CONTENTS

TABLES

FIGURES

1. GENERAL INFORMATION

1.1 Introduction

The Versa-Pac Shipping Package features a patented [1] design concept in combination with the familiar drum exterior packaging to provide enhanced structural protection to payloads under Hypothetical Accident Conditions (HAC). 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

Weight Percent U-235	U-235 Mass Limit (g)	Uranium Mass Limit (g)
100	350	350
20	410	2,050
10	470	4,700
5	580	11,600

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.

A new Versa-Pac package design, called the VP-55HC (High Capacity), which features a 5-inch steel inner container to facilitate transport of greater quantities of U-235, is fully described in Appendix 1.4.6. The VP-55HC 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-55HC

Weight Percent U-235	U-235 Mass Limit (g)	Uranium Mass Limit (g)
100	695	695
20	1215	6,075
10	1605	16,050
5	1065	21,300

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

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/X400/S for the VP-55 with a 16-gauge body, bottom and cover. The drums use a 12-gauge bolted closure ring, standard carbon steel lugs, 5/8" diameter, ASTM (American Society for Testing Materials) A307 bolts and nuts, and a closed-cell EPDM (ethylene propylene diene monomer) gasket. The overall outer dimensions of the 55-gallon drum are 23-1/16" 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 with 16-gauge body, bottom and cover. The drums use a 12-gauge bolted closure ring, standard carbon steel lugs, 5/8" diameter ASTM A307 bolts and nuts, and a closed-cell EPDM 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 interior is completely insulated with the appropriate layers of ceramic fiber blanket around the containment area with 6 pcf 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 and 1.4.4 for the blanket and polyurethane, respectively. 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 from FK (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 [2].

1.2.1.1 Gross Weights

The gross weights of the Versa-Pac are provided in Table 1-2.

1.2.1.2 Materials of Construction

The materials of construction of the Versa-Pac are provided in Tables 1-3 and 1-4 for the VP-55 and VP-110, respectively.

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 EPDM 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. Table 1-6 identifies the limits for U-234 and U-236 as applied to the Versa-Pac. The A_2 values are used as stated in 10CFR71 [2] and are applied to the package since the payload is limited to normal form material.

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.

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 250 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*.

