August 17, 2016

Paul Blanton, Program Manager
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Bldg 730-A
Aiken, SC 29808

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9979, REVISION NO. 0, FOR THE MODEL NO. 9979 PACKAGE

Dear Mr. Blanton:

As requested by your application dated May 3, 2016, supplemented July 18, 2016, enclosed is Certificate of Compliance No. 9979, Revision No. 0, for the Model No. 9979 package. The staff's safety evaluation report is also enclosed.

The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of Title 49 of the *Code of Federal Regulations* (49 CFR) 173.471.

If you have any questions regarding this certificate, please contact Pierre Saverot of my staff at (301) 415-7505.

Sincerely,

/RA/

John McKirgan, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9979
TAC No. L25101

Enclosures:
1. Certificate of Compliance No. 9979, Rev. No. 0
2. Safety Evaluation Report

cc w/encls. 1&2: R. Boyle, Department of Transportation
J. Shuler, Department of Energy, c/o L. Gelder

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OFC	SFM	E	SFM	E	SFM	E	SFM	E	SFM	E	SFM	SFM
NAME	PSaverot		ARigato		CKenny		JSmith		ASotomayor		JPiotter	ZLi
DATE	07/28/2016		08/02/16		08/04/2016		08/09/2016		08/08/2016		08/02/2016	08/10/2016
OFC	SFM	E	SFM	E	SFM	E	SFM	E	SFM	E	SFM	SFM
NAME	SFigueroa		JMcKirgan									
DATE	08/11/2016		8/17/16									

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SAFETY EVALUATION REPORT

Model No. 9979 Package
Certificate of Compliance No. 9979
Revision No. 0

SUMMARY

By letter dated May 3, 2016, the U.S. Department of Energy (DOE) submitted an application for the Model No. 9979 package. Revision No. 1 of the package application, dated July 17, 2016, supersedes in its entirety the application dated May 2016.

The Model No. 9979 package is a Type AF-96 package. Contents are limited to one A_2 quantity. The package has a calculated Criticality Safety Index (CSI) of 1.0 based on the content mass and the number of packages shipped in one conveyance. Packages may be shipped by commercial carrier in a closed or covered non-exclusive use conveyance. The package utilizes passive cooling to maintain internal temperatures below allowable limits.

The package was evaluated against the regulatory standards in 10 CFR Part 71, including the general standards for all packages and the performance standards specific to fissile material packages under normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

Based on the statements and representations in the application, and the conditions listed in the certificate of compliance, the staff concludes that the package meets the requirements of 10 CFR Part 71.

References

Safety Analysis Report Model 9979 Type AF Shipping Package, S-SAR-G-00002, Revision 1, dated July 17, 2016.

EVALUATION

1.0 GENERAL INFORMATION

1.1 Packaging Description

The Model No. 9979 package is composed of one 55-gallon drum overpack and one 30-gallon inner drum.

The 55-gallon drum and its lid, fabricated from 16-gauge carbon steel, include a welded steel liner containing a polyurethane foam for thermal insulation and structural support. When installed, the lid assembly extends into the drum body liner. An EPDM gasket seals the overpack closure. The 30-gallon inner drum, fabricated from 16-gauge carbon steel, is positioned centrally, both radially and axially, within the 55-gallon drum overpack steel liner.

The inner drum, which secures the radioactive contents payload, is the containment boundary for the package. A silicon gasket seals the 30-gallon containment drum closure.

Reinforced split-ring devices, fabricated from 12-gauge carbon steel, provide secure closures for both the 30-and 55-gallon drums. Tamper Indicating Devices (TID) can be inserted through the lugs welded at each end of the two split-rings for both the 55-and 30-gallon drums.

Two thermal insulation components, made of a ceramic fiber mat sandwiched and sewn between flexible fiberglass woven cloth, are added to the packaging: a quilted insulation cover, 21 ½ inches in diameter by ½ inch thick is positioned between the 30-gallon and 55-gallon drum closure lid and an insulation bag is installed in the 30-gallon drum.

The 55-gallon drum is nominally 23 inches in diameter and 34 ½ inches in height. The nominal weight of the overpack (body, closure lid and split-ring closure device) is 174.5 lb.
The 30-gallon drum is nominally 18.6 inches in diameter and 29 inches in height. The 30-gallon drum with its lid and the split-ring closure weighs approximately 50 lbs.

The gross weight of a fully loaded package shall not exceed 415 lb. The mass limit for the package, on the ID Plate on the outside of the 55-gallon drum overpack, limits the content/payload mass. The UN rating (e.g., IA2/X430/S) is only specified as a Quality Assurance (QA) verification that the drum shell is fabricated in accordance with the associated UN standards. The applicant stated that the mass in the UN number does not reflect a limitation of the package and only means that the fabricator of the 9979 overpack uses a drum shell that meets UN standards as a starting point in the fabrication of the packaging.

1.2 Contents

Contents are limited to the Texas A&M AGN fuel, as shown in Table 1 below:

Table 1: Authorized Contents

AGN UO_2 Fuel Form	Size (cm)
Four disks numbered 20497,20498, 20499 and 204100	Ø25.6 x 4
Three disks numbered 204101, 204102, and 204103	Ø25.6 x 2
Two disks numbered 204104 and 204105	Ø25.6 x 1
One core fuse	Ø3.2 x 1.3
Two safety rods	Ø4.8 x 16
One course rod	Ø4.8 x 16
One fine rod	Ø2.51 x 16

The maximum quantity of material per package is shown in Table 2 below:

Table 2: Maximum Mass of Contents

Material	Mass (g)
U-235	300
U-238	1,200
Carbon	1,000
Hydrocarbon, e.g., polyethylene, plastics	unlimited
Radioactive material	1,500
Package payload	90,000

The maximum weight of contents is 90 kg. The AGN contents, separated by flexible polyurethane disks, are required to be packaged within a thermal insulation bag, as specified on Drawing No. R-R4-G-00164.

Contents are specified to be all material within the 30-gallon drum, including the radioactive and non-radioactive content materials, such as polyethylene and aluminum, the insulation bags, and the dunnage, e.g., polyurethane foam disks.

The maximum decay heat of the contents is 1.0 milliwatts.

1.3 Criticality Safety Index

The Criticality Safety Index (CSI) for the package is 1.0. The design of the packaging does not include any specific criticality-control features. Subcriticality is ensured by limiting package contents and maintaining a minimum distance between adjacent fissile materials.

1.4 Licensing Drawings

The packaging is constructed in accordance with the following drawings:

Drawing No. R-R1-G-00026, 9979 Type AF 30-Gallon Container Split Ring Assembly (U), Rev. 5.

Drawing No. R-R1-G-0027, 9979 Type AF 55-Gallon Drum Lid Split Ring Assembly (U), Rev.5.

