application includes the material mechanical properties used in the structural evaluation (Section 2.12 of the application) of the HLW packaging components (overpack, transport inserts, spacer assemblies). The staff had previously reviewed these mechanical properties during prior amendment requests and found them to be adequate for analysis of the behavior of the package over the ranges of temperature for NCT and HAC, as defined in 10 CFR 71.33(a)(5), 10 CFR 71.43(f), 10 CFR 72.51(a)(1), 10 CFR 71.51(a)(2), 10 CFR 71.55(d), and 10 CFR 71.55(e).

2.2.1 Chemical and Galvanic Reactions

The waste form is HLW vitrified in borosilicate glass, which is poured inside 304 stainless steel canisters that are permanently welded closed (Section 1.2.3.3 of the application). As indicated in Section 4.7.2 of the application, since the material was poured into the HLW canisters at a high temperature and allowed to cool within the canister, no further gas should be produced within the canister and any that was produced is expected to be trapped within the borosilicate glass. The staff reviewed the applicant's analysis of the gas generation and trapping[1] and found it to be acceptable. The waste form is loaded into the canister dry (Section 7.6.3 of the application), therefore, galvanic interactions are not expected.

[1] WDVP-186, WVDP Waste Form Qualification Report – Canistered Waste Form Specification. (NAC Proprietary)

The effects of the radiation from the WVDP-HLW content were evaluated in Section 2.12.4.1 of the application. The application limits the maximum time that the WVDP-HLW content can be in the overpack as 1 year. HLW canisters loaded in HLW Overpacks may have been loaded just prior to shipment or may have been in interim storage in a separate storage overpack (Section 7.2.2 of the application). The staff agrees with the applicant's conclusion that significant neutron or gamma radiation damage of stainless steel components is not expected for neutron fluences below 10^{19} n/cm^2 or gamma doses below 10^{18} rads. These values are higher than those experienced by the package assembly components.

The staff reviewed the potential of radiation dose damage on the revised fluorocarbon (Viton) O-rings (change from Parker compound V747-75 to Parker compound V0835-75) to be used in the transportation package. More specifically, the staff reviewed Figure 5.7.1-1 of the application, which defines locations for maximum dose rates for normal conditions of transport and Table 5.7.1-1, which defines the maximum total (gamma and neutron) dose rates at those locations. During NCT, Table 5.7.1-1 identifies the maximum dose rates as 1.0×10^{-2} mrem/hr (gamma) and 4.87×10^{-1} mrem/hr (neutron). At the end of one (1) year of continuous exposure, the staff determined that the seals will be subject to a maximum absorbed gamma dose of 8.76×10^{-4} Gy (8.76×10^{-2} rad) and a maximum neutron dose of 4.27×10^{-2} Gy (4.27 rad) [assumes a conservative conversion factor of 1 rad = 1 rem in both dose calculations]; both values are well below the threshold defined in NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility-Final Report," for adversely affecting fluorocarbon seal performance [i.e. doses exceeding 100 Gy (104 rads)]. In addition the application states that the seals will be changed after every shipment to minimize any radiation damage. Therefore, the staff concludes that radiation deterioration of the polymer seals is not credible for the proposed WVDP-HLW content. The staff concludes that the application provides reasonable assurance that the requirement of 10 CFR 71.43(d) is met.

2.3 Fabrication

The applicant specifies SS as the material of construction of the following components:

a. HLW Overpack shell and bottom plate (Type 304/304L)
b. HLW Overpack basket (Type 304)
c. shell weldment (Type 304/304L)
d. closure lid (Type 304/304L)
e. transport inserts (Type 304)
f. top and bottom spacer assemblies (Type 304)
g. Impact limiters (redwood or balsa wood)

The mechanical and thermal properties of the materials of construction for these components have been previously reviewed and approved for the contents approved in Revision13 of the CoC for the Model No. NAC-STC.

2.4 General Standards for All Packaging

In Section 2.12.4 of the application, the applicant noted that the "General Standards" for transporting the HLW Overpack are the same as those previously certified for the Model No. NAC-STC package, including minimum package size, tamper-indication feature, and positive closure. The staff finds that the assessments provided by the applicant meet the requirements of 10 CFR 71.45, "Lifting and Tie-Down Standards for All Packages."

2.5 Lifting and Tiedown Standards

The total weight of 260,000 lb for the certified NAC-STC is greater than the loaded NAC-STC WVDP package of 236,000 lb.

Table 5. Changes to Lifting and Tiedown Devices

Application's Section	NAC-STC Device(s)	Changes for Transporting the HLW Overpack
Section 2.12.5.1	NAC-STC lifting devices	None
Section 2.12.5.2	NAC-STC tiedown devices	None

The applicant considered the evaluations for previously approved configuration (260,000 lb) are applicable to the WVDP-HLW content (236,000 lb). Based on the information provided by the applicant, the staff concludes that the previous lifting device evaluations for the package are acceptable. The staff also concludes that the tiedown evaluation for a previously certified package configuration with the balsa impact limiters bounds that for transporting the WVDP-HLW contents.

2.5.1 HLW Overpack Shell

Section 2.5.1.3.6.3 of the application summarizes the stress results for the overpack shell assembly components with the same FEA approach used in the package end-drop analysis described in Section 2.12.6.12.2. Considering the at-temperature stress allowable of 20 ksi for the Type 304 SS at 300 °F, which is bounding, the applicant reported the factors of safety as 10.6 and 6.29 for the maximum membrane stress and the membrane-plus-bending stress, respectively, which are greater than 1 and are, therefore, acceptable.

2.5.2 HLW Overpack Closure Lid

Section 2.5.1.3.6.1 of the application presents stress analysis of the 1-½ 6 UNC threaded holes in the overpack closure lid. The calculation considered redundant lifting similar to that used previously in Section 2.5.1.3 of the application for determining shear stresses in the thread. For the loaded overpack of 41,825 lb and by applying a dynamic load factor of 1.1, the resulting calculated shear stress for the thread is 2.87 ksi. Table 6 includes a summary of the safety factors related to this analysis.

Table 6. Stress Analysis of the 1-½ 6 UNC Threaded Holes in the HLW Overpack Closure Lid

Shear Stress Parameters	Calculated Factor of Safety =	Required Factor of Safety
Yield Strength	4.51	3
Ultimate Strength	13.3	5

The factors of safety are greater than the required 3 and 5 and are, therefore, acceptable.

For the 3/8-inch-thick closure lid-to-shell weld, the applicant considered a shear area of 583.3 in^2 (the entire lid circumference) to calculate an average closure weld shear stress of 0.071 ksi with a large factor of safety (see Section 2.5.1.3.6.2 of the application). This hand calculation of shear stress followed the common weld design practice for support structures.

Since the applicant did not evaluate the closure lid with a leakage tight function, the staff finds the weld stress analysis method and calculated margin acceptable.

2.6 Structural Evaluation under Normal Conditions of Transport

The staff evaluated the structural performance of the packaging for meeting the 10 CFR 71.71 NCT requirements in two aspects:

a. the performance of the package body and its lids under the inertial forces and thermal loadings associated with the HLW Overpack content, and
b. the structural capability of the HLW Overpack for positioning the content in the analyzed configuration within the package cavity.

2.6.1 Heat

The applicant noted that the evaluations for the previously approved Model No. NAC-STC configurations bounded the STC-WVDP configuration and did not perform further evaluations. The applicant provided the following rationale:

- In Section 2.12.6.1 of the application, the applicant noted that, when transporting the HLW Overpack, the "heat condition" evaluation of the NAC-STC package in the directly-loaded fuel and Yankee-MPC configurations bound the NAC-STC package in the STC-WVDP configuration.
- In Sections 2.12.6.7.5 and 2.12.6.7.6 of the application, the applicant noted that, for the respective canister closure and neutron shield analyses, the temperatures used for determining the allowable stresses also bound the package temperatures associated with the HLW Overpack heat load of 1.5 kW.

The staff finds the applicant's approach to demonstrating structural performance acceptable because it has followed the commonly practiced similarity analysis.

In Section 2.12.6.12.5 of the application, the applicant calculated the thermal stresses of the HLW Overpack by using the thermal analysis model converted from the structural model. For the thermal heat case, the calculated maximum membrane and membrane-plus-bending stresses are 2.53 ksi and 2.78 ksi, respectively, which would be evaluated with the stress associated with the free drop condition. As noted in Section 2.12.6.12.6 of the application, when combined with the maximum stress of 51.0 ksi of the overpack "accident condition" free drop evaluated in Section 2.6.7 below, the cold condition evaluated in Section 2.6.2 of this SER is prevalent. For the maximum combined stress of 55.2 ksi, the corresponding margin of safety is +0.09, considering the at-temperature stress allowable of 60 ksi, which is positive and, therefore, acceptable.

Based on the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate and meets the requirements of 10 CFR 71.71(c)(1) for the heat condition.

2.6.2 Cold

In Section 2.12.6.2 of the application, the applicant noted that, when transporting the HLW Overpack, the cold condition evaluation of the package in the directly-loaded fuel and Yankee-MPC configurations (this information is in Section 2.6.2.1 of the application) bounds the

STC-WVDP configuration. Therefore, the applicant mentions that a separate evaluation for the STC-WVDP configuration is not necessary. The staff finds the applicant's approach acceptable because it followed the commonly practiced similarity analysis to demonstrate structural performance.