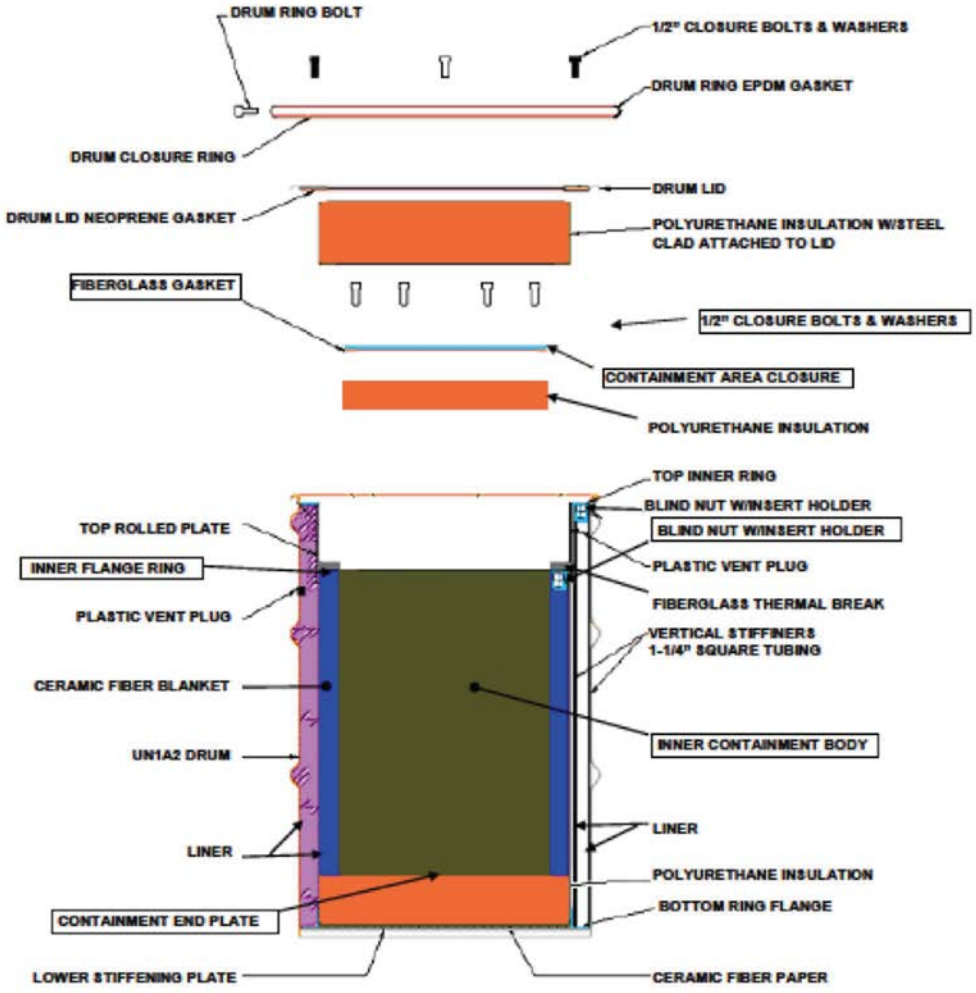


Figure 1-1: Versa-Pac Component Illustration

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

1.3 References

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

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

[3] T.C. Forensic, PTY Limited. Physical Constants for Investigators. [Online]. http://www.tcforensic.com.au/docs/article10.html

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

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

[6] Nuclear Regulatory Commission (NRC), "Regulatory Guide 7.9, Standard Format and Content of Part 71 Applications for Approval of Packages for Radioactive Material, Revision 2," March 2005.

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

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

1.4 Appendices

1.4.1 Versa-Pac Shipping Package Drawings
Drawing No.
VP-55-LD-1 & -2, VP-110-LD-1 & -2

1.4.2 General Notes

1.4.3 SOP 9.2.16: UF-1 Polyurethane Closed Cell Foam Specification for Daher-TLI Products

1.4.4 SOP 9.2.17: CFI-1 Ceramic Fiber Insulation Specification

1.4.5 SOP 9.2.18: Structural Fiberglass Component Specification

1.4.6 VP-55HC Inner Container

Table 1-2 Versa-Pac Shipping Package Gross Weights

55-Gallon Version – Model No. VP-55		
Component	Weight (kg)	Weight (lb.)
Versa-Pac Shipping Package	178	390
Maximum Payload	114	250
Maximum Gross Weight of Loaded Package	291	640
110-Gallon Version – Model No. VP-110		
Component	Weight (kg)	Weight (lb.)
Versa-Pac Shipping Package	321	705
Maximum Payload	119	260
Maximum Gross Weight of Loaded Package	439	965

Table 1-3: VP-55 Materials of Construction

Item	Material	Specification
55-Gallon Drum	16 Gauge, Carbon Steel	UN1A2/X400/S Design Minimum
Closure Ring	12 Gauge, Carbon Steel	UN1A2/X400/S
Drum Bolt	Carbon Steel	ASTM A307
Drum Gasket	EPDM Closed Cell	Certificate of Compliance
Inner Flat Gasket	Silicone Rubber Coated Fiberglass	Certificate of Compliance
Top Flange Gasket	Silicone Sponge Rubber	AMS-3195, Commercial ZZR 765, MILR 46089
Inner Flat Pads	Neoprene Sponge Rubber	ASTM D105668SCE41, ASTM 1056002C1
Inner Pads	Neoprene Rubber	ASTM D-2000, SAE J200 MIL R-33065
Sheet Materials	Carbon Steel	ASTM A1011
Plate Materials	Carbon Steel	ASTM A36
Angle	Carbon Steel	ASTM A36
Square Tubing	Carbon Steel	ASTM A500
Square Bar	Carbon Steel	AISI C1018
Thread Inserts	Carbon Steel	Fastenal-EZ LOK Part No.60158 or equivalent
All Other Closure Bolts	Carbon Steel – Zinc Plated	ASTM SAE J429 Grade 5
Lock Washers	Carbon Steel – Zinc Plated	Clad
Insulation	Polyurethane Foam	Daher-TLI SOP 9.2.16
Insulation	Ceramic Fiber Blanket/Paper	Daher-TLI SOP 9.2.17
Thermal Break	Fiberglass Band/Rings	Daher-TLI SOP 9.2.18
Nameplate	Stainless Steel	ASTM 300 Series
Paint	Industrial Primer (Inside Surfaces)	Industrial Grade (Minimum)
Paint	Enamel Touch Up	Industrial Grade (Minimum)