Drawing No. R-R1-G-00028, 9979 Type AF 30-Gallon Drum Assembly (U), Rev. 5.

Drawing No. R-R1-G-00029, 9979 Type AF 55-Gallon Drum Assembly (U), Rev. 5.

Drawing No. R-R1-G-00030, 9979 Type AF Packaging Assembly (U), Rev. 3.

Drawing No. R-R2-G-00057, 9979 Type AF 55-Gallon Drum Sub-Assembly and Weldment (U), Rev. 8.

Drawing No. R-R2-G-00058, 9979 Type AF 30-Gallon Drum (U), Rev. 3.

Drawing No. R-R2-G-00059, 9979 Type AF 55-Gallon Drum Lid Sub-Assembly and Weldment (U), Rev.6.

Drawing No. R-R2-G-00060, 9979 Type AF 30-Gallon Drum Lid with Dual Bung Closures (U), Rev. 4.

Drawing No. R-R4-G-00062, 9979 Type AF 30-Gallon Drum Lid Gasket (U), Rev. 3.

Drawing No. R-R4-G-00064, 9979 Type AF Insulation Bag, Rev. 3.

Drawing No. R-R4-G-00065, 9979 Type AF Insulation Cover Assembly for 30-Gallon Drum, Rev. 3.

Drawing No. R-R4-G-00163, 9979 Texas A&M AGN 30-Gallon Drum Payload Insert (U), Rev. 1.

Drawing No. R-R4-G-00164, 9979 Texas A&M AGN 30-Gallon Drum Foam Spacers (U), Rev. 1.

1.5 Evaluation Findings

The staff concludes that the information presented in this section of the application provides an adequate basis for the evaluation of the Model No. 9979 package against 10 CFR Part 71 requirements for each technical discipline.

2.0 STRUCTURAL EVALUATION

2.1 Description of Structural Design

The objective of this review is to verify that the structural performance of the package design has been adequately evaluated for the tests specified under normal conditions of transport (NCT) and hypothetical accident conditions (HAC), and that the package has adequate structural integrity to meet the requirements of 10 CFR Part 71.

2.1.1 Discussion

The 9979 Type AF package is comprised primarily of a 55-gallon drum (overpack) which contains a 30-gallon drum. Between these two drums is a carbon steel liner which makes direct contact with the 30-gallon drum. The void between the 55-gallon drum and the steel liner is filled with Dow BETAFOAM™ 87100/87124 which protects the 30-gallon drum from the tests and conditions specified for NCT and HAC. The 30-gallon drum, which houses the payload (see Table 1.1 of the application), also provides the containment function of the package.

Overall, the cylindrical package (55-gallon drum) measures 34.25 inches high and is 23.5 inches in diameter. The inner 30-gallon drum measures 28.75 inches high and is 18.6 inches wide. The 55-gallon drum, liner, and closure lid are made of 16 gauge carbon steel. The 30-gallon drum is made of 18 gauge carbon steel and its closure lid is made of 16 gauge carbon steel.

Both drums utilize a split-ring closure device made of 12-gauge carbon steel connected by ½" lug bolts. The 30-gallon drum also utilizes a commercial pressure relieving plug to release pressure under HAC. Additional details can be found in the licensing drawings.

2.1.2 Codes and Standards

The applicant evaluated external pressures along with vibration and shock normally incident to transportation using criteria equivalent to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC), Section III-NB level A service conditions.

2.1.3 Design Criteria

The applicant stated that the Model No. 9979 package complies with Sections 71.41 through 71.47 and 71.55 of 10 CFR 71. The structural performance of the package is qualified principally by full-scale testing of five prototypes.

Table 2.2 details the test matrix used to comply with load combinations summarized in Table 2.1.

2.1.4 Load Combinations

Load combinations, based on Regulatory Guide 7.8, are shown in Table 2.1 of the application.

2.1.5 Weights and Centers of Gravity

The maximum calculated package weight is 426.5 lb. Specific component weights are listed in Table 2.3 of the application.

The center of gravity (CG) of the empty package was found to be located on the longitudinal axis. The loaded package itself was found to shift the center of gravity two inches from the empty package location and was bound by a 6-inch shift in the vertical direction of the CG and a radial shift of 4 inches by prototype testing.

The NRC staff has reviewed the package structural design description and concludes that the contents of the application meet the requirements of 10 CFR 71.31

2.2 Material Properties

Regulatory Guide 7.11 specifies the level of safety of this package as ‘Category III’. NUREG/CR 3854 specifies an acceptable fabrication criteria for transporting ‘Category III’ material as ASME B&PVC, Section VIII, Division 1 or ASME B&PVC Section III, Subsection NF and Department of Transportation (DOT) specifications for drums used in the design. The drum and its closure lid are fabricated from 18 and16-gauge carbon steel, respectively.

The UN rating is specified as a QA verification that the drum shell is fabricated in accordance with the associated UN standards.

The package application provided material thermal properties such as thermal conductivity, density, specific heat, and emissivity for all components of the package. The staff found these properties acceptable.

The 30-gallon drum EPDM and silicon closure gasket materials have been tested above the HAC fire temperatures to demonstrate the continued functionality of the materials at 600°F and 690°F, respectively. Likewise, the packing materials of the 30-gallon drum and the contents, i.e., polyurethane packing foam and ceramic packing/dunnage materials, have been tested to 300° and 400° with minimal change in size and weight.

2.3 Lifting and Tie-Down Standards

2.3.1 Lifting Devices

The applicant stated that the package does not incorporate any structural feature that is used as a lifting device.

2.3.2 Tie-Down Devices

The applicant stated that the package does not incorporate any structural feature that is used as a tie-down device.

2.4 General Requirements for All Packages

2.4.1 Minimum Package Size

The smallest overall dimension of the package is over 22 inches according to the licensing drawings. Therefore, the NRC staff agrees that the package meets the requirements of 10 CFR 71.43(a) for minimum size.

2.4.2 Tamper-Indicating Features

The applicant stated that wire tamper indicating devices are installed with each split-ring closure, as shown in Figure 7.4 of the application. Based on this figure, the NRC staff agrees with the applicant that the requirements of 10 CFR 71.43(c) are satisfied.

2.4.3 Positive Closure

The applicant stated that the package incorporates a split-ring closure device for both drums which utilizes two threaded fasteners that are torqued. The NRC staff agrees that positive closure will be maintained by the split-ring closure device and finds that the applicant satisfied the requirements of 10 CFR 71.43(c).

2.5 Normal Conditions of Transport

The applicant used prototypes to demonstrate package performance with respect to drop and penetration tests. The applicant recorded the yield strength of the steel (ASTM A1008 CRCQ) used to fabricate the prototypes since it can vary. The actual package is constructed with yield strength that is higher than that of the prototypes.

