## CONTENTS



## TABLES



## FIGURES

# 1. GENERAL INFORMATION

## *1.1 Introduction*

The Versa-Pac is a drum type package that features a patented [1] design concept in combination with the familiar drum exterior packaging to provide enhanced structural protection to payloads during the Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC) [2]. Principal design of the Versa-Pac packaging maintains the use of an inner container positioned inside a 55-gallon (VP-55) or 110-gallon drum (VP-110). The Versa-Pac is used directly or in conjunction with pails, pipe containers, poly bottles, and a variety of smaller containers, inserts and vessels. The Versa-Pac standard configuration shipping packages, model numbers VP-55 and VP-110, have been designed to transport Type A fissile materials limited to U-235 masses based on the loading limits in Table 1-1.

**Table 1-1: U-235 Loading Table for VP-55 and VP-110 Standard Configuration**

| Enrichment U-235 (wt.%) | U-235 Mass Limit (g) | |
|---|---|---|
| | Ground/Vessel | Air |
| ≤ 100 | 350 | 350 |
| ≤ 20 | 410 | 410 |
| ≤ 10 | 470 | 470 |
| ≤ 5 | 580 | 580 |
| ≤ 1.25 | 2000 | -- |

The payload containment area of the 55-gallon version (VP-55) has an inside diameter of 15 inches and is 25-7/8 inches in length. The 110-gallon version (VP-110) has an inside diameter of 21 inches and is 29-3/4 inches in length. The package has two distinct areas of insulation for thermal and impact protection.

An additional Versa-Pac packaging configuration features a 5-inch steel inner container to facilitate transport of greater quantities of U-235, and is fully described in Appendix 1.4.6. The VP-55 with 5-inch pipe configuration is designed to transport Type A fissile materials limited to U-235 masses based on the loading limits in Table 1-1A.

**Table 1-1A: U-235 Loading Table for the VP-55 with 5-inch Pipe**

| Enrichment U-235 (wt.%) | U-235 Mass Limit (g) | |
|---|---|---|
| | Ground/Vessel | Air |
| ≤ 100 | 695 | 395 |
| ≤ 20 | 1215 | 495 |
| ≤ 10 | 1605 | 590 |
| ≤ 5 | 1065 | 790 |

The Criticality Safety Index (CSI) for the VP-55 and VP-110 standard configuration is 1.0. The CSI for the VP-55 with 5-inch pipe configuration is 0.7 for material up to 10wt.%, and 1.0 for material greater than 10wt.% up to 100wt.%.

An added content for the VP-55 is ANSI N14.1 [2] compliant 1S and 2S cylinders filled with uranium hexafluoride ($UF_6$). The VP-55 can ship 1S or 2S $UF_6$ cylinders based on the 20wt.% U-235 limits provided in Table 1-1B. Each shipment of this content type may only contain either 1S cylinders or 2S cylinders. Quantities of cylinders greater than the limits stated in Table 1-1B, or combinations of 1S and 2S cylinders in a single package (e.g. one 1S cylinders and two 2S cylinders) are permissible if the total U-235 quantity meets the fissile limit, for the maximum enrichment, established in Table 1-1. The air transport U-235 mass limits in Table 1-1B are the lesser of the 1S/2S cylinder limits and the air transport limits determined in Section 6.7.

**Table 1-1B: 1S/2S Cylinder Limits for the VP-55 (up to 20wt.% U-235)**

| Content | Maximum Cylinders per VP-55 | Mass $UF_6$ per VP-55 (lb/g) | Enrichment U-235 (wt.%) | U-235 Mass Limit per VP-55 (g) | Air U-235 Mass Limit (g) |
|---|---|---|---|---|---|
| 1S Cylinder | 7 | 7.0 / 3,175 | ≤ 20 | 429.8 | 429.8 |
| 2S Cylinder | 2 | 9.8 / 4,445 | ≤ 20 | 600.8 | 495 |