Table 1-4: VP-110 Materials of Construction

Item	Material	Specification
110-Gallon Drum	16 Gauge, Carbon Steel	UN1A2/Y409/S Design Minimum
Closure Ring	12 Gauge, Carbon Steel	UN1A2/X400/S
Drum Bolt	Carbon Steel	ASTM A307
Drum Gasket	EPDM Closed Cell	Certificate of Compliance
Inner Flat Gasket	Silicone Rubber Coated Fiberglass	Certificate of Compliance
Top Flange Gasket	Silicone Sponge Rubber	AMS-3195, Commercial ZZR 765, MILR 46089
Inner Flat Pads	Neoprene Sponge Rubber	ASTM D105668SCE41, ASTM 1056002C1
Inner Pads	Neoprene Rubber	ASTM D-2000, SAE J200 MIL R-33065
Sheet Materials	Carbon Steel	ASTM A1011
Plate Materials	Carbon Steel	ASTM A36
Angle	Carbon Steel	ASTM A36
Square Tubing	Carbon Steel	ASTM A500
Square Bar	Carbon Steel	AISI C1018
Thread Inserts	Carbon Steel	Fastenal-EZ LOK Part No.60158 or equivalent
All Other Closure Bolts	Carbon Steel – Zinc Plated	ASTM SAE J429 Grade 5
Lock Washers	Carbon Steel – Zinc Plated	Clad
Insulation	Polyurethane Foam	Daher-TLI SOP 9.2.16
Insulation	Ceramic Fiber Blanket/Paper	Daher-TLI SOP 9.2.17
Thermal Break	Fiberglass Band/Rings	Daher-TLI SOP 9.2.18
Nameplate	Stainless Steel	ASTM 300 Series
Paint	Industrial Primer (Inside Surfaces)	Industrial Grade (Minimum)
Paint	Enamel Touch Up	Industrial Grade (Minimum)

Table 1-5: Melting Points for Typical Packaging Materials for use within the Versa-Pac

Material	Melting Point		Notes
	(°F)	(°C)	
Carbon Steel	2500	1371	
Aluminum	1220	660	
PTFE	621	327	High Density Plastic
LDPE	240	116	Low Density Plastic

Note for Table 1-4:

1. T.C. Forensic, Physical Constants for Investigators, [3]
2. The Engineering Tool Box, Fuels and Chemicals, Auto Ignition Temperatures [4]

Note: All other materials used for packaging within the Versa-Pac shall be individually evaluated by the user to establish acceptance to the requirements.

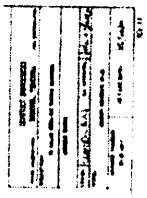
Table 1-6: Summary of Uranium Isotope Limits for U-234 and U-236

Uranium Isotope	A_2	Ci/g	Package Gram Limit (1)
U-234 (2)	2.4	6.2×10^{-3}	387
U-234 (3)	5.4×10^{-1}	6.2×10^{-3}	87
U-234 (4)	1.6×10^{-1}	6.2×10^{-3}	25
U-236 (2)	Unlimited	6.5×10^{-5}	Unlimited
U-236 (3)	5.4×10^{-1}	6.5×10^{-5}	87
U-236 (4)	1.6×10^{-1}	6.5×10^{-5}	25

1. The mixture A_2 value is calculated per 10CFR71 by the user. The payload radionuclide inventory including U-234 and U-236 shall be less than the calculated mixture A_2 value.
2. These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2, and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.
3. These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4 and hexavalent compounds in both normal and accident conditions of transport.
4. These values apply to all compounds of uranium other than those specified in (2) and (3) of this table.