2.5.1 Heat

The applicant tested prototypes at temperatures as high as at 60°F. The NRC staff concluded that due to the ductility of the thin gauge material, any thermal stresses due to temperatures as high as 100°F would result in the package deforming and redistributing any additional stress. Given the drum and closure device's ductility and thickness, the NRC staff finds that the package meets the conditions and tests of 10 CFR 71.71(c)(1).

2.5.2 Cold

The applicant drop tested a prototype (SN-01) at -20°F from a height of 30 feet (side drop orientation). The drop actually resulted in a slap down configuration where the closure device struck the unyielding surface first. The package closure device is made of the same steel as the drums. The applicant stated that fracture nor brittle behavior was observed. The prototype was also subjected to the crush test as part of demonstrating package performance with respect to cumulative damage. The applicant stated that fracture and brittle behavior was not observed for this material.

The NRC staff concluded that due to the ductility of the thin gauge material, any thermal stresses due to the cold would result in the package deforming and redistributing any additional stress.

The NRC staff also concluded that the material used for the drum and closure device was not susceptible to brittle fracture given its chemical composition and thickness, according to Regulatory Guide 7.11.

Given the drum and closure device's ductility, non-brittle behavior, thickness, and NRC guidance, the NRC staff finds that the package meets the conditions and tests of 10 CFR 71.71(c)(2).

2.5.3 Reduced External Pressure

The applicant calculated the effective pressure across both the overpack drum and containment drum for the case of increased external pressure, assuming that the overpack is either pressure tight or not pressure tight.

From this analysis, a maximum pressure differential of 16.5 psig was determined. The applicant stated that the drums to be used will be rated for 22.5 psig. Because the drums are rated for a pressure above the maximum normal operating pressure, the NRC staff finds that the applicant satisfied the requirements of 10 CFR 71.71(c)(3).

2.5.4 Increased External Pressure

The applicant calculated the effective pressure across both the overpack drum and containment drum for the case of increased external pressure assuming that the overpack is either pressure tight or not pressure tight. From this analysis, a maximum pressure differential of 5.3 psig was determined.

The applicant performed an analysis with increased external pressure since the drums are not rated for this loading condition. The applicant stated that since the lid and bottom plates are tested to 22.5 psig, these components can withstand a 5.3 psig loading.

While the NRC staff does not agree the loading condition is the same, staff does agree that the lid is able to withstand the applied pressure due to the large available capacity in the lid. The applicant calculates the allowable stress in the 30-gallon drum using ASME III, NB-3133.3 and determines that it can withstand 17.5 psig vs. 5.3 psig. Because of the available capacity in the system relative to the pressure demand, the NRC staff finds that the applicant satisfied the requirements of 10 CFR 71.71(c)(3).

2.5.5 Vibration and Fatigue

2.5.5.1 Vibration

The applicant used a power spectral density curve that was based on Safe-Secure Trailers (SST) and Safeguards Transporters (SGT) normally used to transport NNSA Drum-type packages to calculate an equivalent static force of 4g. The applicant showed how bolts, torqued to at least 3,000 lb, are greater than the 150 lb load observed from vibration and showed how the 4g loading is well below the foam's crush strength.

The applicant stated that these loads are below the elastic load limit. Because of the assumed conveyance and large margins calculated for both foam and split closure ring bolts with respect to vibratory loads relative to the yield of the material, the NRC staff concludes that the package will be able to meet the requirements of 10 CFR 71.71(c)(5).

2.5.5.2 Fatigue

The applicant claimed that fatigue effects to the package would be small due to the small vibrational loads. The NRC staff confirmed that the effect of fatigue independently by calculating stresses in the package assuming a large stress concentration factor, maximum vibrational load, and examining the design fatigue curve found in ASME Section III Appendices, Figure I-9.1 at 10^{11} cycles for carbon, low ally steel.

Since the calculated stress due to fatigue is below the fatigue design fatigue curve at 10^{11} cycles, the NRC staff concludes that the package adequately addresses fatigue.

2.5.6 Water Spray

The applicant stated that the package is an insulated overpack that is protected by steel liner and drum wall. The applicant stated that the foam insulation is impervious to water due to closed-cell structure. Both drum closures are gasketed. The applicant stated that two full-scale prototypes were subjected to the one-hour spray test and that, based on the before and after weight measurements, the drums were not found to retain water. Based on the results of the spray test, the NRC staff finds that the package meets the requirements of 10 CFR 71.71(c)(6).

2.5.7 Free Drop

The applicant described the impact surface used for drop testing as being unyielding due to its construction as a 4-ft square by 3-inch thick steel plate bonded to a concrete foundation weighing more than 14 times the package weight (6,000 lb). Based on these dimensions, the NRC staff concludes that the impact surface qualifies as an unyielding one.

The applicant stated that two full-scale prototypes of the package were dropped 4 feet. Both prototypes were dropped top down CG over corner (CGOC) with impact targeted at the closure device. The applicant stated for both drops that the closure device was neither punctured nor loosened, and that no significant change was observed in content configuration. In all cases, gravel was used as a contents surrogate instead of fuel packaged with polyurethane and polyethylene material. It is expected that loads experienced by the 30-gallon drum due to gravel contents are higher than actual contents.

The applicant stated that the calculated shift in CG does not adversely affect the structural performance of the package. The applicant examined 2 effects: CGOC drops and slapdown effects. With regards to CGOC drop orientations, the applicant stated that the intent was to maximize the impact into the corner of the package which was accomplished by prototype drop testing. A shift in CG would alter this goal.

The applicant also calculated slapdown effects with a shifted CG, and noted a 2% increase in package damage by the shift in CG. Based on this minimal increase in energy and results of a similar, 600 lb package of inferior construction, the applicant stated that slapdown effects will not adversely affect package performance.

Because of reported prototype package performance from physical testing, aggressive package orientation selection, gravel contents rather actual contents, and CG shift considerations, NRC staff agrees with the applicant that the requirements of 10 CFR 71.71(c)(7) are satisfied.

2.5.8 Corner Drop

The minimum package weight of the 9979 (224 lb.) exceeds 220 lb. Therefore, the package does need to meet the requirements of 71.71(c)(8).

2.5.9 Compression

The applicant stated that no effect on the package was observed when more than 5 times its weight was applied to it (2165 lb). Based on the results of the compression test, the NRC staff finds that the package meets the requirements of 10 CFR 71.71(c)(9).

2.5.10 Penetration

The applicant stated that the damage observed (Figure 2.8 of the application) from the steel bar (13.2 lb) when dropped normal to the package overpack (unreinforced location) was a 1/16" deep indentation. This damage does not affect the packages ability to meet NCT. Based on the applicant's description of the test results, the NRC staff finds that the package meets the requirements of 10 CFR 71.71(c)(10).