Also, ANSI N14.1 compliant 1S and 2S cylinders filled with uranium hexafluoride ($UF_6$) with U-235 enrichments up to 100% can be shipped in the VP-55 with 5-inch pipe configuration based on the limits provided in Table 1-1C. For this configuration, each 1S or 2S cylinder is loaded into a 5-inch pipe and the 5-inch pipes are loaded into the VP-55 prior to shipment. Each shipment of this content type may only contain either 1S cylinders or 2S cylinders. Quantities of cylinders greater than the limits stated in Table 1-1C, or combinations of 1S and 2S cylinders in a single package (e.g. one 1S cylinders and two 2S cylinders) are permissible if the total U-235 quantity meets the fissile limit, for the maximum enrichment, established in Table 1-1. The air transport U-235 mass limits in Table 1-1C are the lesser of the 1S/2S cylinder limits and the air transport limits determined in Section 6.7.

**Table 1-1C: 1S/2S Cylinder Limits for the VP-55 with 5-inch Pipe (up to 100wt.% U-235)**

| Content | Maximum Cylinders per VP-55 (in 5-inch Pipe(s)) | Mass $UF_6$ per VP-55 (lb/g) | Enrichment U-235 (wt.%) | U-235 Mass Limit per VP-55 (g) | Air U-235 Mass Limit (g) |
|---|---|---|---|---|---|
| 1S Cylinder | 1 [a] | 1.0 / 454 | ≤ 100 | 306 | 306 |
| 2S Cylinder | 1 | 4.9 / 2,223 | ≤ 100 | 1497 | 395 |

Notes: [a] Limited to one cylinder based on fit inside of the VP-55 cavity with the required 2-inch thick foam liner.

## *1.2 Package Description*

### 1.2.1 Packaging

Engineering Drawings are provided in Appendix 1.4.1. General notes pertaining to fabrication are provided in Appendix 1.4.2. An illustration of the packaging configuration is provided in Figure 1-1. Packaging markings are shown on the drawings in Appendix 1.4.1.

The exterior skin of the Versa-Pac consists of at a minimum, a UN1A2/Y425/S for the VP-55. The drums use a bolted closure ring, standard carbon steel lugs, 5/8" diameter, ASTM (American Society for Testing Materials) A429 bolts and nuts, and a closed-cell rubber lid gasket. The overall outer dimensions of the 55-gallon drum are 23-3/16" OD x 34-3/4" in height to the top of the outer drum bolt ring. The drum cover is reinforced by a 10-gauge thick 22-3/8" OD x 18-3/8" ID plate, and four ½" bolts are provided to lend additional strength to the drum closure ring.

The VP-110 utilizes at a minimum a UN/1A2/Y409/S. The drums use a bolted closure ring, standard carbon steel lugs, 5/8" diameter ASTM A429 bolts and nuts, and a closed-cell lid rubber gasket. The overall outer dimensions for the 110-gallon drum are 30-7/16" OD x 42-3/4" in height to the top of the outer drum bolt ring. The drum cover is reinforced by a 10-gauge thick 29-3/4" OD x 27-1/4" ID plate and eight ½" bolts are provided to lend additional strength to the drum closure ring.

Both drums are further strengthened with vertical stiffeners fabricated from 1-1/4" carbon steel square tubing, two inner liners of rolled 16-gauge carbon steel insulated by ceramic fiber blanket encase the vertical tubing, and a ¼" carbon steel reinforcing plate on the bottom.

The package's inner container is completely insulated with the appropriate layers of ceramic fiber blanket around the containment area with rigid polyurethane foam disk on the top and on the bottom to complete the insulation of the package. Specifications for the insulation are provided in Appendices 1.4.3 for the polyurethane foam and 1.4.4 for the ceramic fiber blanket. The primary function of both insulations is to provide thermal protection. Although the rigid polyurethane provides some impact protection, the frame of the packaging performs the majority of the required impact protection.