1.4.1 Appendix 1.4.1 Versa-Pac Shipping Package Licensing Drawings

(4 Sheets)



Security-Related Information
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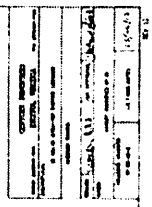
2.390



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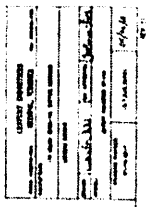

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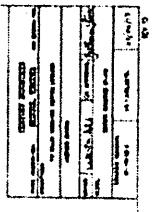

Security-Related Information
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1.4.2 Appendix 1.4.2 - General Notes

1. Paint all carbon steel surfaces with (2 mils.) of industrial primer in accordance with manufacturer's specifications. The drum exterior surface is to be painted with enamel top coat in accordance with the drum manufacturers' specification, touchup with spray enamel.
2. Placard as required.
3. Welding procedures and personnel shall be qualified in accordance with AWS D1.1 and AWS D1.3 as applicable.
4. NDT Personnel shall be qualified in accordance with SNT-TC-1A [5]. 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 ±1/8" 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 [2]. Quality Assurance shall perform visual and magnetic particle inspection through the use of hold points on the Fabrication Control Records for individual packages at pre-determined points to insure that the package is produced according to specifications.
9. The nameplate shall be a minimum of 6" x 6" x 22 gauge stainless steel, ASTM A240, 300 Series. The letters shall be at least ½" high as follows:

(Packages manufactured before _____)		(Packages manufactured after _____)	
MFG. By: Century Industries, USA		Mfg. by Daher-TLI	
S/N:		S/N:	
Century Versa-Pac VP-(55 or 110)		Versa-Pac VP-55 or VP-110	
Type AF		Type AF-96	
Tare Wt:	_____ LB	Tare Wt:	_____ LB
	_____ KG		_____ KG
Max. Gross Wt:	_____ LB	Max. Gross Wt:	_____ LB
	_____ KG		_____ KG

10. Gaskets and Plugs shall be installed using the appropriate material as described in Standard Operating Procedures.
11. Ceramic fiber paper/blanket/boards and polyurethane foam products shall be in accordance with Century SOPs.
12. Certifications, test reports and QA records shall be stored and maintained as required by Century Industries' 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

(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 Appendix 1.4.3: SOP 9.2.16: UF-1 Polyurethane Closed Cell Foam Specification for Daher-TLI Products

DAHER-TLI Manufacturing

Bristol, Virginia

Procedure Type: Standard Operating Procedure
Procedure No: SOP 9.2.16
Description: UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

This page is a record of revisions to this procedure. Each time a revision is made, only the revised pages are reissued. Remarks indicate a brief description of the revision and are not a part of the procedure.

REVISION	DATE	AFFECTED PAGE (S)	REMARKS
0	04/01/14	ALL	Original

APPROVALS

REV	QA MANAGER	DIRECTOR	PLANT MGR
0	Heather N. Little	William M. [illegible]	[signature]

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the methods of installing UF-1 polyurethane foam in products manufactured under the DAHER-TLI QA Program.

2.0 SCOPE

2.1 The scope of this specification shall cover material requirements of the installation of closed cell urethane foam with a density range of 5.0 to 11.0 pounds per cubic foot (PCF) for all shipping containers manufactured by DAHER-TLI.

3.0 ELEMENTAL COMPOUNDS

3.1 The closed cell urethane foam shall have the following elemental percentages, each with a tolerance of ± 10%.

Hydrogen	6.7%
Carbon	61.7%
Oxygen	26.1%
Nitrogen	5.2%
Other	0.3%

4.0 BASIC PHYSICAL PROPERTIES

4.1 Density

Density measurements of test samples shall be performed in accordance with ASTM D-1622. Density measurement of the urethane foam as installed will be by simple calculation of the foam weight divided by the package cavity volume during the normal production runs.

4.2 Compressive Strength

Compressive strength shall be tested in accordance with ASTM D-1621, Compressive Properties of Rigid Cellular Plastics or ASTM D695, Compressive Properties of Rigid Plastics. Density of the foam shall range between 5.0 and 11.0 PCF, with the compressive strength range between 80 and 300 PSI dependant upon the foam strength required by the product specifications.