Section 2.12.6.12.5 of the application noted the use of the thermal analysis model converted from the structural model to calculate thermal stresses of the HLW Overpack. For the thermal cold case, the applicant evaluated the maximum membrane and membrane-plus-bending stresses of 3.36 ksi and 3.76 ksi, respectively, with the stress associated with the free drop condition. As noted in Section 2.12.6.12.6 of the application, the applicant evaluated the maximum thermal stress for the combined stress with the maximum of 0.48 ksi associated with the internal pressure case and the maximum of 51.0 ksi with the overpack free drop evaluated in Section 2.6.7 of this SER. For the maximum combined stress of 55.2 ksi, the corresponding margin of safety is +0.09, considering the at-temperature stress allowable of 60 ksi, which is positive and is, therefore, acceptable.

On the basis of the above evaluation, the staff finds that the STC-WVDP package configuration is structurally adequate in meeting the requirements of 10 CFR 71.71(c)(2) for the cold condition.

2.6.3 Reduced External Pressure

In Section 2.12.6.3 of the application, the applicant noted that:

- the canistered contents have an insignificant structural effect on the reduced external pressure condition applied to the package body
- the NAC-STC package in the STC-WVDP configuration can be adequately represented by the "Reduced External Pressure Condition" evaluation in Section 2.6.3 of the application

The applicant did not evaluate the reduced external pressure condition for the HLW Overpack. In Section 2.12.6.12.4 of the application, the applicant noted, however, that an internal pressure of 12 psig, which was the maximum pressure calculated for the maximum average gas pressure of 493 °F for the fire transient. This resulted in the maximum membrane and membrane-plus-bending stresses of 0.39 ksi and 1.78 ksi, respectively, which correspond to the respective stress margins of safety of +50.9 and +15.9. The staff finds these values acceptable.

The staff finds the applicant's approach for demonstrating structural performance acceptable because it has followed the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER. Based on the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate in meeting the requirements of 10 CFR 71.71(c)(3) for the reduced external pressure condition.

2.6.4 Increased External Pressure

In Section 2.12.6.4 of the application, the applicant noted that:

- The canistered contents have an insignificant structural effect on the reduced external pressure condition applied to the package body.

- The NAC-STC package in the STC-WVDP configuration can be adequately represented by the "Reduced External Pressure Condition" evaluation in Section 2.6.4 of the application.

The staff finds the applicant's approach for demonstrating structural performance acceptable because it has followed the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER. Based on the assessment of the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate and meets the requirements of 10 CFR 71.71(c)(4) for the increased external pressure condition.

2.6.5 Vibration

In Section 2.12.6.5 of the application, the applicant noted that:

- The contents weight of the STC-WVDP configuration is less than the Yankee-MPC condition applied to the package body.
- The dynamic response to the vibration condition is adequately represented by the "Vibration Condition" evaluation in Section 2.6.5 of the application.

The staff reviewed the applicant's approach of making reference to the previously approved "Vibration Condition" evaluation for the NAC-STC and not performing further analyses related to this licensing request. The staff finds the applicant's approach for demonstrating structural performance acceptable because it has followed the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER. Based on the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate and meets the requirements of 10 CFR 71.71(c)(5) for the vibration condition.

2.6.6 Water Spray

In Section 2.12.6.6 of the application, the applicant noted that:

- The canistered contents have an insignificant structural effect on the water spray condition applied to the package body.
- The NAC-STC package in the STC-WVDP configuration is adequately represented by the "Water Spray Condition" evaluation in Section 2.6.6 of the application.

The staff finds the applicant's approach to demonstrating structural performance acceptable because it followed the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER. Based on the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate and meets the requirements of 10 CFR 71.71(c)(6) for the water spray condition.

2.6.7 Free Drop

2.6.7.1 STC-WVDP Configuration

In Section 2.12.6.7 of the application, the applicant provided an evaluation for the end-, side-, and corner-drop conditions of the following packaging components:

(a) package body
(b) impact limiters
(c) closure lids and bolts
(d) neutron shield shell

As evaluated in Section 2.1.2 of this SER, the applicant compared the effects of the package drop inertia and thermal loadings on the packaging components for transporting the HLW Overpack to those for the Yankee-MPC. Specifically, the applicant noted that the drop condition evaluations of the NAC-STC package in previously approved configurations bound the NAC-STC package in the STC-WVDP configuration. Therefore, the applicant stated that no further evaluation is necessary. The staff finds the applicant's approach to demonstrating structural performance acceptable because it follows the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER.

2.6.7.2 HLW Overpack

In Section 2.12.6.12.3.1 of the application, the applicant used 20g design-basis inertia force for evaluating the HLW Overpack for the 1-ft top-end drop, considering an inertia force of 14.5g calculated for the previously approved Model No. NAC-STC configurations (this information is in Table 2.6.7.4.2-3 of the application). The staff recognized that the applicant did not revise the g-load calculations in Table 2.6.7.4.2-3 for the STC-WVDP configuration. However, considering the use of a 20g design-basis inertia force and the large stress margins of safety calculated by the applicant, the staff has reasonable assurance that the applicant's evaluations are acceptable.

In Section 2.12.6.12.3.2 of the application, the applicant evaluated the overpack for a side-drop with an inertia force of 16.5g, which was in agreement with inertia loads used for the previously approved Model No. NAC-STC configurations (this information is in Table 2.6.7.4.2-3 of the application). Using the FEA approach as evaluated in Section 2.1.2.1 of this SER, the applicant calculated a localized peak stress of 51 ksi on the end of the HLW Overpack. This amounts to a margin of safety of +0.18 for the at-temperature secondary stress limit of 60 ksi for the 304/304L SS. For the primary stresses, the applicant calculated the maximum stresses for the membrane and membrane-plus-bending stress categories of 13.7 and 17.5 ksi, which correspond to the margins of safety of 0.6 and 0.71, respectively. In reviewing the loading condition for the FEA, the staff recognized that the applicant did not revise the g-load calculation in Table 2.6.7.4.2-3 of the application, as opposed to the case of the 30-ft side-drop event, for the STC-WVDP configuration with a smaller package weight. However, given the large safety margins in the stress calculated by the applicant, the staff concluded that the overpack would adequately perform its structural function for a 1-ft side-drop event.

2.6.7.3 NAC-STC—STC-WVDP Assembly Spacers

For the spacer assemblies evaluation, in Section 2.12.6.13.3.1 of the application, the applicant used a 20g inertia force for both the 1-ft top-end and side-drop events, considering the previously approved NAC-STC configurations of 14.5g and 16.5g for the 1-ft top-end drop and side-drop, respectively. The staff recognized that the applicant did not revise the g-load calculations in Table 2.6.7.4.2-2 for the STC-WVDP configuration. However, considering the use of a 20g design-basis inertia force and the large margins of safety commonly observed for a similar type of 1-ft drop analysis, the staff finds acceptable the applicant's approach of applying the 20g inertia force for evaluating the structural performance of the spacers.

In Section 2.12.6.13.3.1 of the application, the applicant evaluated the top spacer assembly by the FEA, using the axisymmetric and half-symmetry models for the 1-ft end- and the side-drop events, respectively. The applicant evaluated only the top spacer because its structural performance bounds the relatively shorter bottom spacer. The application used the same 20g design-basis inertia force for evaluating the spacer, considering the Table 2.6.7.4.2-3 inertia force of 14.5g calculated for the previously approved Model No. NAC-STC configurations. The staff recognized that the applicant did not revise the g-load calculations in Table 2.6.7.4.2-3 for the STC-WVDP configuration. However, considering the use of a 20g design-basis inertia force and the large stress margins of safety calculated by the applicant, the staff finds the applicant's selection of design-basis inertia loads for evaluation acceptable. For the end-drop, this resulted in the maximum membrane and membrane-plus-bending stress intensities of 5.2 ksi and 13.6 ksi with corresponding margins of safety of +2.85 and +1.21, respectively.

The applicant evaluated the buckling strength of the spacer rings considering the spacer ring with the highest load under the HAC of the end-drop loading, which is conservative. The average compressive stress in the spacer ring experiencing the highest load is 11.0 ksi, which corresponds to an acceptable margin of safety of +1.95 for the critical buckling strength of 32.5 ksi.

The stress and the buckling strength evaluations of the spacer assembly followed the common structural analysis practice. For this reason, the staff finds that the spacers will adequately maintain the analyzed configurations during the NCT free drop events.

Conclusion

Based on the staff's review of the evaluation for the structural performance of the packaging provided by the applicant, the staff finds that the Model No. NAC-STC packaging configuration to transport the WVDP-HLW contents meets the requirements of 10 CFR 71.71(c)(7) for the free drop condition.

2.6.8 Corner Drop

The 10 CFR 71.71(c)(8) corner drop condition is not applicable because the package weight exceeds 220 lb.

2.6.9 Compression

The 10 CFR 71.71(c)(9) compression test is not applicable because the package weight is greater than 11,000 lb.