A ½" thick fiberglass ring is used as a thermal break at the payload cavity flange. The thermal break is sandwiched between the steel components, with twelve ½-inch bolts providing the connection between the structural members through the fiberglass and effectively limits the flow of heat to the payload cavity through the steel flange components. There are no moving parts to the thermal break, and its functionality is maintained as long as it separates the steel components FB, top stiffening ring, from FK, connection ring, (See Drawings in Appendix 1.4.1). A specification for the fiberglass material is provided in Appendix 1.4.5.

The containment boundary of the package is defined as the payload vessel with its associated welds, payload vessel high temperature heat resistant silicone coated fiberglass gasket, payload vessel blind flanges, and reinforcing ring.

The payload vessel is comprised of a 10-gauge carbon steel sheet for the body and bottom. The upper end of the vessel is fitted with a ¼" inner carbon steel flange ring with a ½"-thick carbon steel blind flange. The vessel has three circumferential welds (two at the flange, one at the base) and one longitudinal weld. A 1/8" high temperature heat resistant silicone coated fiberglass gasket is used between the steel flange ring and blind flange. The payload vessel blind flange is secured

with twelve ½" bolts. There are no penetrations, valves or venting devices used within the containment boundary.

The Versa-Pac meets the General Requirements for all packages as specified in 10CFR71.43 [3].

#### 1.2.1.1 Gross Weights

The gross weights of the two Versa-Pac models are 750 pounds for the VP-55 and 965 pounds for the VP-110, see Section 2.1.3.

#### 1.2.1.2 Materials of Construction

The materials of construction of the Versa-Pac are provided in the Licensing Drawings parts list presented in Appendix 1.4.1.

#### 1.2.1.3 Outer and Inner Protrusions

There is one outer protrusion on the Versa-Pac consisting of carbon steel fitting which contains a 1" plastic plug on the side of the package. The plug is designed to melt and allow venting of any gases that might develop in the event of a fire. The protrusion extends less than ½" from the sidewall of the outer drum and does not impede the stacking or handling of the shipping package. There are no inner protrusions on the Versa-Pac.

#### 1.2.1.4 Lifting and Tie-Down Devices

The Versa-Pac may be handled by normal industry standards for the safe movement of drums; such equipment might include specifically designed devices, forklifts, pallet jacks or other methods as determined by the User. However, the Versa-Pac does not utilize any specific device or attachment for lifting. Additionally, there are no specific provisions for tie down of the package.

#### 1.2.1.5 Shielding

Neutron and gamma shields are not required for the Versa-Pac payloads.

#### 1.2.1.6 Pressure Relief Systems

There are no pressure relief systems other than the four ¼" holes, closed with vinyl push plugs on the inner liner between the insulation and containment and one in the top cavity area used to vent gases that might be produced in the event of a fire. No special heat transfer mechanisms are provided or required.

#### 1.2.1.7 Containment Features

There are three individual points of closure employed by the Versa-Pac. The payload ½-inch-thick closure plate provides a fastening and seal using twelve ½" bolts and a 1/8"-thick silicone coated fiberglass gasket. A second closure is provided at the outer drum lid. The drum lid is secured using ½" bolts and is sealed with a 3/8"-thick silicone rubber flat gasket. A standard drum ring, its rubber gasket, and a 5/8" tensioning bolt provide the final closure. A 1/8" hole is drilled in the end of the tensioning bolt for use with a security seal.

The primary containment boundary of the Versa-Pac is defined as the inner containment body, containment end plate, inner flange ring, silicone coated fiberglass gasket, ½" blind flange, ½"

bolts, washers and insert holders. Figure 1-1 further illustrates these components by text description enclosed within a text box.

#### 1.2.1.8 Package Markings

Package marking are shown in Appendix 1.4.1 and 1.4.2.