2.6 Hypothetical Accident Condition

The applicant performed physical testing to show compliance with the regulations for most tests specified in 10 CFR Part 71.73. Most prototypes were not tested at the full range of initial temperatures specified in the regulations (-20°F and 100°F). The yield strength of the steel (ASTM A1008 CRCQ) used to fabricate tested prototypes varies. The applicant stated that the actual package is constructed with a yield strength that is higher than that of the prototypes.

2.6.1 30-foot Free Drop

The applicant constructed and dropped four prototypes at various orientations, as stated in Table 2.2 of the application, at a height of 30-feet. The prototypes were dropped in the horizontal orientation, CG over corner (top and bottom), and in the vertical orientation (top down end drop). In all cases, gravel was used as a contents surrogate rather than fuel packaged with polyurethane and polyethylene. The applicant stated that loads experienced by the 30-gallon drum due to gravel contents are expected to be more challenging from gravel contents than actual contents.

End Drop

The applicant dropped the package in a top-down fashion which resulted in a slight out-of-plane deformation of the split-ring closure, crushed foam insulation, and overpack skin deformation. The closure was neither loosed and the overpack skin was not breached. This test was conducted at ambient temperatures (South Carolina winter).

Horizontal Orientation

The applicant dropped the package at -20°F. The drop induced a slight "slap down" effect as the drop was not perfectly horizontal. The split-ring closure was targeted of the drop. Both ends of the drum had local deformations at the site of impact with the closure device remaining firmly attached to the drum, despite the closure device being pressed into the overpack.

Oblique Orientation

The applicant used the performance of a similar, but heavier, 55-gallon, 640-lb, drum package called the 6M to show the robustness of the split ring closure device for an oblique (shallow-angle) drop.

Of the several types of closure devices in the 6M report, it was assumed that the "clam shell" closure device described in the 6M was assumed to be the same as the split ring closure device based on photos.

The referenced report showed that the clam shell closure was able to retain the lid for both the 30-foot CGOC drop and shallow angle drop even when a 4-foot drop (NCT) was used as an initial condition.

Corner Drop

The applicant dropped prototypes SN-02 and SN-03 with CG over corner onto the split ring closure device after having been subjected to similar 4-foot drops for NCT. The observed damage indicated that the closure device and adjacent corner of the package was deformed one to two inches. The closure device remained intact and kept the lid firmly attached to the drum consistently in both prototype drops.

The NRC staff concludes that the drop orientations used to test the prototypes of the package are expected to be the most damaging. Since the observed damage of the overpack and inner 30-gallon drum indicated that they were not breached during testing with more aggressive gravel contents, and the lid remained attached to both drums, NRC staff finds that the package meets the requirements of 10 CFR 71.73(c)(1).

2.6.2 Crush

The applicant subjected 4 prototypes to the crush test as specified by the regulations as part of a sequence of drops. Three of the four were tested at ambient temperature (South Carolina winter) while the remaining prototype SN-01 was tested at -20°F.

Prototype SN-02 was tilted and targeted by the plate such that its line of action would pass through the CG of the package while impacting the split-ring closure. The test resulted in a 3 inch deformation inward and resulted in slight tearing of the upper most hoop of the overpack due to the closure striking it. Some deformation occurred at the opposite corner of the package as a result but no tearing was observed.

Prototype SN-01 and SN-03 were oriented lying down and targeted by the plate such the split-ring closure was impacted by the plate at a temperature of less than -20°F. The impact separated the bottom portion of the drum (chime) from the drum wall for a length of about 5 inches and induced a tear of about 2.5 inches 180 degrees opposite the 5 inch separation. The closure device was not separated despite minor localized buckling.

Prototype SN-04 was oriented vertically where its lid was struck flush by the plate. The split ring closure was not loosened and the skin of the drum was deformed near the impact site but was not breached despite overall shrinking as much as 2 inches in places.

For all prototypes, it was found that the drum liner was not damaged and continued to confine the 30 gallon drum. The NRC staff agrees that the drop orientations used to test the prototypes of the package are expected to be the most damaging. Since the overpack was not breached during testing, the steel liner was not damaged, and the lid to the overpack remained attached to the package, the NRC staff finds that the package meets the requirements of 10 CFR 71.73(c)(2)

2.6.3 Puncture

The applicant described the steel bar and unreinforced concrete section used for subsequent testing. The staff agrees with the test setup. Prototypes SN-04 and SN-01 were subjected to the puncture test in a horizontal orientation and both prototypes were struck by the puncture bar at mid height. Prototype SN-04 was tested at ambient temperature (South Carolina winter) while SN-01 was tested at -20 degrees Fahrenheit. The results demonstrated that the overpack was not breached and left a ¼ inch dent in the side of the package.

The applicant stated that the side puncture drop was not performed near the lid such that the lid would be struck by the bar (and possibly becoming loose). The applicant stated that the stiffness of the location would be less damaging than the damage already observed in the preceding section.

In addition, the applicant did not drop the package at an oblique angle such that the protruding part of the split ring-closure could be struck and driven away from the overpack altogether, as to cause separation of the lid from the overpack.

The NRC staff did not agree with the stiffness argument, nor with the lack of consideration of the aforementioned drop scenarios. However, given the contents authorized for shipment and the corresponding criticality analysis, the NRC staff agrees that the package evaluation in aggregate, meets the requirements of 10 CFR 71.73 (c)(3).

2.6.4 Thermal

The applicant performed the thermal evaluation of the package analytically with results reported in Chapter 3 of the application. The applicant stated that the foam contained within the liner will leave behind a matrix of ash and char when subjected to HAC fire conditions. The maximum estimated temperature in the 55 gallon drum is 1475°F, and 623°F in the 30 gallon drum. The contents reach a temperature of 260°F according to Table 2.13 of the application.

The 30 gallon drum has a pressure relief valve that engages at 15 psig and the drums are rated for 22.5 psig. The applicant stated that thermal stresses will not be of concern since the insulation between the 55 gallon overpack and 30 gallon drum burns away. Vent holes in the overpack drum allow any built up pressure to escape during the HAC fire test.

The NRC staff agrees that thermal stresses and pressure observed will not be of any consequence to the package during HAC fire test. This is in part is due to the contents description and its configuration, as described at the beginning of Section 2.7.

Since criticality of the package is maintained during the HAC fire event, staff finds that the package meets the requirements of 10 CFR 71.73 (c)(4).

2.6.5 Cumulative Damage Summary

Following the HAC drop, crush and puncture test, the applicant disassembled 4 of the 5 prototypes and examined the inner 30-gallon drum closure and found that the closure device continued to retain the lid. The lid did suffer some deformation in several instances; however, the containment was not breached.