2.6.10 Penetration

In Section 2.12.6.10 of the application, the applicant noted that the penetration analyses of the NAC-STC package bound the NAC-STC package in the STC-WVDP configuration. The staff reviewed the applicant's approach of making reference to the previously approved penetration analyses for the NAC-STC and not performing further analyses related to this licensing request. The staff finds the applicant's approach to demonstrating structural performance acceptable because it follows the practice of similarity analysis as previously mentioned in Section 2.1.2 of this SER.

Based on the evaluation provided by the applicant, the staff finds that the STC-WVDP package configuration is structurally adequate to meet the requirements of 10 CFR 71.71(c)(10) for the penetration test.

2.7 Structural Evaluation under Hypothetical Accident Conditions

The applicant noted the close resemblance of applicable design attributes between package configurations, including the 30-ft free drop deceleration g-loads. As noted in Section 2.1.2 of this SER, the staff finds acceptable the applicant's approach of justifying and demonstrating that results from evaluations of the package body previously approved by the staff bounded the evaluation of the STC-WVDP configuration. Based on this approach, the applicant did not include a HAC analysis to demonstrate the structural performance of the package. The staff concludes that the applicant has adequately demonstrated the structural performance of the STC-WVDP components. The staff finds acceptable that the applicant has not included an evaluation of the STC-WVDP configuration for the HAC.

In Sections 2.12.6.13.3 and 2.12.6.13.4 of the application, the applicant provided an evaluation of the top and bottom spacer assemblies, respectively, for the inertia g-loads associated with the accident conditions. The applicant noted the 48g inertia force for the top-end drop bounded the end-drop case of 40.8g used in the previously approved package drop events. As noted in Section 2.6.7 of this SER, this resulted in the maximum membrane and membrane-plus-bending stress intensities of 5.2 ksi and 13.6 ksi with the corresponding margins of safety of +2.85 and +1.21, respectively. The average compressive stress in the highest loaded outmost ring of 14.5 ksi also corresponds to a margin of safety of +1.24, which is positive and acceptable, for the critical buckling strength of 32.5 ksi.

For the 30-ft side-drop, the applicant applied a bounding lateral inertial load of 55g to perform a FEA of the top spacer, which is bounding. This resulted in the maximum membrane and membrane-plus-bending stress intensities of 10.29 ksi and 46.3 ksi, respectively. These stresses corresponded to the respective margins of +3.50 and +0.43, which are positive and, therefore, acceptable.

This review supplements the structural evaluation for demonstrating adequate structural performance of the STC-WVDP configuration in meeting the requirements of 10 CFR 71.73, "Hypothetical Accident Conditions."

2.8 Evaluation Findings

The staff reviewed documentation provided by the applicant including detailed calculation packages and test results to confirm that statements presented by the applicant were accurate and within acceptable engineering practices. Based on the review of these statements, representations, and supplemental calculations provided by the applicant, the staff concludes that the applicant has adequately described and evaluated the structural integrity of the package. The staff has reasonable assurance that the structural design of the package meets the requirements of 10 CFR Part 71.

3.0 THERMAL EVALUATION

The staff reviewed the Model No. NAC-STC application (STC-WVDP configuration) for adding the HLW canister (WVDP-HLW canister) to confirm that:

(1) The applicant adequately evaluated the thermal performance of the package including the tests specified under NCT.
(2) The package design satisfies the thermal requirements of HAC in 10 CFR Part 71.

For the thermal evaluation of the STC-WVDP configuration, the staff considered the criteria in NUREG-1609 to confirm that the applicant analyzed the boundary conditions summarized in Table 7, below.

Table 7. Review Criteria for Boundary Conditions of a Thermal Evaluation per NUREG-1609

Conditions of Transport	Test Conditions	Regulatory Requirement	Regulatory Justification
NCT	Steady-state conditions	An ambient temperature of 100 °F without insolation in still air, for limiting the maximum accessible package surface temperature to not exceed 185 °F for exclusive use shipments	Defined in 10 CFR 71.43(g)
		An ambient temperature of –40 °F without insolation in still air	Described in 10 CFR 71.71(c)(2)
	Transient conditions	An ambient temperature of 100 °F with insolation in still air	Defined in 10 CFR 71.71(c)(1)
HAC	Transient conditions	Prefire conditions at an ambient temperature of 100 °F in still air with insolation	Defined in 10 CFR 71.73(b)
		Sufficiently quiescent ambient conditions to provide an average emissivity coefficient of at least 0.9 at an ambient temperature of 1,475 °F, without insolation, for 30 minutes and with a package surface emissivity of at least 0.8 and an external convection coefficient based on a fire environment	Defined in 10 CFR 71.73(c)(4)
		Postfire conditions at an ambient temperature of 100 °F with insolation in still air, until maximum temperatures for all package components have been achieved	Described in 10 CFR 71.73(c)(4)

3.1 Description of the Thermal Design

Except for the canisters which contain the HLW (MPC-WVDP) and the HLW Overpack, the packaging design features are documented in the application.

3.1.1 Content Heat Load Specification

The HLW Overpack has a capacity of up to five HLW canisters. The design of the HLW Overpack includes a five-cell basket for transporting the HLW canisters. The basket is used to position the HLW canisters during the atmospheric dry loading of the overpack. The maximum heat load for the WVDP-HLW contents is 1.5 kW. The thermal loads are different for NCT and HAC (i.e., the surface thermal load (combustion heat) is external during a fire accident, while the surface thermal load (insolation) is applied continuously during NCT).

3.1.2 Summary Tables of Temperatures

The applicant provided a summary of the temperatures for the package components and proposed contents in Tables 3.7-4, 3.7-5, and 3.7-6 of the application. The components included in these tables are the following:

- WVDP-HLW contents (HLW contents)
- HLW canister and basket tubes
- HLW Overpack shell
- average air temperature inside the HLW Overpack
- package inner shell
- gamma shield (lead)
- package outer shell
- radial neutron shield
- package surface (neutron shield shell)
- package cavity (average air temperature inside the package)

The staff confirmed that the temperatures for NCT and HAC were consistent throughout the application. The staff verified that all components remained below their material property limits listed in the application.

3.1.3 Summary Tables of Pressures in the Containment System

The applicant did not provide summary tables of the containment pressure under NCT and HAC. However, the applicant included applicable calculations and results in Chapter 4 of the application, which were acceptable to the staff. The reported values correspond to the maximum normal operating pressure (MNOP) for NCT and maximum reached pressures during HAC (fire). The staff confirmed that these values were within the design pressure of the NAC-STC containment boundary.

As described above, the staff reviewed the applicant's description of its thermal design, specified thermal loads, summary tables of temperatures, and pressures related to the containment boundary to confirm that these were consistent with the guidance specified in Chapter 3 of NUREG-1609. The staff finds that the description of the thermal design meets the thermal requirements of 10 CFR Part 71.

3.2 Material Properties and Component Specifications

3.2.1 Thermal Properties of the Materials

All material thermal properties provided in the application for the new packaging components are the same as those used for the previously-reviewed and approved Yankee-MPC (Section 3.4.1.2 of the application), except for the thermal properties of the WVDP-HLW contents, which is specified as glass. The previously reviewed and approved thermal properties are provided in Section 3.2 of the application. The values for the thermal conductivity, density, and specific heat for glass at different temperatures are given in Table 3.7-2.

The revised packaging (see Section 1.1 of this SER) includes components fabricated from 304/304L austenitic SS, a material that has been previously approved for prior amendments of the NAC-STC package and which does not undergo a ductile-to-brittle transition (Section 2.12.1.3 of the application) in the temperature range of transport, per 10 CFR 71.71 and 10 CFR 71.73. The maximum operating temperature of 304/304L stainless steel is defined as 800°F per the ASME B&PV Code for components serving a structural function.

The staff confirmed the suggested operating range of the shielding materials. To prevent melting of the lead gamma shield under NCT, the temperature must be maintained below the melting point of lead [327.5°C (621°F)]. The maximum expected temperature for the gamma shield under NCT is (304°F) 151 °C, which is well under the melting point [i.e., 327.5°C (621°F)]. NS-4-FR is a solid borated polymer used for neutron shielding. The applicant notes that in order to preclude localized lead temperatures from exceeding their safe operating range, Fiberfrax 972-H Ceramic Fiber Paper is used to insulate the lead from the high temperatures that occur during the 10 CFR Part 71 hypothetical fire accident. The use of Fiberfrax 972-H Ceramic Fiber Paper is not new to this application, as its use has been previously approved for compatibility with the Model No. NAC-STC package (pertinent supporting information is included in Section 4.5.4 of the application). Table 3.7-6 of the application provides maximum temperatures for the fire transient during HAC, which demonstrate that the lead gamma shield is maintained in its safe operating range.

All non-containment Viton seals in the Model No. NAC-STC package were revised (changed from Parker compound V747-75 to Parker compound V0835-75). Supporting datasheets for the VM835 compound were provided in Section 4.5.2 of the application and demonstrate compliance with the necessary temperature range of -40°F to 400°F.

The metallic O-rings used for containment in the Model No. NAC-STC package during transport of the WVDP-HLW content are fabricated from 321 stainless steel coated with silver. The staff verified the operating temperature range in the Garlock Helicoflex handbook to be -40°F to 700°F, which bounds the range identified in the application. The maximum temperature even under fire conditions is 465 °F which below the maximum rated temperature.