### 1.2.2 Contents

All materials must be in solid form with no freestanding liquids; density is not limited. These material quantities may not exceed the U-235 limits established in Table 1-1 in any non-pyrophoric form. Materials that may be shipped in the Versa-Pac include uranium oxides ($U_yO_x$), uranium metal (U-metal), uranyl nitrate crystals (UNX), and other uranium compounds (e.g., Uranyl Fluorides and Uranyl Carbonates). The uranium compounds may also contain carbon or graphite (e.g., UC, $U_2C_3$ and $UC_2$). UNX may be in the form of uranyl nitrate hexahydrate, trihydrate or dihydrate, and must be in solid form. The payload may be in homogeneous (powder or crystalline) or non-homogeneous form. The contents are limited to Type A, normal form material per 10CFR71 [3].

The Versa-Pac is evaluated assuming optimum moderation using a bounding high-density polyethylene plastic (Density = 0.98 g/cc) and supports packaging applications containing both carbon (e.g., graphite, paraffin, and polyethylene) and hydrogen based materials (e.g., water paraffin, and polyethylene). Non-fissile chemical impurities do not increase the reactivity of the system; therefore, they may be present in any quantity. The payload may be enriched in U-235 to 100 wt.% while maintaining the limits in Table 1-1. Because the payload decay is essentially zero (approximately 11.4 W, *Section 3.4.2*), there are no radiolytic decay products.

When using the 5-inch pipe configuration, all fissile contents must be loaded into a single 5-inch pipe and sealed per the instructions in Section 7. The fissile quantity for this configuration shall meet the limits in Table 1-1A.

Additional contents include uranium hexafluoride ($UF_6$) in ANSI N14.1 compliant 1s and 2s cylinders. For any shipments of 1S and 2S cylinders, a foam insert (9 PCF polyethylene) shall be used to provide thermal protection for the cylinder. The minimum foam insert thickness shall be 2 inches, circumferentially between the 1S/2S cylinders and the cavity wall of the Versa-Pac. Cribbing or dunnage may be used inside the foam insert to restrict movement of the contents during transport, providing a snug fit for the 1S/2S cylinders or multiple 5-inch pipes. The fissile quantity of material in any shipment of 1S/2S cylinders must meet one of the following requirements:

1. The number of cylinders in a single package shall meet the limitations in Table 1-1B, or Table 1-1C when each cylinder is packaged into a separate 5-inch pipe. For this case, either 1S or 2S cylinders may be loaded into a single package (i.e., no mixing of cylinder types).
2. The total fissile mass (in grams of U-235) from all cylinders shall meet the limits set in Table 1-1. For this case, any number or combination of 1S and 2S cylinders is acceptable, so long as the U-235 mass limit is not exceeded. The U-235 mass limit for this case is established based on the cylinder with the highest enrichment (e.g. for two cylinders with enrichments of 5 wt.% and 15 wt.%, respectively, the U-235 mass limit is based on the 20 wt.% limit).

The payload material may be pre-packaged in hydrogenous or non-hydrogenous containers within the payload vessel. Hydrogenous pre-packaging materials may include polyethylene, polypropylene, and PVC (polyvinyl chloride). PTFE (Polytetrafluoroethylene) or Teflon® pre-packaging material is also allowed. Metallic pre-packaging materials such as aluminum, stainless and carbon steel are allowed. Table 1-5 provides a listing of typical packaging materials used to pack the Versa-Pac.

Package contents are typically shipped in an axial array to fill the payload cavity. A fireproof perlite like packing material is often used as dunnage to fill the voids between the cans and inner vessel wall. The Versa-Pac design allows for the use of two neoprene pads, a 1/8-inch bottom pad, and a 3/8-inch top pad. The pads serve the purpose of protecting the inner containment shell during repeated use. The use of these pads is optional for packages not intended for reuse.

No materials, excluding the minimum steel wall thickness of the package, are used as neutron absorbers or moderators.

The maximum payload capacity for the VP-55 is 350 pounds. The maximum payload capacity for the VP-110 is 260 pounds.