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

4.3 Thermal Conductivity

Thermal conductivity shall meet the requirements of and be performed in accordance with ASTM C518. Based upon previous test results the thermal conductivity of the foam K Factor = 4.05 Btu-in/ (h-sq ft-°F).

4.4 Flame Retardancy

Testing for flame retardancy shall be performed in accordance with ASTM E84 and meet the minimum requirements.

4.5 Water Absorption

Testing for Water Absorption shall be in accordance with ASTM C209.

4.6 Chloride Content

Leachable chloride content shall be less than 200 ppm.

5.0 Storage Requirements

Urethane foam resins and urethane foam and other raw materials and processing chemicals should be stored at room temperature.

6.0 Operating Procedure

6.1 Raw Materials

6.1.1 The urethane foam will be a two component, rigid polyurethane system that produces hard foam with a nominal, free rinse core density of 5 to 11 pcf. The system should be a water blown foam formula with a polymeric MDI as the "A" component.

6.1.2 The flame retardant should be either a carbon intumescent or mono-penta-erythritol based material.

6.2 Foam In Place Procedure

6.2.1 Calculate the amount of foam required for volume and add 10%.

6.2.2 Weigh container to be foamed – Record reading.

6.2.3 Weigh raw materials for a 7 ± 2% flame retardant formulation.

3

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

6.2.4 Temperature adjustment of container prior to foaming shall be made by means of indirect heat, such as space heaters or other methods of radiant heat. The container temperature shall be between 70-110°F. Additional information can be found by referring to the manufacturer's literature.

6.2.5 Pre-mix flame retardant and Part A of urethane system in container that will hold all of the components.

6.2.6 Add Part R and mix.

6.2.7 Pour into container cavity.

6.2.8 Watch foam rise for any abnormalities.

6.2.9 When the rise is complete, allow foam to cure before cutting. Curing temperature shall be between 50-100°F.

6.2.10 Trim excess foam from container.

6.2.11 Weigh foamed container.

6.2.12 Calculate density of the foam in the container based on container void volume and net weight of the foam installed.

6.3 Mold Fabrication Foam Procedure

6.3.1 This procedure is used for foaming molds, blocks or buns of material to be cut to a particular finished component part to be used in the final container.

6.3.2 Calculate the amount of foam required for the mold.

6.3.3 Temperature adjustment of the mold prior to foaming shall be made by means of indirect heat, such as space heaters or other methods of radiant heat. The mold temperature shall be between 70-110°F. Additional information, if needed, can be found by referring to the manufacturer's literature.

6.3.4 Weigh out the raw materials.

6.3.5 Pre-mix flame retardant and Part A of the urethane system in a container that will hold all components.

6.3.6 Add Part R and mix.

6.3.7 Pour evenly into mold.

4

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

6.3.8 Watch for abnormalities.

6.3.9 Once the rise is complete, record total rise height.

6.3.10 Curing temperature shall be between 50-100°F. Once the foam has cured, cut the foam to the specified shape.

6.3.11 As required, take sample and calculate pcf.

6.3.12 A specific bun number (Pour No.) is assigned to the bun and spray painted on the top.

6.3 Mold Fabrication Foam Procedure – Cutting

6.4.1 Cutting: After curing, each bun will be cut on the wire saw to the required foam component shape per the instructions and drawings provided. Each individual component shape will have a unique letter identification assigned to it.

6.4.2 Each component shape that is cut will be segregated by the Bun Number and the Component Shape ID.

6.4.3 A sample of left over foam from each bun will be collected and labeled for pcf calculation.

7.0 Quality Assurance

7.1 Production

Prior to production of each product utilizing the closed cell urethane foam, Quality Assurance shall establish the correct weight of the foam materials required to produce the correct density.

7.2 Records

7.2.1 Foam in Place

A foaming record must be completed for each foam installation in each individual package and it shall become a part of the final QA record. This record shall include as a minimum: foam components, weight of the container before and after the foaming and trimming, and have proper QA verifications.