Table 8, below, includes the safe operating temperature ranges for the limiting shielding and seal materials. Section 3.7.3 of the application includes a summary of the package materials and their safe operating temperature ranges, including the O-rings in the inner lid and inner lid port cover plate, the lead gamma shield, and the NS-4-FR solid neutron shield.

Table 8. Safe Operating Temperature Limits for Some Components Related to the STC-WVDP Configuration

Component	Material of Construction	Safe Operating Range
Gamma Shield (Lead)	SS	–40°F to +600 °F
Radial Neutron Shield	NS-4-FR solid	–40°F to +300 °F[a]
Metallic O-rings	—	–40°F to +500 °F[b]
Viton O-rings	Fluorocarbon-based polymer	–40°F to +600 °F[c]

[a] CRWMS M&O 1998, *Evaluation of WP Transporter Neutron Shielding Materials*, BCAE00000-01717-0210-00002 REV 00, Las Vegas, NV, CRWMS M&O, ACC: MOL.19990119.0320, (DIRS 105951)
[b] Garlock Helicoflex handbook.
[c] Compound Data Sheet, VM835-75 (Section 4.5.2 of the application).

The staff reviewed the thermal physical properties and the safe operating temperature ranges defined for the materials used for the NAC-STC during transport of the WVDP-HLW content and finds them adequate to demonstrate that the package complies with the requirements in 10 CFR 71.71 and 10 CFR 71.73.

3.2.2 Specifications of the Components of the Package

The staff also reviewed the specifications of the components related to this licensing action request and confirmed that the structural analysis provided by the applicant demonstrated that the material stresses were within acceptable limits for the temperatures limiting the package design for the STC-WVDP components. The minimum expected temperature occurs with no heat load and –40 °F ambient temperature (this information is in application Section 3.7.4.3). The staff finds these specifications acceptable because the limits proposed by the applicant assure the safe operation and transport of the package and its contents.

For the metallic O-rings, the maximum temperature under NAC fire conditions is 465 °F (240°C), which is below the maximum rated temperature for these seals. Table 9, below, includes the temperatures estimated by the applicant under normal and hypothetical accident conditions. The staff agrees with the applicant's assessment provided in Section 3.7.3.2 of the application that the materials will be operated within safe temperature ranges.

In all cases, the staff does not expect any thermal deterioration of the components as discussed in this section due to the WVDP-HLW content. The staff reviewed the properties of the materials and component specifications used in the thermal evaluation and concludes that the applicant has provided sufficient information for evaluating the package against the thermal requirements of 10 CFR Part 71.

Table 9. Summary of Estimated Temperatures during NCT and HAC for the STC-WVDP Configuration

Component	Material of Construction	NCT		HAC
		Maximum Temperature, 100 °F Ambient [a]	Maximum Temperatures, Maximum Decay Heat, T_A [b, c]	HAC Fire Transient, T_{max} [d]
HLW and Contents	HLW & SS	206 °F	91 °F	515 °F
HLW Canister and Basket Tubes	SS	202 °F	87 °F	511 °F
HLW Overpack Shell	SS	168 °F	32 °F	477 °F
Cask Inner Shell	SS	151 °F	0 °F	—
HLW Overpack Lid (maximum)	SS	—	—	465 °F
Gamma Shield (Lead)	SS	151 °F	−1 °F	—
Cask Outer Shell	SS	147 °F	−5 °F	—
Radial Neutron Shield	NS-4-FR solid	146 °F	−6 °F	—
Cask Surface (Neutron Shield Shell)	SS	145 °F	−7 °F	—
HLW Overpack Lid	SS	—	—	465 °F

[a] Table 3.7-4 of the application.
[b] T_A is the minimum ambient temperature for the cold case (i.e., −40 °F ambient temperature).
[c] Table 3.7-5 of the application.
[d] Table 3.7-6 of the application.

3.3 Thermal Evaluation under Normal Conditions of Transport

3.3.1 Evaluation by Analyses

To evaluate the thermal performance of the STC-HLW package configuration, the applicant developed a three-dimensional (3-D) ANSYS finite element model. Gaps between the HLW canister and HLW Overpack and between the HLW Overpack with the transport package inner shell are included in the thermal model. The model is a 72° section of the loaded HLW canisters, HLW Overpack, and package due to the symmetry of the geometry and the heat load. The 72° model is one-fifth of the complete STC-WVDP transport package. The plane of symmetry of the model is considered to be adiabatic. The volumetric heat generation rate for the HLW canister contents is applied as a uniform heat generation to the elements representing the WVDP-HLW contents. Cavity gas inside the HLW Overpack, and inside the Model No. NAC-STC cavity, is modeled as air. Solar insolation and ambient temperature conditions are applied to the outer surface of the transport package neutron shield shell for the appropriate transport condition. The staff finds the overall analysis approach and assumptions acceptable because the description satisfies the guidance in NUREG-1609.

Based on the developed thermal model, the applicant performed the analysis for NCT conditions to determine the temperatures for the major components of the package body, HLW Overpack, the HLW canister and the basket, and the WVDP-HLW contents. The maximum and minimum temperatures of the major Model No. NAC-STC components, the HLW Overpack, the basket components, and WVDP-HLW contents temperatures, are shown in Tables 3.7-4 and 3.7-5 of the application. Table 10 found in Chapter 5 of this safety evaluation report also includes a summary of temperature limits related to the components of the Model No. NAC-STC package. The staff confirmed that the reported values are below the recommended limits established in the application.

3.3.2 Evaluation by Tests

The applicant evaluated the STC-WVDP package configuration by analysis (i.e., the applicant did not perform tests for the proposed WVDP-HLW content). Since the applicant demonstrated that its analyses had an adequate margin, the staff finds the applicant's approach acceptable.

3.3.3 Temperatures

See Section 3.1.4 of this SER.

3.3.4 Pressures

See Section 3.1.5 of this SER.

3.3.5 Thermal Stresses

The applicant evaluated the thermal stresses in Chapter 2 of the application, using the thermal results obtained in Chapter 3 of the application. The methods presented are standard methods described in textbooks on the subject. The applicant assumed the worst operating conditions for evaluating the thermal stresses, and the results show adequate margin. The staff finds the evaluation methods acceptable because the description and analysis satisfy the regulatory requirements in 10 CFR Part 71.

3.3.6 Evaluation of Accessible Surface Temperature

Under NCT, the temperature on the surface of the package (with the design-basis heat load and no solar insolation) is above the 85°C (185°F) temperature required in 10 CFR 71.43(g). According to Section 3.7.4.2 of the application, the maximum temperature of the personnel barrier is below the allowable temperature of 85°C (185°F) for exclusive use shipment. Therefore, the design basis of the STC-WVDP configuration allows the safe transport of its content under the NCT specified in 10 CFR 71.43.

The staff reviewed the information provided by the applicant regarding the package's design, construction, and preparation for shipment. The staff concluded that the temperatures of the package materials and components would not exceed the specified allowable limits during NCT consistent with the tests specified in 10 CFR 71.71.

3.4 Thermal Evaluation under Hypothetical Accident Conditions

The applicant did not develop a model to perform the thermal analysis of the STC-WVDP during HAC. Instead, the applicant's approach consisted in establishing the maximum temperatures for the Model No. NAC-STC loaded with the WVDP-HLW contents by adding a temperature increase (delta T or ΔT) of 309°F (154°C) to the STC-WVDP normal condition basket and clad temperatures as listed in Table 3.7-4 of the application (hot case). The ΔT is the fire accident temperature increase of the Model No. NAC-STC (directly-loaded configuration) package inner shell surface [460°F (238°C), Figure 3.5-2 of the Model No. NAC-STC application] from the normal condition [151°F (66°C), Table 3.7-4 of the application].

The staff evaluated the applicant's approach to predict the maximum temperatures during HAC and concludes the approach is conservative because it would result in higher temperatures as compared to analysis predictions (i.e., fire analysis using the STC-WVDP thermal model). The ΔT used to predict the package maximum temperature is based on a higher heat load (i.e., 22.1 kW) as compared to 1.5 kW for the STC-WVDP configuration.

The staff reviewed the package design, construction, evaluation, and preparation for shipment and concludes that the package material and component temperatures would not exceed the specified allowable short time limits during HAC consistent with the tests specified in 10 CFR 71.73.

3.5 Evaluation Findings

The staff reviewed documentation provided by the applicant including detailed calculation packages to confirm that statements presented by the applicant were accurate and within acceptable engineering practices. Based on the review of these statements, representations, and supplemental calculations provided by the applicant, the staff concludes that the applicant has adequately described and evaluated the thermal design of the package. The staff has reasonable assurance that the thermal performance of the package meets the requirements of 10 CFR Part 71.

4.0 CONTAINMENT

The purpose of this evaluation is to verify that the Model No. NAC-STC package containment design meets the containment requirements of 10 CFR Part 71 under NCT and HAC with West Valley Demonstration Project high-level waste (WVDP-HLW) contents.

4.1 Containment System Design

The containment boundary of the Model No. NAC-STC package with WVDP-HLW contents was defined under containment condition B of the Model No. NAC-STC transport system. Table 4.1-1, "NAC-STC Containment Boundaries," of the application includes details of the components, under containment condition B, using metallic seals. These components include:

a. an inner shell
b. upper and lower shell rings transitional sections,
c. bottom inner forging,
d. top forging,
e. inner lid,
f. inner lid inner seal,
g. vent port cover plate,
h. vent port cover plate inner seal,
i. drain port cover plate, and
j. drain port cover plate inner seal.