### 1.2.3 Special Requirements for Plutonium

The Versa-Pac is not approved for the transport of Plutonium above minimum detectable quantities.

### 1.2.4 Operational Features

The Versa-Pac provides for two individual closures and seals to secure the payload within the inner containment area. Connections and closures are accomplished using bolt and gasket seals.

There are no operationally complex features of the Versa-Pac. All operational features are readily apparent from an inspection of the drawings provided in Appendix 1.4.1, *Packaging General Arrangement Drawings*. Operation procedures and instructions for loading, unloading, and preparing an empty Versa-Pac for transport are provided in Chapter 7.0, *Operating Procedures*.

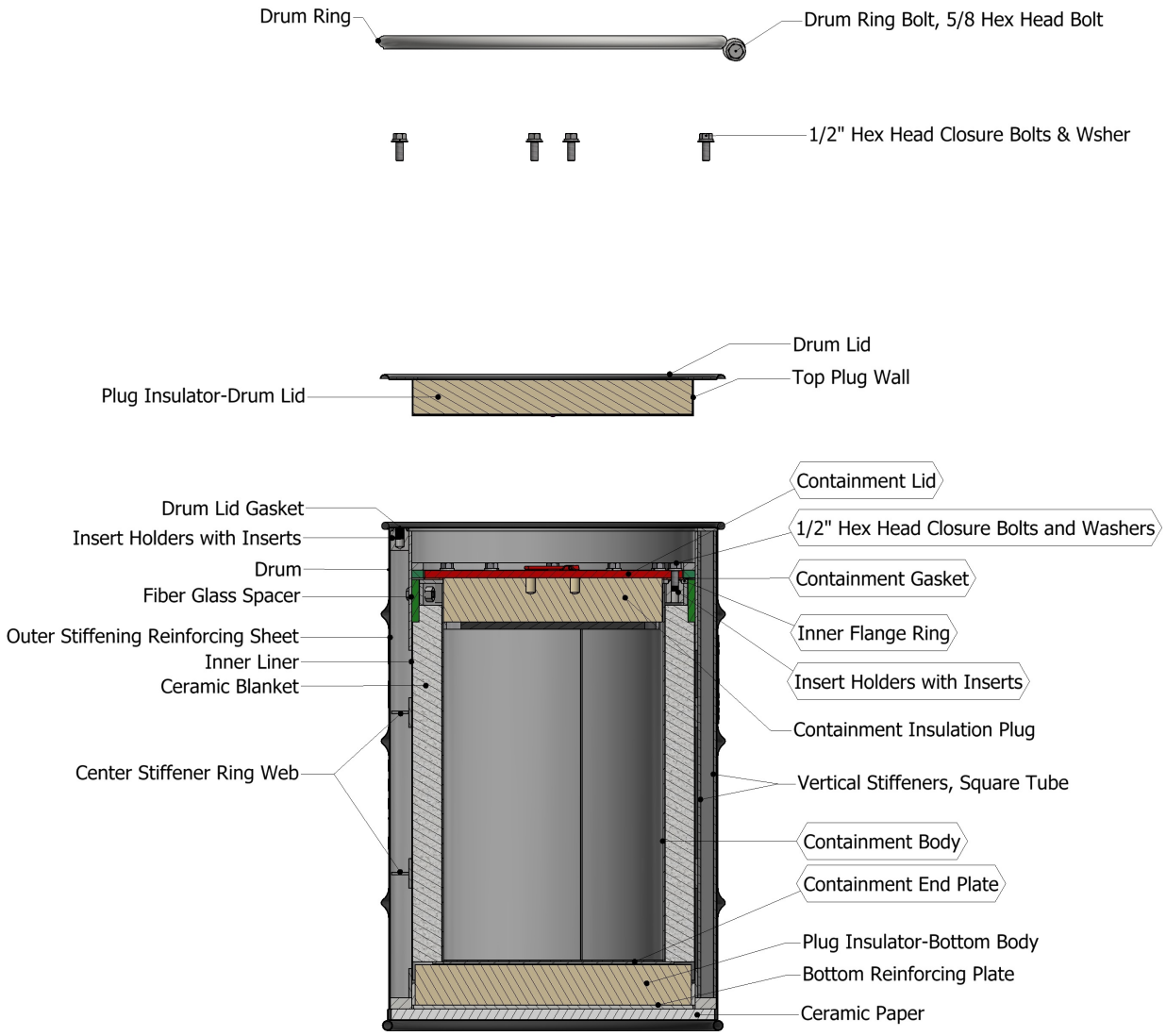


**Figure 1-1: Versa-Pac Component Illustration**

(Containment boundary components, as indicated in Section 1.2.1.7, are described in text boxes)

[Table 1-2 deleted, see Chapter 2.0, Section 2.1.3 for weight table]

[Table 1-3 deleted, see Licensing Drawing VP-55-LD in Appendix 1.4.1]

[Table 1-4 deleted, see Licensing Drawing VP-110-LD in Appendix 1.4.1]

[Table 1-5 deleted, see Chapter 3.0, Section 3.2.2 for material limits]

[Table 1-6 deleted, contents defined in Section 1.2.2]

## 1.3 References

IAEA package design regulations, SSR-6, 2012 Ed. [4], has been incorporated by reference into 49 CFR 171.7 [5]. The design requirements for Type A packages are typically the same between the IAEA and NRC 10 CFR 71 [3] regulations, therefore, the package design maintains compliance to both regulatory references. Note the in-text references are specific to NRC regulations.