Based on the contents of the package, consequences of the fire test with respect to cumulative damage will not result in an increased criticality. Many of the prototypes underwent NCT drop tests prior to HAC drop tests.

Since criticality of the package is maintained during cumulative damage scenarios, the staff finds that the package meets the requirements of 10 CFR 71.71(a).

2.6.6 Immersion – Fissile

The applicant stated that an array of damaged and fully loaded 9979 packages assuming water flooding was examined. Since water in leakage has been considered in the package's design, the staff finds that the package meets the requirements of 10 CFR 71.73(c)(5).

2.6.7 Immersion – All packages

The applicant stated that an array of damaged and fully loaded packages, assuming water flooding, was examined. Since water in leakage has been considered in the package's design, the staff finds that the package meets the requirements of 10 CFR 71.73(c)(6).

2.7 Special Requirements for Irradiated Nuclear Fuel Shipments

2.7.1 Deep Immersion

Deep immersion considerations are not applicable for a Type A package.

Based on review of the statements and representations in the application, the staff concludes that the structural design has been adequately described and evaluated and that the package has adequate structural integrity to meet the requirements of 10 CFR Part 71.

3.0 THERMAL EVALUATION

3.1 Review Objective

The objective of this review is to verify that the thermal performance of the package design has been adequately evaluated for the thermal tests specified under NCT and HAC, and that the package design meets the thermal performance requirements of 10 CFR Part 71.

3.2 Description of Thermal Design

3.2.1 Design Features

Sections 1.2.1 and 2.1.1 of the application describe the packaging components and their design functions. The package consists of an insulated 55-gallon drum overpack surrounding a 30-gallon drum. A steel liner protects the insulation material within the 55-gallon drum and the 30-gallon drum sits within the overpack liner. The 55-gallon drum overpack provides impact and thermal protection for the 30-gallon drum and the payload therein.

Split-ring closure devices secure both of the drum closure lids. An EPDM gasket seals the 55-gallon overpack body and closure lid. A silicone gasket seals the 30-gallon drum body and closure lid. EPDM gaskets are also used for two bung fittings on the 30-gallon drum.

The closure lid of the 30-gallon drum incorporates a pressure relieving device designed to release pressure between 12-15 psig and to reseal by 3 psig to assure controlled release of gases that may be generated under HAC. If this vent does not function as expected, the total pressure in the 30-gallon drum can be up to 40.7 psig which is above the design limit of 22.5 psig.

Packing and dunnage material use within the 30-gallon drum is considered part of the payload for the thermal evaluation. This includes the insert assembly and insulation bag, which are both comprised of ceramic fiber, and the polyether polyurethane packing foam spacers.

The design transfers heat passively under NCT and HAC. Insulation of the 55-gallon drum is provided by Dow Automotive BETAFOAM. The BETAFOAM in the 55-gallon drum limits heat transfer to the payload. This BETAFOAM will generate small amounts of gases from thermal decomposition during the HAC-fire event. The exterior shell of the overpack incorporates nine holes arranged 120 degrees apart and three axial drum elevations to provide vent paths for these gases.

A ½ inch think insulation cover fits over the top of the 30-gallon drum, under the 55-gallon drum closure lid, as part of the package thermal insulation. This cover consists of ceramic fiber material sewn into a disk.

An insulation bag made of the same ceramic fiber fits inside the 30-gallon drum to provide additional thermal insulation for the contents during HAC fire.

The applicant considered a less than 0.5 inch gap in the annular space between the inner drum and the outer drum liner. Gaps are treated as uniform in thickness.

3.2.2 Content's Decay Heat

Appendix 4.1 of the application calculated the total decay heat of the package contents to be 6.37×10^{-5} watts. The thermal analysis of the package is conservatively based on a total decay heat load of 1 milliwatt. Specific total decay heat per fuel piece is provided in Appendix 4.1 and packing configurations are shows in Figures 1.5, 1.6 and 1.7.

3.2.3 Summary Tables of Temperatures

The summary tables of package component temperatures were reviewed. The components include the 55-gallon drum and liner, 30-gallon drum, overpack insulation Dow BETAFOAM, EPDM and silicon gaskets, AGN fuel contents, polyether polyurethane foam packaging/dunnage material, ceramic fiber packaging/dunnage material and the ceramic fiber/fiberglass insulation bag.

Table 3.1 of the application presents the thermal design limits for components under NCT and HAC. Table 3.2 presents maximum component temperatures under NCT and HAC.

For HAC, the applicant presented the pre-fire, during-fire, and post-fire cool-down component temperatures.

The temperatures are consistently presented throughout the application for both NCT and HAC. With exception of the polyether polyurethane packing/dunnage material, all components remain below their material property limits listed in Table 3.1 of the application.

3.2.4 Summary Tables of Maximum Pressures

The summary tables of the maximum pressures under NCT and HAC were reviewed and found to be consistent throughout the application.

Table 3.1 of the application presents the NCT pressure limits for the components. Table 3.5 of the application provides a summary of the maximum pressures under NCT and HAC for both the 30- and 55-gallon drums with a comparison to the design limits.

The NRC staff reviewed the design features, design criteria, and content's decay heat of the package.

Based on the information provided in the application regarding these items, the staff determines that the application is consistent with the guidance provided in NUREG-1617. Therefore, the NRC staff concludes that the description of the thermal design is acceptable.

3.3 Material Properties and Component Specifications

3.3.1 Material Properties

The package application provided material thermal properties such as thermal conductivity, density, specific heat, and emissivity for all modeled components of the package. The NRC staff found these properties acceptable. The thermal properties used for the analysis of the package were appropriate for the materials specified and for the conditions of the package required by 10 CFR Part 71 during NCT and HAC.

3.3.2 Component Specifications

Section 3.2.2 of the application provided component technical specifications for components relevant to the thermal analysis including the 55-gallon drum overpack and insulation, 30-gallon drum, drum gaskets and the ceramic insulation material. The maximum allowable service temperatures and pressures for these components are specified in Table 3.1 and are appropriate for each package component. The NRC staff verified that the minimum allowable service temperature for all components is less than or equal to -40°F.

3.4 Thermal Evaluation under NCT

3.4.2 Heat and Cold

The NRC staff reviewed the analysis in Section 3.3.1 of the application showing that the effectiveness of the design is not reduced significantly when subjected to NCT tests. The applicant performed steady state analysis using the thermal model without insolation to determine the accessible surface temperature of the package in the shade. A heat load of 1-milliwatt and boundary conditions at 100°F and no insolation are considered in the cask model to calculate the maximum accessible surface temperature under shade. The NRC staff finds, based on Table 3.11, that all accessible surfaces of the package remain below 122°F for non-exclusive use shipment, when subjected to the heat conditions of 10 CFR 71.43(g).