For the WVDP contents, the application specified metallic seals, and the staff confirmed that the containment boundary seals are metallic on the licensing drawings. The containment design had been previously approved for the Model No. NAC-STC.

4.2 Containment Evaluation under Normal Conditions of Transport

The Model No. NAC-STC package design includes testing to the leaktight criteria per the American National Standards Institute (ANSI) N14.5-1997 (i.e., for a leak rate of $1{\times}10^{-7}$ ref-cm^3/s). In Section 4.7.2, "High Level Waste (HLW) Overpack and Cask Pressurization," of the application, the applicant stated that the HLW canisters:

a. Contain the maximum radionuclide quantities.
b. Generate the maximum heat.
c. Have the potential for maximum alpha gas generation equivalent to 0.16 psi over 100 years.

Therefore, the applicant noted that the analyses related to the HLW canister content bound the evacuated canister and debris canisters, and any combination of canisters that can be loaded into the Model No. NAC-STC. Section 4.7.2 of the application includes a discussion about the combustible gas generation for the WVDP-HLW contents. The applicant stated that the non-alpha gas generated by the canisters (HLW, evacuated, or debris canisters) at NCT temperatures was not significant. Therefore, the staff concludes that the combustible gas generation during a period of 1 year does not exceed 5 percent (by volume) of the free gas volume in any confined region of the package for the WVDP-HLW contents.

The maximum operating pressure for NCT, 1.29 atm (4.25 psig), is within the design limit of 75 psig according to Section 4.7.2 of the application. The staff confirmed the NCT pressure calculations for the Model No. NAC-STC containment boundary and the HLW Overpack, based on the ideal gas law and the maximum WVDP content temperature (210 °F). The maximum component temperatures for the metallic seals during NCT were also within the design limits according to Table 3.7-4, "Maximum Component Temperatures – Normal Transport Conditions, Maximum Decay Heat and Maximum Ambient Temperature – STC-WVDP," of the application. The applicant demonstrated the structural integrity of the package containment in Sections 2.6, "Normal Conditions of Transport," and 2.12, "Structural Evaluation – STC-WVDP Cask with HLW Overpack and Spacers," of the application.

The fabrication, periodic, maintenance, and pre-shipment leakage rate testing methods for the Model No. NAC-STC package with WVDP contents are performed in accordance with ANSI N14.5. The staff also confirmed the acceptance criterion was provided for the pre-shipment leakage rate test in Chapter 7, "Operating Procedures," of the application. The leakage rate testing requirements in Sections 7.4, "Leak Test Requirements," 8.1.3, "Leakage Tests," and 8.2.2, "Leak Tests," of the application have been modified to specify that the leak tests procedures shall be prepared by qualified personnel and approved by personnel qualified in accordance with the requirements of SNT-TC-1A as a Nondestructive Testing (NDT) Level III in leak testing and performed by personnel qualified in accordance with ANSI/ASNT CP-189-2006, "Standard for Qualification and Certification of Nondestructive Testing Personnel." Sections 7.4, 8.1.3, and 8.2.2 have also been modified to clarify the leakage rate test acceptance criterion and minimum test sensitivity for the various contents. The staff does not accept or approve any information in the application regarding the use of Viton O-rings to meet the leaktight leakage rate test acceptance criterion in accordance with ANSI N14.5. The staff reviewed the evaluation of the containment system under NCT and concluded that the package satisfied the containment requirements of 10 CFR 71.43(f) and 10 CFR 71.51(a)(1) with no dependence on filters or a mechanical cooling system.

4.3 Containment Evaluation under Hypothetical Accident Conditions

Section 4.7.2 of the application noted that the HLW canisters contain the maximum radionuclide quantities, generate the maximum heat, and have the potential for maximum alpha gas generation equivalent to 0.16 psi over 100 years. Therefore the HLW canister content bounds that of the evacuated canister and debris canisters, and the applicant concluded any combination of canisters can be loaded into the Model No. NAC-STC. Section 4.7.2 of the application described the combustible gas generation for the WVDP-HLW contents and stated there was no significant non-alpha gas generated by the canisters (HLW, evacuated, or debris canisters) at HAC temperatures. Based on the applicant's assumptions about the HLW canister content and combustible gas generation, as discussed in Section 4.2 of this SER, the staff concluded that the combustible gas generation during a period of 1 year would not exceed 5 percent (by volume) of the free gas volume in any confined region of the package for the WVDP-HLW contents.

The maximum operating pressure for HAC, 1.89 atm (13.1 psig), is within the design limit of 75 psig according to Section 4.7.2 of the application. The staff confirmed the HAC pressure calculations for the Model No. NAC-STC containment boundary and the HLW Overpack based on the ideal gas law and the maximum WVDP-HLW content temperature (520 °F). The maximum temperatures for the metallic seals during HAC were also within the design limits according to Table 3.7-6, "Maximum Temperature of the HLW and Contents, Basket, and HLW Overpack – Hypothetical Accident Condition Fire Transient," of the application. The structural integrity of the package containment during HAC is demonstrated in Sections 2.7, "Hypothetical Accident Conditions," and 2.12, Structural Evaluation-STC-WVDP Cask with HLW Overpack and Spacers," of the application. The staff reviewed the evaluation of the containment system under HAC and concluded that the package satisfies the containment requirements of 10 CFR 71.51(a)(2).

4.4 Evaluation Findings

Based on review of the statements and representations in the application, the staff finds that the applicant adequately described and evaluated the containment design for the Model No. NAC-STC WVDP-HLW contents and that the package design for the WVDP-HLW contents meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The staff reviewed the application to confirm that the changes made to the package, as part of this licensing action request, provide adequate protection against radiation and meet the external radiation requirements of 10 CFR Part 71 under NCT and HAC. This section includes the staff's evaluation of the applicant's changes to the shielding evaluation of the Model No. NAC-STC for transporting WVDP-HLW as authorized contents.

5.1 Description of the Shielding Design

5.1.1 Packaging Design Features

The staff reviewed the information provided by the applicant related to the shielding design of the Model No. NAC-STC. The shielding design includes multi-walled shielding materials that completely surround the package contents. These materials include SS and lead for gamma shielding and a borated polymer (NS-4-FR) for neutron shielding.

The Model No. NAC-STC is designed to transport five canisters containing solid HLW or HLW debris in a HLW Overpack. The applicant assigned a nominal Transport Index of 0.1 (TI = 0.1) based on the analysis presented in Section 5.7.4.3 of the application. The maximum dose rate at 1 m from the Model No. NAC-STC during NCT is 9×10^{-2} mrem/hr. Table 5.7.2-2 of the application includes analyses on a transport date of April 1, 2014, and bounding activities for each canister.

The overpack is placed in the Model No. NAC-STC cavity between bottom and top spacers containing HLW canisters. The following components provide radial and axial shielding of the WVDP-HLW content:

- the overpack 3/8-inch shell
- the 4 in. of SS from the overpack closure lid 2 in. of steel from the overpack bottom
- 1 in. of steel from the basket bottom

The package body and lids also serve as shielding for this configuration. The HLW basket is constructed with five loading tubes with support plates and a top shield disk. Section 1 of this SER includes a description of the overpack basket and HLW canisters, including approximate dimensions.

5.1.2 Design Criteria

For NCT, the dose rate on the external surface is less than 200 mrem/hr and the TI is 0.1, which are less than the limits specified in 10 CFR 71.47. Under HAC, the dose rate is less than 1,000 mrem/hr at 1 m from the surface of the package, which meets the 10 CFR 71.51 requirement.

5.2 Summary Tables of Maximum Radiation Levels

The applicant performed the shielding analysis using the following computer codes:

a. *ORIGEN-S module of the SCALE 6* —Package source terms for both neutron and gamma sources
b. *MCNP5 version 1.6 computer code*—Dose rates, including from n-gamma reactions

The applicant includes parameters and/or results of the shielding analysis in the following portions of the application:

a. Figure 5.7.1-1 and Table 5.7.1-1—summary of the dose rates for NCT for the maximum allowable dose rates for exclusive use according to 10 CFR 71.47(b)
b. Figure 5.7.1-2 and Table 5.7.1-2—maximum dose rates for HAC in accordance with 10 CFR 71.51
c. Tables 5.7.1-1 and -2—fractional standard deviations (FSD) from the Monte Carlo calculation

The staff reviewed the shielding analyses, including the methodology, model, and results as presented in Tables 5.7.1-1 and 5.7.1-2 of the application, to ensure that the package met the requirements in 10 CFR 71.47 and 10 CFR 71.51.

5.3 Radiation Source

Table 5.7.2-2 of the application includes a description of the contents, including the activity limits and bounding activity per isotope. The applicant provided the contents of specific radionuclides. The applicant evaluated the maximum source based on the maximum activity per kilogram per canister for each radionuclide and maximum possible mass of glass in each canister. The limits account for the contribution to dose rates resulting from the buildup of the proposed contents' decay progeny with time as well. The applicant used the MCNP (Monte Carlo N-Particle Transport Code) analysis to calculate the contribution of subcritical neutron multiplication.