[1] U.S. Patent and Trademark Office (USPTO), "Patent No. 7,628,287 B1, Reusable Container Having Spaced Protective Housings," 2009.

[2] Nuclear Regulatory Commission (NRC), *Title 10, Part 71-Packaging and Transportation of Radioactive Material.*

[3] American National Standards Institute, "Uranium Hexafluoride – Packagings for Transport," ANSI N14.1-2012, 2012.

[4] International Atomic Energy Agency (IAEA), *Regulations for the Safe Transport of Radioactive Material, SSR-6, 2012 Edition.*

[5] United States Department of Transportation (USDOT), *Title 49, Code of Federal Regulations Part 173, Subpart I - Class 7 (Radioactive) Materials.*

[6] The American Society for Nondestructive Testing, Inc., "Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing," 2006.

[7] The Engineering Tool Box, "Fuels and Chemicals - Auto Ignition Temperatures," [Online]. Available: http://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html.

## *1.4 Appendices*

1.4.1 Versa-Pac Shipping Package Drawings
Drawing No. VP-55-LD Rev. 0, VP-110-LD Rev. 0

1.4.2 General Notes

1.4.3 UF-1 Polyurethane Closed Cell Foam Specification

1.4.4 CFI-1 Ceramic Fiber Insulation Specification

1.4.5 Structural Fiberglass Component Specification

1.4.6 VP-55 5-inch Pipe Description

1.4.7 VP-55 5-inch Pipe Licensing Drawing

### 1.4.1 Versa-Pac Shipping Package Licensing Drawings

(4 Sheets)