Table 3.11 of the application presents the maximum calculated temperatures for the components under NCT. The NRC staff confirms that the applicant's calculated maximum temperatures are below the material temperature limits with a sufficient margin and finds them acceptable.

There are no changes in material conditions or properties that would affect the heat-transfer capability or structural performance of the package.

3.4.3 Maximum Normal Operating Pressure

Table 3.12 of the application presents the maximum pressures in the 30-gallon and 55-gallon drums under NCT. For the 30-gallon drum, the applicant states that contributions to pressure come from heat of decay from the contents and evaporation of moisture. There are no gases from radioactive decay or radiation induced decomposition of materials to affect the maximum normal operating pressure (MNOP). This BETAFOAM will generate small amounts of gases from thermal decomposition, during the HAC-fire event, which will be vented through the holes in the 55-gallon drum, but the BETAFOAM will not decompose during NCT and therefore will not affect the MNOP. The maximum calculated temperature of the package's contents, considering one year of NCT/solar conditions, is used.

The applicant states that the 55-gallon drum overpack is not specifically designed to retain pressure as a safety design pressure but, since it has a weather seal, pressure could develop. Contributions to pressure in the 55-gallon drum also come from the heat of decay from the contents and evaporation of moisture. There are no gases from radioactive decay or radiation induced decomposition of materials to affect pressure and the maximum calculated temperature of the 55-gallon drum, considering one year of NCT/solar conditions, is used.

The MNOP is below the containment design pressure, as reported in the application, and therefore is acceptable. The NRC staff reviewed selected calculations and results of the package for NCT conditions and found them acceptable.

3.5 Thermal Evaluation under HAC

The HAC thermal analyses address three sequential phases including the pre-fire, fire, and post-fire conditions.

3.5.1 Initial Conditions

Section 3.4.1 of the application describes the initial conditions for the HAC analysis. The HAC model geometry is the same as that used in the NCT analysis. The applicant references Chapter 2 of the application to describe the geometric changes and deformations of the drum exteriors after the NCT and HAC drop and crush impact tests. These deformations are minimal and the applicant does not include these deformations in the HAC thermal analysis model. The staff finds this acceptable because the BETAFOAM is a stiff material and does not suffer substantial volumetric reduction from these tests. Even if the surrounding sheet metal has deformed and there is local damage to the exterior of the 55-gallon drum, nearly all of the BETAFOAM thickness remains after impact. Thus, the local damage of the 55-gallon drum does not significantly affect the thermal results.

The pre-fire HAC model is identical to the NCT model including the ambient temperature and insolation heat flux, as described in Section 3.4.1 of the application. The 30-minute fire boundary conditions are 100°F with no solar flux. The contents are at a maximum decay heat of 0.001 watts decay power which is even greater than the 6.37 10^{-5} watts total decay heat of the package. Modified thermal properties for the package BETAFOAM insulation material are applied to the analysis. BETAFOAM insulation properties are replaced with the fire temperature air thermal conductivity, as well as the density and specific heat of air which are all conservative assumptions.

3.5.2 Fire Test Conditions

Section 3.4.2 of the application discusses the fire test conditions. Evaluation of the thermal performance is by analysis. For the HAC thermal analysis, a 1475°F air, with forced convection and a fire emissivity of 1.0, simulates the engulfing fire for a period of 30 minutes in compliance with the requirements in 10 CFR 71.73.

3.5.3 Maximum Temperatures and Pressure

Table 3.13 lists package component temperatures at the end of the 30-minute fire and Table 3.14 presents results from the post-fire cool-down analysis.

With the exception of the polyether polyurethane packing/dunnage material, all components remain below their maximum thermal design limits listed in Table 3.1 of the application. The polyether polyurethane packing/dunnage material reaches a maximum temperature of 363°F in the post-fire cool-down, while note h of Table 3.1 states that it is unaffected at 300°F for short term duration. Appendix 3.10 presents thermal testing of the packing/dunnage material which heated three samples of the polyether polyurethane foam to 300°F, 400°F and 554°F. At 400°F, there was no observable size change or loss of flexibility and negligible weight loss in the foam. The NRC staff finds the maximum HAC temperature of the packing/dunnage material to be acceptable.

The maximum internal pressures inside the 30-gallon drum during the HAC fire event are summarized in Table 3.15. The maximum internal pressure is 40.7 psig which is greater than the pressure rating for the drum of 22.5 psig. The NRC staff finds this to be acceptable because the 30-gallon drum lid incorporates a device that vents gases between 12-15 psig and reseals by 3 psig. Each individual pressure relieving plug is 100% inspected and verified to relieve pressure between 12-15 psig and reseal by 3 psig.

3.5.4 Maximum Thermal Stresses

Package contents are installed into the insert assembly with a clearance around them. Contents are free to move axially and radially, therefore significant thermal stresses cannot develop. Thermal stresses for the package are discussed in Chapter 2.7.4 of the application.

3.5.5 Accident Conditions for Fissile Material Packages for Air Transport

The application does not evaluate the package for air transport. Therefore, this section is not applicable.

The staff reviewed the applicant’s analysis of the package during HAC. Based on the information provided in the application regarding the HAC analysis, the NRC staff determined that the HAC analysis is acceptable.

3.6 Evaluation Findings

The NRC staff reviewed the package description and evaluation and found reasonable assurance that they satisfy the thermal requirements of 10 CFR Part 71. The NRC staff reviewed the material properties and component specifications used in the thermal evaluation and found reasonable assurance that they are sufficient to provide a basis for evaluation of the package against the thermal requirements of 10 CFR Part 71. The NRC staff reviewed the methods used in the thermal evaluation and found reasonable assurance that they are described in sufficient detail to permit an independent review, with confirmatory calculations, of the package thermal design.

4.0 CONTAINMENT EVALUATION

The NRC staff reviewed the application to verify that the package containment design has been described and evaluated under NCT and HAC, as required in 10 CFR Part 71.

The package is designed to ship items containing fissile uranium metals totaling less than one A_2, permitting transport in a Type A package. Since the content is Type A fissile material, the packaging is designed to meet the requirements of 10 CFR 71.55.

Because the contents are not to exceed one A_2 quantity, the regulatory requirements in 10 CFR 71.51 do not apply; the packaging design is not required to satisfy the activity release limits specified in 10 CFR 71.51, 10^{-6} A_2 per hour and A_2 per week and the associated performance leakage rate testing specified for Type B packages per ANSI N14.5.

4.1 Description of Containment Boundary

Containment is provided by the 30-gallon drum assembly, fabricated per 49 CFR 178.504 and qualified as a Department of Transportation (DOT) 7A Type A container.