The foam fabricator shall supply records from the resin manufacturer for each urethane resin batch. They shall also supply from an independent laboratory, results to verify that the leachable chloride content taken from

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Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

foam samples of each resin batch, meet the leachable chloride content requirement of less than 200 ppm.

7.2.2 Foam Panels

A foaming record must be completed for each foam panel bun produced and it shall become a part of the final QA record. This record shall include as a minimum: foam components, weight of raw materials charged, the dimensions of the foamed bun, and have proper QA verifications.

The density of the representative foam panel material from each bun shall be calculated and recorded in the Panel Foam Density Record.

The foam fabricator shall supply records from the resin manufacturer for each urethane resin batch. They shall also supply from an independent laboratory, results to verify that the leachable chloride content taken from foam samples of each resin batch, meet the leachable chloride content requirement of less than 200 ppm.

8.0 Attachments

8.1 DAHER-TLI UF-1 Production Foam Record

8.2 DAHER-TLI UF-1 Panel Foam Density Record

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

Attachment 8.1

DAHER-TLI UF-1 Production Foam Record

Date: _____ Time: _____ Pour/Bun No: _____

Mold Room Temperature: _____ Type of Pour: In-Place _____ Mold ____

Chemical	LBS	Grams	Lot/Batch Number
"A" System			
"R" System			
Flame Retardant			
Total			

Foam in Place Density Data

Containers Empty Weight	
Trimmed Foam Container Weight	
Volume of Container Cavity Foamed	
Density of Container Foam	

Mold Foam Density **Expected PCF:** _____

Mold size in Inches	
Height of Foam in Mold	
Weight of Foam Charge	
Density of Foam Component	

Foaming Information

	Plan	Actual
Start Temp. – Resin "A"		
Start Temp. – Resin "R"		
Mixer RPM		
Mixer Type		
Chem. Mix Time in Sec.		
Cream Time in Sec.		
Foam Time in Sec.		
Tack Free Time in Sec.		
Foam Height in Mold(IN.)		

Person Responsible for Formulation: _____

Person Responsible for Production: _____

QA Review By: _____ Date: _____

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DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.16 Rev. 0	UF-1 Polyurethane Closed Cell Foam Specification for DAHER-TLI Products

Attachment 8.2

DAHER-TLI UF-1 Panel Foam Density Record

Bun Number	Calculated Density	Comments

Person Responsible for Calculations: _____

QA Review By: _____ Date: _____

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1.4.4 Appendix 1.4.4 SOP 9.2.17: CFI-1 Ceramic Fiber Insulation Specification

DAHER-TLI Manufacturing

Bristol, Virginia

Procedure Type: Standard Operating Procedure
Procedure No: SOP 9.2.17
Description: CFI-1 Ceramic Fiber Insulation Specification

This page is a record of revisions to this procedure. Each time a revision is made, only the revised pages are reissued. Remarks indicate a brief description of the revision and are not a part of the procedure.

REVISION	DATE	AFFECTED PAGE (S)	REMARKS
0	04/01/14	ALL	Original

APPROVALS

REV	QA MANAGER	DIRECTOR	PLANT MGR
0	Heather W. Little		

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.17 Rev. 0	CFI-1 Ceramic Fiber Insulation Specification for DAHER-TLI Products

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the ceramic fiber materials used in products manufactured under the DAHER-TLI QA Program.

2.0 SCOPE

2.1 The scope of this specification shall cover material requirements for the installation of both ceramic fiber paper and blanket insulation products in DAHER-TLI products.

3.0 BASIC PHYSICAL PROPERTIES

3.1 Paper

Density = 4 pcf, compressed

Thickness = 1/8 in.

Thermal Conductivity, Btu-in./hr.-ft^{2}-°F (ASTM C 201):

4 pcf (Mean Temp. @ 2,000°F) = 1.58

3.2 Blanket

Density = 6 & 8 lb/ft^{3}

Thickness = 0.5 to 2 in.

Thermal Conductivity, Btu-in./hr.-ft^{2}-°F (ASTM C 201):

6 pcf (Mean Temp. @ 2,000°F) = 2.83

8 pcf (Mean Temp. @ 2,000°F) = 2.34

4.0 Storage Requirements

4.1 Store the Ceramic Fiber paper and blanket insulation in an area with relatively low humidity at ambient temperature.

5.0 Quality Assurance

5.1 Production

Quality Assurance shall verify that the density and thickness of the ceramic fiber insulation is correct when received and prior to installation.