a,c

8 7 6 5 4 3 2 1

D C B A

a,c

8 7 6 5 4 3 2 1

D C B A

a,c

8 7 6 5 4 3 2 1

D C B A

a,c

8 7 6 5 4 3 2 1

D C B A

### 1.4.2 General Notes

1. Paint all carbon steel surfaces with (2 mils.) of industrial primer. The drum exterior surface is to be painted with (2 mils.) of enamel top coat, touchup with spray enamel.
2. Placard as required.
3. Welding procedures and personnel shall be qualified in accordance with AWS D1.1, Structural Welding Code – Steel, and AWS D1.3, Structural Welding Code – Sheet Steel, as applicable.
4. NDT Personnel shall be qualified in accordance with SNT-TC-1A [6]. Visual personnel may be certified in addition or in lieu of SNT-TC-1A as an AWS (American Welding Society) CWI (Certified Welding Inspector) or CAWI (Certified Associate Welding Inspector).
5. Nameplates shall be attached after painting by spot welding and paint retouched.
6. General shop tolerances of ±1/4" apply unless noted. Material tolerances are as required under the appropriate specification.
7. Equivalent components must be approved by engineering and submitted to the NRC for approval.
8. This package shall be manufactured under a Quality Assurance Program that meets the program requirements as outlined in 10CFR71 [3]. Quality Assurance shall perform visual inspections on all final welds and magnetic particle (MT) or liquid penetrant (PT) inspections on all final welds indicated as such in the VP-55 and VP-110 Licensing Drawings, per the requirements of AWS D1.1. Although the Licensing Drawings only specify MT, either MT or PT inspections are acceptable for all relevant welds.
9. The nameplate shall be a minimum of 6" x 6" x 22 gauge stainless steel, ASTM 300 Series. The letters shall be at least ½" high as follows and include at a minimum the following information:

| | |
|---|---|
| Mfg. by: | |
| S/N: | |
| Versa-Pac VP-55 or VP-110 | |
| Type AF-96 | |
| Tare Wt: | _____ LB |
| | _____ KG |
| Max. Gross Wt: | _____ LB |
| | _____ KG |

10. Gaskets and Plugs shall be installed using the appropriate material as described on the licensing drawing parts list.

11. Ceramic fiber paper/blanket/boards and polyurethane foam products shall be in accordance with the specifications listed in Appendices 1.4.3 through 1.4.5.
12. Certifications, test reports and QA records shall be stored and maintained as required by the DAHER-TLI Quality Assurance Program.
13. Stenciling shall be in contrasting color and be a minimum of 1" in height unless noted and shall include at a minimum the following information:

| | |
|---|---|
| Design ID Number: | USA/9342/AF-96 Type A (2" Letters) |
| Model Number: | Versa-Pac VP-(55 or 110) |
| Owners Name: | ---------- |
| Owners Address: | City, State, and/or Country |
| | RQ, Radioactive Material, Type A |
| | Package, Fissile Non-Special Form |

14. For the minimum UN specification in Part DA, equivalency between X and Y packing groups is based off of the drop heights required for testing in 49CFR178.603(e). Packing group I (X) requires a test drop height of 1.8 meters and packing group II (Y) requires a test drop height of 1.2 meters. Based on the potential energy, the equivalent mass for the higher drop (X) is equal to (1.2/1.8)*425 = 283.3 kg for the VP-55 and (1.2/1.8)*409 = 272.7 kg for the VP-110. The minimum 'X' specification for both of these is rounded up to 350 kg.

(Additional stenciling of the package is at the discretion of the customer. RQ may not be required since it is dependent on the payload contents.)

### 1.4.3 UF-1 Polyurethane Closed Cell Foam Specification

This appendix provides the specification for all polyurethane closed cell foam products used in the Versa-Pac packaging. The basic physical property requirements for the polyurethane closed cell foam components of the Versa-Pac are listed in Table 1-7. The urethane foam resins, urethane foam components, and other raw processing materials should be stored at room temperature. The foam is a two-component rigid polyurethane system. The foam may be generated in place or with molds, however the process used shall incorporate proper controls to ensure that there are no abnormalities or voids in the foam blocks. All polyurethane foam components used in the Versa-Pac must have a hydrogen density less than that of water.

**Table 1-7: Polyurethane Closed Cell Foam Component Requirements**

| Parameter | Requirement |
|---|---|
| Density[1] | 5 to 11 PCF (Test – ASTM D-1622) |
| Compressive Strength | 80 to 300 PSI (Test – ASTM D-1621 or ASTM D-695) |
| Maximum Thermal Conductivity | 0.274 BTU-in/hr-ft$^2$-°F (Test – ASTM C-518) |
| Flame Retardancy | Meet the minimum requirements of ASTM E84 |
| Chloride Content | Leachable chloride < 200 ppm[a] |

Notes: [a] This value shall be determined through independent laboratory testing.