Table 10. Summary of Sources of Radiation Considered in the Shielding Analysis

	Reference in the Application	**Brief Description of Reference**
HLW Canisters	Table 5.7.2-1	Includes physical parameters of the canisters.
	Table 5.7.2-2	Curie content as of January 1, 2014.
Neutron Source	Table 5.7.2-3	Presents the neutron source spectrum in a 27-group structure resulting from spontaneous fission and from (α,n) reactions within the borosilicate glass.
Gamma Source	Table 5.7.2-4	Design-basis gamma in a 19-group spectrum. The significant contributors to gamma are ^{90}Y and ^{137}Cs.

5.4 Model Specification

The applicant performed its analyses using the computer code MCNP5 version 1.6. The MCNP5 code is a 3-D Monte Carlo code that has the capability of analyzing:

a. neutron, gamma, and charged-particle radiation
b. 3-D problems
c. complex geometries such as streaming paths

The applicant estimated the dose rate profiles at the package surface and at 1 ft, 1 m, 2 m, and 4 m from the package surface or transport vehicle using surface tallies. The applicant used the radial and axial biasing technique for estimating the dose rates at the package radial surface and package top and bottom surface dose rates, respectively. In the MCNP model, surfaces and bodies, such as cylinders and rectangular parallelepipeds, and their respective logical intersections and unions, are used to describe the extent of material zones.

Table 11. Overview of Assumptions for the Shielding Evaluation of Items Related to the WVDP-HLW Contents (MCNP model)

Item Modeled	Main Assumptions
Vitrified HLW Canister	- Glass density of 2.699 g/cm^3 - Maximum mass of glass loaded in an HLW canister is 2,200 kg - Bottom of the HLW canister is a flat plate instead of being slightly concave, which increases the canister free volume slightly and has no impact on dose rates
Overpack	Includes the canister, basket cells, basket inside plates and bottom plates; no gap between the closure lid and overpack. Welded closure lid onto the overpack to prevent radiation streaming.
NAC-STC Package	Reduced dimensions of: - the radial neutron shield - shield shell - upper and lower impact limiters (due to crush and deformation) - balsa wood impact limiters

5.4.1 NAC-STC Model

The staff reviewed Chapters 2 (structural evaluation) and 3 (thermal evaluation) of the application to determine the effects of the NCT and HAC on the packaging and its contents. Section 5.7.3.3 of the application includes a summary of the features of the Model No. NAC-STC package evaluated during NCT. The applicant included the radial neutron shield and shield shell and the upper and lower impact limiters with reduced dimensions. The impact limiter is assumed to be all balsa wood. Chapter 2 of the application showed that NCT tests required by 10 CFR 71.71 did not impact the geometry of the package. However, the impact limiters experience some crush and deformation, which is the basis for reducing the dimensions of the impact limiters in the shielding evaluation. The dimensions assumed in the model bound the effects of the NCT tests. During HAC, the applicant does not include the upper and lower impact limiters as part of the shielding model. The staff finds that the shielding model is consistent with the effects of the tests performed in compliance with 10 CFR 71.71.

5.5 Shielding Evaluation under Normal Conditions of Transport and Hypothetical Accident Conditions

The applicant used the source terms obtained in the shielding calculations, per Section 5.7.2 of the application, and the maximum activities reports in Table 5.7.2-2 of the application. The dose rates are reported as a function of distance from the radial and axial surfaces of the Model No. NAC-STC for both NCT and HAC. Sections 5.1.4 and 5.1.5 of this SER include a summary of the main assumptions related to the radiation source and the computer model used for the shielding evaluation, respectively.

The MCNP5 code uses the ENDF/B-V and VI data and the MCPLIB04 photo atomic libraries continuous energy for the shielding analysis. The MCNP XSDIR file includes the libraries for each material (perisotope and element of interest). The staff performed confirmatory calculations using SCALE 6.1 for source term and MCNP for shielding evaluations to validate the applicant's calculation.

5.5.1 Flux-to-Dose Rate Conversion Factors

The applicant used the ANSI/ANS Standard 6.1.1-1977 flux-to-dose rate conversion factors to calculate dose rates. The staff finds the applicant's approach acceptable and consistent with the staff's guidance in NUREG-1609.

5.5.2 Dose Rates

Table 12, below, includes the information provided by the applicant with the estimated dose rates under NCT and HAC. All these dose rates are in compliance with 10 CFR Part 71 limits.

Table 12. Estimated Dose Rates under NCT and HAC—WVDP-HLW Content

	Reference in the Application	Brief Description of the Information Provided
NCT	Figure 5.7.4-1	Contains the dose rates for NCT for a 3-D package model. This figure presents the dose rate profiles at various radial distances from the package surface.
	Figure 5.7.4-2	Includes the radial surface dose rate for neutron, gamma, and neutron-gamma.
	Figure 5.7.4-3	Includes the surface dose rate azimuthal variations for the WVDP-HLW at the package midplane.
	Figure 5.7.4-4 Figure 5.7.4-5	Show the top and bottom axial dose rate profiles at various axial distances from the package surface.
HAC	Figure 5.7.4-6	Shows the dose rate profiles at various radial distances from the package surface.
	Figure 5.7.4-7	Shows the contributions to the radial 1-m dose rate from each source component.
	Figure 5.7.4-8	Shows the 1-m azimuthal variations for the WVDP-HLW at the package -midplane and the bounding radial 1-m dose rates.

5.5.3 Confirmatory Calculations

The staff performed confirmatory analyses of the gamma and neutron source terms for the design basis using the SCALE 6.1 and ORIGEN-S system of computer codes. The staff also reviewed the parameters, material densities, and code input files. The staff finds that the calculated dose rates do not exceed the external radiation limits of 10 CFR Part 71 for NCT and HAC. The dose rates calculated by the staff were consistent with those reported in the application.

5.6 Evaluation Findings

Based on the information provided by the applicant and the staff's confirmatory calculations, the staff has reasonable assurance that the applicant's shielding analyses demonstrate that the package design meets the requirements of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

The purpose of this section is to verify that the package design satisfies the criticality safety requirements of 10 CFR Part 71 under NCT and HAC. The staff reviewed the application to verify that the changes made to the package, as part of this licensing action request, provide adequate protection in terms of criticality safety. This section includes the staff's evaluation of the applicant's changes to the criticality safety analysis of the NAC-STC for transporting WVDP-HLW as authorized contents.

6.1 West Valley Demonstration Project High-Level Waste Content

The applicant described the proposed contents in Sections 6.9 and 6.9.1 of the application. The waste is in the form of glass log canisters, evacuated canisters, and debris canisters. The latter two canisters may be only partially filled and contain remnants of glass material and other non-fissile debris. The amount of fissile material is limited (less than 420 g). Based on the process that produces the glass, waste, and debris, their composition should be relatively uniform. Hence, the applicant evaluated these contents versus the limits in 10 CFR 71.15 for exemption from fissile material classification. In particular, the applicant evaluated the contents in terms of the limits in 10 CFR 71.15(c).

The staff reviewed the applicant's evaluation. The evaluation addresses the limits in 10 CFR 71.15(c). Most of the contents are glass log canisters. Based on the package analyses, the staff finds that these contents will retain their form during NCT and HAC. Therefore, these contents will be able to meet the limits to be considered fissile exempt. The applicant also provided details in Chapter 1 of the application (see definition of "HLW Debris Canister") to clearly describe the contents of the evacuated canisters and debris canisters. The staff notes that the evacuated canisters may be partially filled. However, the canister's contents are glass, which is the same material as in the glass log canisters. So, the composition of the materials will be relatively uniform for the material in these canisters also. The debris canisters also include HLW material in a glass matrix as well as refractory materials and alumina from melter inserts. The staff further notes that the contents of a package containing the WVDP-HLW are limited to up to two evacuated canisters and one debris canister.

Based on considerations of the material properties of the contents and the proposed quantity limits, as described, the staff has reasonable assurance that the contents will meet the limits in 10 CFR 71.15 and do not require a criticality safety evaluation. The CoC will include appropriate conditions to ensure only WVDP-HLW contents that meet these limits are transported in the package.

6.2 Evaluation Findings

Based on the information in the application, the staff finds, with reasonable assurance, that the package with the proposed changes satisfies the nuclear criticality safety requirements in 10 CFR Part 71.

7.0 PACKAGE OPERATIONS

The applicant made changes in Chapter 7 of the application related to the proposed contents: (1) WVDP-HLW and (2) directly-loaded uncanistered high burnup fuel. The staff's review focused on the WVDP-HLW content and not on high burnup fuel due to the unresolved issues related to the evaluation of high burnup fuel as authorized contents. Therefore, changes in Chapter 7 related to high burnup fuel, neutron absorber and fuel tube for the direct load configuration, and the Viton containment boundary O-rings tested to the leaktight criterion are not approved for use.

The staff also reviewed the package operations descriptions in terms of the criticality design of the package. The staff has reasonable assurance that the package will be operated in a manner consistent with the criticality design of the package. This finding is based on the revisions to package operations to account for the new contents. The revisions include confirmations that the contents to be loaded in the package meet the package conditions for shipment. One example is the verification that the WVDP-HLW contents meet the limits in 10 CFR 71.15 for classifying the contents as fissile exempt.