The closure lid of the 30 gallon drum includes one ¾-inch and one 2-inch 'bung-hole' flanges. The ¾-inch flange is sealed with a non-venting plug. The 2-inch flange is closed with a pressure-relieving plug that limits the drum pressure between 12-15 psig and ensures that an over pressure condition does not occur during an HAC thermal event. This device does not permit continuous venting under NCT. The 30-gallon drum is rated for pressure retention of 22.5 psig. Both plugs include white ethylene propylene diene monomer (EPDM) gaskets to seal against the lid.

A reinforced split-ring closure provides secure closure for the drum with closure sealed by a high temperature silicon gasket. The split-ring closure device contains two 12-gauge rings each with a lug welded to each end to facilitate bolting and secures the closure lid to the drum via two 2 ½ inch long, 1/2-inch carbon steel socket head screws which are torqued to 40 ft-lb.

Based on the material to be transported in the package, Regulatory Guide 7.11 specifies the level of safety as 'Category III'. NUREG/CR 3854 specifies an acceptable fabrication criteria for transporting 'Category III' material as ASME B&PVC, Section VIII, Division 1 or ASME B&PVC Section III, Subsection NF and Department of Transportation (DOT) Specifications for drums used in the design. The drum and its closure lid are fabricated from 18 and 16-gauge carbon steel, respectively.

4.2 Containment under Normal Conditions of Transport

The applicant presented NCT structural and thermal evaluations in Sections 2.6 and 3.3, respectively, which demonstrate the containment boundary remains intact in all NCT scenarios and there will be no loss or dispersal of the solid radioactive material under NCT.

According to the applicant, the maximum pressure differential achieved under NCT is 16.5 psig, including MNOP and the effects of 10 CFR 71 reduced external pressure. This is less that the drum's pressure rating of 22.5 psig. Tables 3.1 and 3.2 show packaging thermal design limits and maximum temperatures, respectively. Based on a comparison of these tables and their analysis, the NRC staff concludes all components of the 30-gallon drum will remain below their thermal design limits during NCT.

Section 2.6 described NCT impact testing of a fully loaded package. This testing demonstrated no loss or dispersal of radioactive contents and the two bolts that secure the split-ring closure of each drum remained tight.

Impact testing led to a little more external impact damage than scuffed paint or a minor dent from penetration testing.

The applicant also stated that fully loaded packages subjected to the series of water spray, free drop and penetration impacts demonstrated no water entry and no degradation or loss of effectiveness of the 30-gallon drum.

Based on these analyses, the NRC staff concludes there will be no loss or dispersal of radioactive material under NCT and has reasonable assurance the package will contain the contents to ensure subcriticality under NCT.

4.3 Containment under Hypothetical Accident Conditions

10 CFR 71.51(a)(2) requires that there is no escape of radioactive materials during HAC from the packaging that would occur in excess of A_2 in one week or 10 A2 of Krypton in 1 week. This requirement is only applied for containment of Type B packages. The Model No. 9979 package is a Type AF package design and its contents do not exceed one A_2.

HAC impact testing, described in Section 2.7 of the application, produced minimal localized denting and deformation of the 9979 50-gallon drum overpack and its closure. The applicant states that, after destructive opening of the overpack, the 30-gallon drum had little damage and its closure remained tight.

Additionally, the criticality analysis in Section 6.6 assumed total loss of the overpack and showed that the 6X6X3 array of fully loaded 30-gallon drums would remain subcritical.

Section 3.4 of the application demonstrates the 30-gallon drum EPDM and silicon closure gasket maximum normal temperature limits will be exceeded in HAC. The gaskets reach a maximum post-temperature fire of 596°F which is above their normal temperature limits of 350°F and 500°F, respectively. However, reference 3-10 in the application documents short term thermal testing of the gasket materials above the HAC fire temperatures which demonstrates continued functionality of the materials at 600°F and 690°F, respectively.

Based on the comparison of maximum temperatures under HAC fire conditions to thermal design limits, the NRC staff agrees with the applicant that the 30-gallon split-ring bolted closure will be unaffected by the HAC temperatures and will remain tight thereby retaining the content within the 30-gallon drum.

The applicant states the packing materials of the 30-gallon drum and the contents are not significantly affected by the HAC fire as well. The polyurethane packing foam and ceramic packing materials reach a maximum post-fire temperature of 363°F. The ceramic packing/dunnage material has a thermal design limit of 2,300°F: thus, the NRC staff agrees it will not be affected by the HAC fire.

Reference 3-10 documents short term thermal testing of polyurethane foam packing/dunnage material which is tested to 300° and 400° with minimal change in size and weight. The staff finds this material will not be affected by the HAC fire. The 30-gallon drum contents reach a maximum post-fire temperature of 260°F but the AGN fuel content melting point is identified as 392°F.

Section 4.3 states that the heat from the HAC fire will consume the 55-gallon overpack’s foam insulation which turns to char at 640°F. The foam will continue to provide insulation and spacing control for the 30-gallon drum even with the thermal decomposition of the insulation.

The NRC staff concludes that the package will maintain containment and ensure subcriticality under HAC.

4.4 Leakage Rate Tests

The radioactive contents of the package do not to exceed one A2 quantity; therefore, the regulatory requirements in 10 CFR 71.51, additional requirements for Type B packages, and the associated performance leakage rate testing specified for Type B packages per ANSI N14.5 does not apply to the package.

4.5 Evaluation Findings

Based on review of the statements and representations in the application, the NRC staff concludes that the containment design has been adequately described and evaluated and that the package design meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The applicant performed depletion calculations, determined the isotopic inventory of the fuel, and calculated the A_2 mixture using the calculated isotopic inventory and the associated A_2 values in Table A-1 of 10 CFR Part 71 to justify the qualification of the package as a Type AF package.

Contents are limited to one A_2. Thus, the package, designed for transport of Type A quantities of fissile material, does not require a shielding evaluation.

6.0 CRITICALITY EVALUATION

The objective of this review is to verify that the transport of AGN-201M fuel and corresponding components meets the criticality safety requirements of 10 CFR Part 71 under both NCT and HAC.

6.1 Criticality Evaluation

The package is a drum package consisting of a 30 gallon containment drum in a 55 gallon drum overpack as defined by drawing R-R1-G-00030. The package is limited to a maximum radioactive payload of 200 lbs. The fissile contents are defined in Table 1.1 of the application for the limited materials that will be transported, and have a maximum u^{235} content of 300 grams per package.

Based on the fissile material type, the fuel is placed into the containment drum utilizing polyurethane foam as a spacer between the various fuel disks, rods, and fuse: however, the applicant conservatively assumes that all materials are consolidated into a single sphere of U^{235} and water at the optimal H/X ratio, with no spacing credited in the evaluation. There is no limitation on the amount of polyethylene allowed in a package. Based on the array sizes for NCT and HAC, the calculated CSI is 1.0.