### 1.4.4 Ceramic Fiber Insulation Specification

This appendix provides the specification for all ceramic fiber insulation products used in the Versa-Pac packaging. The ceramic fiber insulation components of the Versa-Pac shall be Morgan Thermal Ceramics Kaowool 500, or equivalent for paper products (12 to 14 PCF), and Morgan Thermal Ceramics Cerablanket (6 or 8 PCF), or equivalent for blanket products. Because the ceramic fiber paper and blanket products in the Versa-Pac are only necessary for thermal protection, equivalency is based on the composition, density, and thermal conductivity of the products.

Material –
For a paper or blanket product to be considered equivalent to the specified products, it must be composed of alumina and silica oxides.

Density –

Papers: 12 - 14 PCF

Blankets: 6 - 8 PCF

Thermal Conductivity –

**Table 1-8: Ceramic Fiber Insulation Requirements**

| Temperature (°F) | Thermal Conductivity (BTU-in/hr-ft$^2$-°F) |
|---|---|
| 500 | ≤ 0.47 |
| 1000 | ≤ 1.06 |
| 1500 | ≤ 1.90 |

## 1.4.5 Structural Fiberglass Component Specification

This appendix provides the specification for all structural fiberglass insulation products used in the Versa-Pac packaging. The Structural Fiberglass components of the Versa-Pac shall be Strongwell Series 500/525 structural fiberglass, or equivalent. Because the structural fiberglass products in the Versa-Pac are only necessary for thermal protection, equivalency is based on the composition, density, and thermal conductivity of the products.

Material –
For a structural fiberglass product to be considered equivalent to the product specified, the material shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix with glass reinforcements.

Density –
The density of any structural fiberglass component to be considered equivalent shall be in the following range: 0.062 – 0.070 $lb/in^3$.

Thermal Conductivity –
The thermal conductivity of any structural fiberglass component to be considered equivalent shall be ≤ 4.0 BTU-in/hr-$ft^2$-°F.

## 1.4.6 Versa Pac VP-55 5-inch Pipe

### 1.4.6.1 VP-55 with 5-inch Pipe Packaging Description

The 5-inch pipe container fits inside the VP-55 payload vessel. The payload vessel is described in Section 1.2.1. Licensing Drawings are provided in Section 1.4.1.

The 5-inch pipe container is fabricated from Schedule-40 carbon steel. There is a carbon steel plate welded to the bottom. The top is closed with a 5-inch threaded cap made from malleable iron. The pipe container is held in place during routine transport by a “birdcage” device that provides no structural support. It is considered dunnage. No credit is taken for the pipe maintaining a specific position within the payload cavity under non-routine conditions.

Handling instructions for the VP-55 5-inch Pipe are provided in Section 7.1.1. When utilized in the VP-55, the 5-inch pipe is simply used for geometric confinement of the fissile material in the contents. Although all radioactive material is confined inside the pipe during all transport conditions, the containment boundary of the package is always the inner vessel of the Versa-Pac package. The 5-inch pipe, contents, and any additional dunnage/cribbing are accounted for as the total content weight in the determination of the maximum payload weight for the VP-55 package (see Section 2.1.3).

### 1.4.6.2 VP-55 with 5-inch Pipe Contents

The 5-inch pipe container and any additional dunnage/cribbing are considered contents of the VP-55 package in this configuration. All radioactive contents are loaded directly into the 5-inch pipe when shipping in this configuration. The material requirements for the 5-inch pipe configuration are identical to the standard VP-55 requirements. The fissile material limits for the VP-55 with 5-inch pipe configuration are provided in Table 1-1A and Table 1-1C.

a,c