7.1 Loading and Closing of the HLW Overpack

The staff reviewed the loading and closing procedures for the HLW Overpack in Section 7.6.3 of the application. Each HLW Overpack is designed to load up to five HLW canisters, melter-evacuated canisters, or HLW debris canisters. The staff notes that the contents of a package containing the WVDP-HLW are limited to up to two evacuated canisters and one debris canister. In the event that the overpack is only partially loaded (i.e., less than 5 canisters), a transport insert is loaded into the unused basket locations. These operations are conducted in a dry environment and in a hot cell.

The overpack closure lid is welded in place and visually inspected. After a smear survey to ensure the contamination limits are met, the loaded HLW Overpack may be transferred into the Model No. NAC-STC in accordance with the procedures presented in Section 7.1 of the application. The loaded contents must meet the requirements for the authorized contents, as described in the CoC of the Model No. NAC-STC, prior to transport. The staff finds this procedure to be adequate.

7.2 Preparation for Transport

Prior to transport, the shipper must perform a preshipment leakage rate test to confirm proper assembly of the containment system. The preshipment leakage rate testing methods for the Model No. NAC-STC package with WVDP-HLW contents are performed in accordance with ANSI N14.5, "American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment." The leakage rate testing requirements in Section 7.4, "Leak Test Requirements," of the application were modified to specify that the leak test procedures shall be prepared by qualified personnel and approved by personnel qualified in accordance with the requirements of SNT-TC-1A as a Nondestructive Testing (NDT) Level III in leak testing and performed by personnel qualified in accordance with ANSI/ASNT CP-189-2006, "Standard for Qualification and Certification of Nondestructive Testing Personnel." Section 7.4 was also modified to clarify the leakage rate test acceptance criterion and minimum test sensitivity for the various contents.

The applicant included information in the application regarding directly-loaded intact/undamaged high burnup pressurized water reactor (PWR) fuel, as well as containment boundary Viton O-rings that could meet the leaktight leakage rate test acceptance criterion. An adequate evaluation was not provided by the applicant for the staff to approve the directly-loaded intact/undamaged high burnup PWR fuel contents, therefore, the staff does not approve any information in the application regarding high burnup fuel contents. An adequate evaluation was not provided by the applicant to show that the Viton O-rings meet the leaktight leakage rate test acceptance criterion. Therefore, the staff does not accept or approve any information in the application regarding the use of Viton O-rings to meet the leaktight leakage rate test acceptance criterion.

7.3 Preparation of Empty Package for Transport

The applicant provided a description of the process for preparing an empty package for shipment. The applicant stated that O-ring seals on the lids, port cover plates, and test plugs would not require replacement for an empty packaging shipment.

7.4 Evaluation Findings

Based on review of the statements and representations in the application, the staff concludes that the operating procedures meet the requirements of 10 CFR Part 71 and that the changes to the procedures provided by the applicant are adequate to ensure the package will be operated in a manner consistent with its evaluation for approval.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM REVIEW

The applicant made changes in Chapter 8 of the application related to the proposed contents: (1) WVDP-HLW and (2) directly-loaded uncanistered high burnup fuel. Changes in Chapter 8 related to high burnup fuel are not approved for use. The applicant also made changes to the neutron absorbers and containment Viton O-rings, including their testing. Since these changes appear to be related to the proposed high burnup fuel contents, changes to Chapter 8 regarding the neutron absorbers and the containment Viton O-rings tested to the leaktight acceptance criterion are also not approved for use.[2]

8.1 Visual Inspections and Measurements

Table 4.1-2 includes the types of weld examinations related to the containment boundary of the Model No. NAC-STC. The applicant did not revise this information. Based on the approved contents, no further evaluation is required.

8.2 Leakage Rate Tests

Each Model No. NAC-STC package used to transport WVDP-HLW contents will have fabrication leakage tests to the leaktight criterion of 1.0×10^{-7} reference-cm^3/s (or 2.0×10^{-7} cm^3/s, helium), in accordance with ANSI N14.5. The fabricator must perform a fabrication leakage rate test to demonstrate that the containment boundary will provide the required level of containment. The Model No. NAC-STC package used to transport WVDP-HLW contents will have maintenance and periodic leakage rate tests to a leaktight criterion of 1.0×10^{-7} ref-cm^3/s (or 2.0×10^{-7} cm^3/s, helium), in accordance with ANSI N14.5.

The applicant revised Sections 8.1.3, "Leakage Tests," and 8.2.2, "Leak Tests," of the application to specify that the leak test procedures shall be prepared and approved by qualified personnel in accordance with the requirements of SNT-TC-1A (i.e., an NDT Level III in leak testing). Personnel performing leak testing must be qualified in accordance with American National Standards Institute\American Society for Nondestructive Testing (ANSI/ASNT) CP-189-2006. The applicant also revised Sections 8.1.3 and 8.2.2 to clarify the leakage rate test acceptance criterion and minimum test sensitivity for the various contents. The staff does not approve any information in the application regarding the use of Viton O-rings to meet the leakage rate for the leaktight test acceptance criterion.

8.3 Evaluation Findings

The evaluations presented in the application include acceptable structural and thermal margins for the proposed contents, conservative assumptions, and heat transfer properties. Therefore, thermal testing will not be performed because the information provided by the applicant is reasonable to demonstrate compliance with 10 CFR Part 71 regulatory requirements.

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[2] This means that only Boral and TalBor are acceptable neutron absorbers for the direct load basket, acceptance testing of these absorbers must be conducted per the requirements in Section 8.1.7, and these absorbers are only qualified for 75% credit of their boron-10 content. The materials, acceptance testing, and boron-10 credit described in proposed Section 8.1.11 is not approved.

Based on review of the statements and representations in the application, the staff concludes that the acceptance tests for the packaging meet the requirements of 10 CFR Part 71 and that the maintenance program is adequate to ensure packaging performance during its service life.

9.0 CONDITIONS

The staff made editorial changes to improve the readability of the CoC. The CoC includes the following condition(s) of approval:

(1) Condition No. 5.(a)(2), "Description," includes information to reflect the addition of "West Valley Demonstration Project (WVDP) High-Level Waste (HLW) canisters in an HLW Overpack" as approved contents. This condition also includes the following revisions:

a. Per the applicant's request, delete the word "Connecticut" from the sentence including "the Connecticut Yankee-multi-purpose canister (MPC) configuration."

b. Revise the description of the "Basket and transportable storage canister" as follows:

"*Basket and transportable storage canister.* The spent fuel contents are transported either directly-loaded (uncanistered) into a stainless steel fuel basket, or within a stainless steel transportable storage canister (TSC). The WVDP-HLW contents are transported in a stainless steel basket inside a transportable canister referred to as the HLW Overpack or WVDP-HLW Overpack."

c. Added the following descriptions for the "WVDP-HLW Overpack and transport inserts" and "Spacer assemblies for WVDP-HLW Overpack":

"*WVDP-HLW Overpack and transport inserts.* The WVDP-HLW Overpack measures 126.5 in. in length by 70.6 in. in diameter. The WVDP-HLW Overpack consists of three (3) principal components, namely the WVDP-HLW Overpack shell, basket, and closure lid. The HLW Overpack consists of an annular right circular shell closed at one end by a bottom plate. The shell is constructed of 3/8-inch rolled dual certified Type 304/304L stainless steel plate. The edges of the rolled plates are joined with full penetration welds. The dual certified Type 304/304L stainless steel bottom plate is also attached to the shell by using a full penetration weld. The basket is an assembly of five vertical cylindrical cells held by supporting plates, all fabricated from 304 stainless steel. The basket's cells position up to five (5) HLW canisters, melter-evacuated canisters, or HLW debris canisters inside the Overpack. For shipments of less than 5 HLW canisters (i.e., partially loaded basket), transport inserts occupy the unused cylindrical cells. The material used for fabricating the transport insert is 304 stainless steel.

Spacer assemblies for WVDP-HLW Overpack. Two spacer assemblies serve for configuration control of the WVDP-HLW Overpack within the NAC-STC package. One spacer is positioned below the HLW Overpack and a second spacer is positioned above the HLW Overpack. Both spacer assemblies are constructed of concentric rings of 304 stainless steel welded to a stainless steel base plate."

(2) Condition No. 5.(a)(3), "Drawings," contains the approved changes to drawings for the NAC-STC package as well as new drawings for transporting the WVDP-HLW contents. The staff included the following statement in this condition related to high burnup fuel because some of the approved drawings contain information related to high burnup fuel, which is not an approved content of the Model No. NAC-STC package:

> "High burnup fuel is not an authorized content for the Model No. NAC-STC. Components and items included in Condition Nos. 5.(a)(3)(i) and 5.(a)(3)(v) related to high burnup fuel are not approved for use. This includes the fuel tube and neutron absorber specifications identified in the notes for the drawings as excluded items."

(3) Condition No. 5.(a)(3)(i) was revised as follows:

> "For the approved contents and quantity of materials specified in Condition No. 5.(b) of this certificate of compliance, the cask is constructed and assembled in accordance with the following Nuclear Assurance Corporation (now NAC International) Drawing Nos:

423-800, sheets 1-3, Rev. 17P(1) and 17NP(1)	423-811, sheets 1-2, Rev. 11
423-802, sheets 1-7, Rev. 21	423-812, Rev. 6
423-803, sheets 1-2, Rev. 10	423-900, Rev. 6
423-804, sheets 1-3, Rev. 9	423-209, Rev. 0
423-805, sheets 1-2, Rev. 7	423-210, Rev. 0
423-806, Rev. 8	423-901, Rev. 2
423-807, sheets 1-3, Rev. 4	

> Note:
> (1) Excludes components and items related to Assembly No. 97, Note 14, and the reference in Note 1 to Assembly 423-870-98. These three items are specific for high burnup fuel contents."