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DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.17 Rev. 0	CFI-1 Ceramic Fiber Insulation Specification for DAHER-TLI Products

5.2 Records

A ceramic fiber insulation record must be completed for each individual package and it shall become a part of the final QA record. This record shall include as a minimum: verification of density and thickness and serial number of the package(s) in which the insulation was installed.

6.0 Attachments

6.1 DAHER-TLI CFI-1 Ceramic Fiber Installation Record

3

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.17 Rev. 0	CFI-1 Ceramic Fiber Insulation Specification for DAHER-TLI Products

Attachment 6.1

DAHER-TLI CFI-1
Ceramic Fiber Installation Record

Ceramic Fiber Paper

Package Serial Number(s)	Density	Thickness	Manufacturer/Product	Lot/Batch No.

Ceramic Fiber Blanket

Package Serial Number(s)	Density	Thickness	Manufacturer/Product	Lot/Batch No.

Production Signature: _____ Date: _____

QA Signature: _____ Date: _____

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1.4.5 Appendix 1.4.5 SOP 9.2.18: Structural Fiberglass Component Specification

DAHER-TLI Manufacturing

Bristol, Virginia

Procedure Type: Standard Operating Procedure
Procedure No: SOP 9.2.18
Description: Structural Fiberglass Component Specification

This page is a record of revisions to this procedure. Each time a revision is made, only the revised pages are reissued. Remarks indicate a brief description of the revision and are not a part of the procedure.

REVISION	DATE	AFFECTED PAGE (S)	REMARKS
0	04/01/14	ALL	Original

APPROVALS

REV	QA MANAGER	DIRECTOR	PLANT MGR
0	Heather N. Little	Will M Hall	

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.18 Rev. 0	Structural Fiberglass Component Specification for Century Products

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the structural fiberglass component materials used in products manufactured under the DAHER-TLI QA Program.

2.0 SCOPE

2.1 The scope of this specification shall cover material requirements for the structural fiberglass components utilized in DAHER-TLI products.

3.0 BASIC PHYSICAL PROPERTIES

3.1

Property	Value	ASTM Test
Mechanical		
Tensile Stress, LW	30,000 psi	D638
Tensile Stress, CW	7,000 psi	D638
Compressive Stress, LW	30,000 psi	D695
Compressive Stress, CW	15,000 psi	D695
Flexural Stress, LW	30,000 psi	D790
Flexural Stress, CW	10,000 psi	D790
Modulus of Elasticity[1]	2.6×10^6 psi	Full Section
Modulus of Elasticity >4"[1]	2.5×10^6 psi	Full Section
Physical		
Barcol Hardness	45	D2583
24 Hour Water Absorption	0.6% Maximum	D570
Density	.062 - .070 lbs/in^3	D792
Thermal Conductivity	4-BTU-in/ft^2/hr/°F	C177
Electrical		
Arc Resistance, LW	120 Seconds	D495
Flammability		
Tunnel Test	25 Maximum	E84
Flammability	Self Extinguishing	D635

LW – Lengthwise
CW – Crosswise

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.18 Rev. 0	Structural Fiberglass Component Specification for Century Products

Note:

1. This value is to be determined from full section simple beam bending of structural shapes.

2. All test requirements are minimum ultimate coupon properties of structural shapes per the referenced ASTM Specification, unless otherwise noted.

3.2 Description of Tests

Tensile Strength (ASTM D638)

The tensile strength is determined by pulling ends of a test specimen until failure.

Compressive Strength (ASTM D695)

The ultimate compressive strength of a material is a force required to rupture the test specimen when a load is applied such that the specimen is crushed.

Flexural Properties (ASTM D790)

The flexural strength is determined by placing a test specimen between two supports and applying a load to the center.

Modulus of Elasticity (Full Section)

This test is conducted by loading a prescribed length of the full shape (not a coupon) with a support at each end and applying a center load.