The applicant's NCT model assumed an 8x8x8 rectangular array with thick water reflection on all sides and reduced the radii of the drums by 7% to simulate a triangular-pitch array, which is then demonstrated to be equivalent with respect to k_{eff} values using the guidance of NUREG/CR-5661. This reduction reduced the effective mass of the carbon steel in the package, which is a conservative assumption.

The spheres were arranged internally in each drum, assuming no restriction of movement, and were either shifted to the left or right of the package to place the most fissile material in a position of maximum interaction with the adjacent packages. The maximum $k_{eff} + 2\sigma$ was found to be 0.9166 with a payload of 300 grams u^{235} per package, at an H/X ratio of 700 for packages in the NCT array.

For the HAC model, the applicant again assumed a 7% reduction in drum radii to simulate a close packed triangular pitch array of 6x6x3 packages, which assumes complete radial crushing of the overpack during accident conditions. This array was modeled with 60cm of water on all sides, and utilized the same optimally moderated spherical model used in the NCT analysis with the same shifting of spheres to cause maximum neutronic communication between adjacent packages. The maximum $k_{eff} + 2\sigma$ was found to be 0.9253 with a payload of 300 grams u^{235} per package at an H/X ratio of 700 for packages in the HAC array.

For all computer modeling, the applicant used the SCALE 5 / KENO-V.a code system with the 238-group ENDF/B-VII cross section set to calculate k_{eff} values for their evaluation. The applicant bounded the single Model No. 9979 package evaluation with the NCT and HAC evaluations.

Staff evaluated the representative inputs provided by the applicant and constructed an independent model of the Model No. 9799 package, for NCT and HAC package arrays using the SCALE 6.2 code package with continuous energy cross section. The resulting calculated k_{eff} values agreed closely with those of the applicant in all cases.

6.2 Conclusions

Based on the staff review of the proposed use of the Model 9979 package to ship AGN-201M fuel and components, the applicant's conservative evaluation, and staff confirmatory calculations, staff agrees that this use of the Model No. 9979 package meets the requirements of 10 CFR Part 71.

7.0 PACKAGE OPERATIONS

Users shall prepare written operating procedures to reflect site-specific needs and comply with their facility's operational requirements.

Such operating procedures ensure that (i) the condition of the packaging is unimpaired prior to loading, (ii) contents are authorized for shipment, and (iii) the package is properly loaded and prepared for transport.

7.1 Package Loading

A number of steps have to be implemented to prepare the package for loading, including the verification that:

- (i) the package identification plate is attached and legible,
- (ii) the exterior surfaces of the 55-gallon overpack and the accessible internal components, e.g., accessible surfaces of the overpack body, closure lid, and the accessible surfaces of the 30-gallon drum, do not exceed the applicable radioactive contamination limits,
- (iii) the ¾-inch plug is undamaged and threaded into the 30-gallon drum bung hole with its supplied white EPDM gasket to 15 ft-lbs ±10%, while the 2-inch pressure relieving plug is undamaged and threaded into the 30-gallon drum 2-inch 'bung-hole' flange with its supplied white EPDM gasket to 30 ft-lbs ±10%,
- (iv) the 30- and 55-gallon split-ring closure devices are undamaged,
- (v) the overpack drum and 30-gallon drum are not damaged (top, bottom, and side) in any way that would affect packaging or transportation operations, and
- (vi) the gaskets are securely fixed to their respective closure lids.

The user shall verify that the weight of the payload does not exceed 200 lbs and that the gross weight of the package does not exceed 415 lbs. The contents and the foam spacers are placed within the insulation bag. Acceptable payload configurations are described in Section 1.2.2 of the application.

In preparation for transport, the outer surfaces of the loaded 30-gallon drum is surveyed for compliance with contamination limits, the insulation cover is placed over the 30-gallon drum closure, the 55-gallon closure lid is installed, and the split-ring closure bolts are torqued to 40 ±5 ft-lbs.

7.2 Package unloading

The conveyance surfaces and package exterior surfaces shall be surveyed for radiation levels in accordance with 10 CFR 71.47 and for surface contamination in accordance with 49 CFR 173.443.

Site-specific unloading procedures shall include the following elements:

- (i) document the removal of the TID per the receiving site procedures,
- (ii) survey the bottom surface of the overpack closure lid, the insulation cover, and the top surface of the 30-gallon drum closure lid for contamination,
- (iii) remove the 30-gallon drum using a drum lifting device and any packing/dunnage and contents from the 30-gallon drum,
- (iv) compare the package contents and configuration with the shipping papers and the Certificate of Compliance and note any discrepancies, and
- (v) survey the insulation bag and the interior surface of the 30-gallon drum for contamination to verify that it does not exceed radioactive contamination limits.

7.3 Preparation of empty package for transport

The packaging shall be prepared for transport per written procedures that include the following verifications: (i) the package is undamaged and the internal contamination does not exceed regulatory limits, and (ii) radiation levels and non-fixed contamination do not exceed regulatory limits.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

Throughout the fabrication process, visual inspections, dimensional measurements and tests are performed to assess and verify compliance with all requirements (e.g., component materials and component dimensions) given in the licensing drawings. Fabrication and QA records shall be complete and traceable. Inspection methods, inspection criteria, weld procedures, personnel qualifications, and weld reports shall meet the American Welding Society (AWS) D1.3.

The 30-gallon drum requires a hydrostatic pressure test and the 30-gallon drum pressure relieving plug shall be 100% inspected and verified to relieve pressure between 12-15 psig and reseal by 3 psig. The 30-gallon drum also requires structural batch lot testing and a leak-tightness test with a 100% inspection of the longitudinal drum seam and bottom chime.

The packaging design does not require annual maintenance, i.e., periodic structural or pressure tests, annual thermal performance testing, periodic or pre-shipment leak tests, routine maintenance of materials or components.

The inspections required for normal use are sufficient to ensure that the performance of the packaging has not been degraded. Prior to shipment, pre-loading inspection requirements, described in Section 7.1.1 of the application, will segregate out units that need repair. Gasket materials that are found to be faulty during routine visual inspections, e.g., by being are cut, gouged, cracked, etc., shall be replaced.

CONDITIONS

The following conditions were included in the Certificate of Compliance No. 9979:

Condition No. 10: Package may be shipped as non-exclusive use conveyance. For shipments under this certificate, the package identification number on the nameplate of existing packages shall have the “DOE” marking covered. This condition was included for compliance with 10 CFR 71.85(c).

Condition No.11: Transport of fissile material by air is not authorized. The applicant has not demonstrated that requirements for transport of fissile material by air are met, as stipulated in 10 CFR 71.55(f).

CONCLUSION

Based on the statements and representations contained in the application, and the conditions listed above, the staff concludes that the Model No. 9979 package has been adequately described and evaluated and that the package meets the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9979, Revision No. 0,
on August 17, 2016