(4) Condition No. 5.(a)(3)(v) was revised to include Drawing No. 423-843, Revision 5, and Note (1) "Approval of drawing No. 423-843, Rev. 5, excludes components and items related to Assembly No. 91. Assembly No. 91 is specific for high burnup fuel contents."

(5) Condition No. 5.(a)(3)(ix), contains the approved drawings for transporting the WVDP-HLW content.

> "For the West Valley Demonstration Project High-Level Waste, the HLW Overpack (shell, basket, and closure lid), overpack spacers, and transport inserts are constructed and assembled in accordance with the following NAC International Drawing Nos.:

630087-501, sheets 1-2, Rev. 1	630087-511, Rev. 1
630087-504, Rev. 0	630087-512, Rev. 1
630087-505, Rev. 0	630087-513, sheets 1-3, Rev. 1
630087-510, Rev. 1	630087-514, Rev. 0"

(6) Condition No. 5.(b)(1)(vi), "Type and Form of Material," contains the approved WVDP-HLW content that can be shipped in the NAC-STC package, including the limits on the curie content.

(7) Condition No. 5.(b)(2)(vii), "Maximum quantity of material per package," lists the maximum number of the HLW canisters and weight that can be transported in the NAC-STC.

"For the contents Described in 5.(b)(1)(vi): Up to five (5) HLW canisters may be transported in the WVDP-HLW Overpack, including melter-evacuated canisters partially filled with HLW glass or canisters with HLW debris. A single WVDP-HLW Overpack is limited to a load of up to five (5) HLW canisters, two (2) melter-evacuated canisters, and one (1) HLW debris canister, in any combination. For a WVDP-HLW Overpack loaded with less than 5 canisters, a transport insert shall be loaded in all empty basket cell locations.

The NAC-STC content weight shall be ≤ 45,800 lbs. in the WVDP-HLW Overpack configuration. The WVDP-HLW Overpack heat load shall be ≤ 1.5 kW. Top and bottom spacers are used for axial positioning of the WVDP-HLW Overpack within the NAC-STC cavity."

(8) Condition No. 5.(c)(1) was revised as follows (to include the WVDP-HLW content):

"CSI=0.0 for contents described in 5.(b)(1)(i), 5.(b)(1)(ii), 5.(b)(1)(iii), 5.(b)(1)(iv) (i.e., Yankee Class and CY Fuel and GTCC Waste), and 5.(b)(1)(vi)."

(9) Condition No. 9 requires that the operating procedures and the maintenance and acceptance tests listed in Chapter Nos. 7 and 8 of the application, respectively, are followed. Condition No. 9 was revised as follows to exclude the information related to the high-burnup fuel content:

"In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) The package must be prepared for shipment and operated in accordance with the Operating Procedures in Chapter 7 of the application, as supplemented, with exception to Operating procedures related to high burnup fuel content, which is not approved as authorized contents for the Model No. NAC-STC.

(b) Each packaging must be acceptance tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Chapter 8 of the application, as supplemented, except that:

(2) ...the acceptance testing and maintenance related to the high burnup fuel content as well as the use of Viton O-rings to meet the leaktight acceptance criterion are not approved, since high burnup fuel is not approved as authorized contents for the Model No. NAC-STC. For directly-loaded baskets, neutron absorber tests must follow the requirements of Section 8.1.7 of the application, which also limits the absorber materials to Boral and TalBor and

> only allows for crediting of 75% of the absorber's boron-10 content."

The references section contains the original application and the supplements provided as part of this review.

10.0 CONCLUSIONS

Based on the statements and representations contained in the application, as supplemented, and the conditions listed above, the staff concludes that the design has been adequately described and evaluated, and the Model No. NAC-STC package meets the requirements of 10 CFR Part 71 for transporting the WVDP-HLW contents.

Issued with Certificate of Compliance No. NAC-STC, Revision 14
on February 17, 2016.

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APPENDIX A

Table A.1. Cross-Walk of the Staff's Evaluation of Some Drawings Submitted as part of Revision 14 of the Certificate Of Compliance for the Model No. NAC-STC

Applicant Submittal	Brief Description of the Drawing	Drawing No.	Latest Revision No. Submitted	Sheet No.	Assembly No.	Brief Description Component or Item	Comments
Application Revision 15B ADAMS Accession No. ML15229A028	Transport Assembly	423-843	5	1 of 1	Assy. 91	Cask Assembly STC-High Burnup Fuel (HBUF)	The staff approves Drawing No. 423-843, Revision 5, with exception to the information related to Assembly No. 91 and Item 18 of the Bill of Materials (BoM). Assembly No. 91 and Item 18 are specific to the directly-loaded uncanistered high burnup fuel contents.
	Tube, NAC-STC Cask	423-875	11	1 to 2	Assy. 99	Transport Assembly – STC Neutron Absorbers and fuel tubes	The staff does not approve Revisions 8-11 of Drawing No. 423-875. The changes in those revisions are specific to the directly-loaded uncanistered high burnup fuel contents. The revised CoC (Revision 14) references Drawing No. 423-875, Revision 7, which is the same revision referenced in Revision 13.
	Alternate Tube Assembly, NAC-STC	423-878	3	1 to 2	Assy. 99	Transport Assembly – STC Neutron Absorbers and fuel tubes	The staff does not approve any of the revisions of Drawing No. 423-878, since these changes are specific to the directly-loaded uncanistered high burnup fuel contents.
Application Revision 15A ADAMS Accession No. ML15174A291	Cask Assembly NAC-STC Cask	423-800	17P and 17NP	1	Assy. 97	Cask Assembly – Directly-loaded HBUF Transport	The staff approves Drawing No. 423-800, Revision 17P, with exception of Assembly No. 97, Note 14, and Note 1 reference to Assembly 423-870-98. These three items are specific to the directly-loaded uncanistered high burnup fuel contents.
	Lid Assy. – Inner, NAC-STC Cask	423-803	10	1 to 2	Assy. 98	Storage/ transport and canistered contents with metal O-rings	The staff approves Drawing No. 423-803, Revision 10.
					Assy. 99	Alternate directly-loaded transport with polymer O-rings	

Table A.1. Cross-Walk of the Staff's Evaluation of Some Drawings Submitted as part of Revision 14 of the Certificate Of Compliance for the Model No. NAC-STC

Applicant Submittal	Brief Description of the Drawing	Drawing No.	Latest Revision No. Submitted	Sheet No.	Assembly No.	Brief Description Component or Item	Comments
Application Revision 15A ADAMS Accession No. ML15174A291	Lid Assy. – Outer, NAC-STC Cask	423-805	7	1 to 2	Assy. 98	Storage/ transport and canistered contents with metal O-rings	The staff approves Drawing No. 423-805, Revision 7, for transporting contents approved in revision 14 of the CoC for the Model No. NAC-STC.
					Assy. 99	Alternate directly-loaded transport with polymer O-rings	
	Port Cover Plate Assy. Inner Lid, NAC-STC Cask	423-806	8	1 of 1	Assy. 98	Storage/ transport and canistered with metal seals – includes WVDP-HLW content	The staff approves Drawing No. 423-806, Revision 8, for transporting contents approved in Revision 14 of the CoC for the Model No. NAC-STC.
					Assy. 99	Alternate directly-loaded transport with polymer O-rings	
	Direct Load Configuration	423-870	5	1 of 1	---	---	The staff does not approve the changes corresponding to Revision 6 of Drawing No. 423-870.
Application Revision 15A ADAMS Accession No. ML15174A291	Assy., Port Cover, NAC-STC Cask	423-807	4	1 to 3	Assys. 96, 97, and 99	96 and 97 – Storage 99 – Transport	The staff approves Drawing No. 423-807, Revision 4, for transporting contents approved in Revision 14 of the CoC for the Model No. NAC-STC.
	Shielded Thermal Shunt Assy., NAC-STC Cask	423-880	1P and 0NP	1 of 1	Assy. 99	Alternate directly-loaded transport with polymer O-rings	The staff does not approve any revisions of this drawing, since these changes are specific to the directly-loaded uncanistered high burnup fuel contents.

Table A.1. Cross-Walk of the Staff's Evaluation of Some Drawings Submitted as part of Revision 14 of the Certificate Of Compliance for the Model No. NAC-STC

Applicant Submittal	Brief Description of the Drawing	Drawing No.	Latest Revision No. Submitted	Sheet No.	Assembly No.	Brief Description Component or Item	Comments
Application Revision 13A ADAMS Accession No. ML13352A204	Package Assembly Transportation – NAC-STC Cask	423-900	7	1 of 1	Assy. 97	Package Assembly - HBUF	The staff does not approve Drawing No. 423-900, Revision 7. These changes are specific to the directly-loaded uncanistered high burnup fuel contents (i.e., Assembly No. 97). The revised CoC (Revision 14) will continue to reference Drawing No. 423-900, Revision 6, which was previously approved in Revision 13 of the CoC.