Barcol Hardness (ASTM D2583)

The barcol hardness is a measurement of the resistance of the surface of a test specimen to penetration by a needle probe which is spring driven. The barcol hardness is generally an average of multiple measurements on the same part and is an approximate measure of the materials completeness of cure.

Water Absorption (ASTM D570)

The specimens are immersed in water for a period of 24 hours and the change in weight is measured.

Density (ASTM D792)

The density is the ratio of the mass (weight) of a specimen to the volume of the specimen.

DAHER-TLI Manufacturing

Procedure Type	Procedure No.	Description
Standard Operating Procedures	SOP 9.2.18 Rev. 0	Structural Fiberglass Component Specification for Century Products

Thermal Conductivity (C177)

This test establishes the criteria for the laboratory measurement of the steady-state heat flux through flat, homogeneous specimens when the surface is in contact with solid, parallel boundaries held at constant temperature using a guarded hot plate apparatus.

Arc Resistance (ASTM D495)

This test is performed by placing two probes on a test specimen at a distance of ¼". A high voltage, low current, arc is passed between the probes with a specified on/off cycle for the arc. The time taken for the arc to completely burn a path through the composite is measured.

Tunnel Test (ASTM E84)

In the 25 foot tunnel test, a smoke generation value and the rate of flame spread are determined.

Flammability (ASTM D635)

The specimen is held horizontally with one end subjected to a flame for 30 seconds.

4.0 Storage Requirements

4.1 All fiberglass products shall be stored in a dry area at ambient temperatures. Fiberglass products may be stored either vertically or horizontally and should be properly supported to reduce the possibility of damage.

5.0 Quality Assurance

5.1 Production

Quality Assurance shall verify that the materials are free from damage and that the certificate of compliance for the product is correct and that it meets the requirements of this procedure when received and prior to installation.

5.2 Records

A Certificate of Compliance from the manufacturer must be reviewed for compliance with this procedure and it shall become a part of the final QA record.

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1.4.6 Versa Pac VP-55HC (High Capacity)

1.4.6.1 Versa Pac VP-55HC Introduction

1.4.6.2 VP-55HC Packaging Description

1.4.6.2.1 VP-55HC Packaging

The VP-55HC 5-inch pipe container fits inside the VP-55 payload vessel. The payload vessel is described in Section 1.2.1. Engineering 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.

1.4.6.2.1.1 VP-55HC Gross Weights

The gross weight of the VP-55HC is identical to the VP-55 standard configuration, which is found in Table 1-2. The inner container and dunnage to hold the container in place during routine transport are included in the maximum payload weight.

1.4.6.2.1.2 VP-55HC Materials of Construction

The materials of construction of the VP-55HC inner container are provided in Section 1.4.6.2.1. VP-55HC Outer and Inner Protrusions

There are no protrusions on the inner container.

1.4.6.2.1.3 VP-55HC Lifting and Tie-Down Devices

The VP-55HC is handled in the same manner as the Versa-Pac.

1.4.6.2.1.4 VP-55HC Shielding

Neutron and gamma shields are not required for the VP-55HC payloads.

1.4.6.2.1.5 VP-55HC Pressure Relief Systems

There are no pressure relief systems on the VP-55HC inner container.

1.4.6.2.1.6 VP-55HC Containment Features

The containment features for the VP-55HC are identical to those of the Versa-Pac, with the addition of closure system for the inner containment vessel. The containment boundary of the VP-55HC is defined as the inner containment vessel, the payload vessel with its associated welds, payload vessel high temperature heat resistant silicone coated fiberglass gasket, payload vessel blind flanges, and reinforcing ring.

1.4.6.2.2 VP-55HC Contents

The 5-inch pipe container is the required content container for the VP-55HC configuration because the 5-inch pipe container provides geometry control of the contents. The contents for the VP-55HC are identical to the Versa-Pac standard configuration, with the exception that material quantities may not exceed the U-235 limits established Table 1-1A in any non-pyrophoric form.

1.4.6.2.3 Special Requirements for Plutonium

The VP-55HC is not approved for the transport of Plutonium above minimum detectable quantities.

1.4.6.2.4 License Drawing