# SECTION ONE
# GENERAL INFORMATION

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**SAFETY ANALYSIS REPORT**
**FOR MODEL VERSA-PAC**
**SHIPPING CONTAINER**
**(Revision 3, April, 2010)**

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# 1 GENERAL INFORMATION

This Safety Analysis Report for the Versa-Pac Shipping Container is submitted in support of the Century Industries request for approval of the subject shipping container and issuance of a Type A Fissile Material Certificate of Compliance for the container in compliance with the requirements of 10 CFR 71 and IAEA Regulations for the Safe Transport of Radioactive Material, No. TS-R-1, 1996 Edition. This Safety Analysis Report for Packaging (SARP) has been prepared in accordance with U.S. Regulatory Commission (NRC), Regulatory Guide 7.9 Proposed Revision 2, March 2005.

## *1.1 Introduction*

The Versa-Pac Shipping Containers employ an innovative design concept (Patent Pending) in combination with the familiar drum exterior packaging to provide enhanced structural protection to the payloads previously transported per 49 CFR 173.417(a)(6) during Hypothetical Accident Conditions (HAC). The Versa-Pac shipping containers, model numbers VP-55 and VP-110, have been designed to transport Type A Fissile Materials containing less than or equal to 350 grams of U-235 and has been evaluated to transport many of the products currently being transported in older shipping containers. The package has been designed and constructed so that it is acceptable under 71.43(g) for transport in non-exclusive and exclusive means of transport.

The package system includes an outer set of drum closure seals and an inner secondary flat gasket seal. The payload containment area of the 55 gallon version has an inside diameter of 15 inches and is 25-7/8 inches in length; while the 110 gallon version 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.

The Criticality Safety Index (CSI) is 1.0.

## *1.2 Package Description*

### 1.2.1 Packaging

Engineering Drawings are provided in Appendix 1.3.1. General notes pertaining to fabrication are provided in Appendix 1.3.2. An illustration of the packaging configuration is provided in Figure 1-1. Packaging markings are shown on the drawings provided in Appendix 1.3.1 with General Notes shown in Appendix 1.3.2.

The exterior skin of the Versa-Pac Shipping Container consists of at a minimum, a UN1A2/X400/S for the 55-gallon drum version 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 A307 bolts and nuts, and a closed-cell EPDM gasket. The overall outer dimensions of the 55 gallon package 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 110 gallon version 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 package 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 rolled16 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 Appendix 1.3.3 and 1.3.4 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 1/2 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 1.3.1). A specification for the fiberglass material is provided in Appendix 1.3.5.

The containment boundary of the package is defined as the payload vessel with its associated welds, payload vessel high temperature heat resistant fiberglass sleeve 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. An 1/8" high temperature resistant fiberglass sleeve 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.

### 1.2.1.1 Gross Weights

The gross weights of the Versa-Pac Shipping Container are provided in Table1-1.

### 1.2.1.2 Materials of Construction

The materials of construction of the Versa-Pac are provided in Tables 1-2 and 1-3 for the 55-gallon and 110-gallon versions, 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 side-wall of the outer drum and does not impede the stacking or handling of the shipping container. There are no inner protrusions on the Versa-Pac package and no outer or inner protrusion on the Versa-Pac Shipping Container.

### 1.2.1.4 Lifting and Tie-Down Devices

The Versa-Pac shipping container 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 package 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 - ½" holes, closed with vinyl push plugs on the inner liner between the insulation and containment 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 Shipping Container. The payload ½ inch thick closure plate provides a fastening and seal using twelve ½" bolts and a 1/8" thick silicone rubber fiberglass coated flat 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 shipping container 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 1.3.1 and 1.3.2.

### 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 350 grams U-235 in any non-pyrophoric form, enriched up to 100 Wt%. 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) enriched up to 100 Wt% U-235. 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 1-5 identifies the limits for U-234 and U-236 as applied to the Versa-Pac Shipping Container. The $A_2$ values are used as stated in 10 CFR 71 and are applied to the package since the payload is limited to normal form material.

The package 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%. Because the payload decay is essentially zero (approximately 11.4 W, *Section 3.4.2*); thus, 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. PTFE or Teflon® pre-packaging material is also allowed. Metallic pre-packaging materials such as aluminum, stainless and carbon steel are further allowed provided their total weight is controlled to within the payload allotment of the package.

The payload shall be further limited to materials with auto-ignition temperatures greater than or equal to 600°F. Since many varieties of materials are used for packaging the user is required to establish that the auto-ignition temperature is a minimum of 600°F using an established method, such as the method prescribed by ASTM D2883 (Test Method for reaction threshold Temperature of Liquid and Solid Materials). Table 1-4 provides the listing of packaging materials qualified for use within the Versa-Pac shipping container; all other packaging materials must meet the 600°F minimum auto-ignition temperature described above.

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

The maximum payload capacity for the 55-gallon version is 250 pounds. The maximum payload capacity for the 110-galon version is 260 pounds.

### 1.2.3 Special Requirements for Plutonium

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

### 1.2.4 Operational Features

The Versa-Pac Shipping Container 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 Shipping packaging. All operational features are readily apparent from an inspection of the drawings provided in Appendix 1.3.1, *Packaging General Arrangement Drawings*. Operation procedures and instructions for loading, unloading, and preparing an empty Versa-Pac Shipping packaging for transport are provided in Chapter 7.0, *Operating Procedures*.

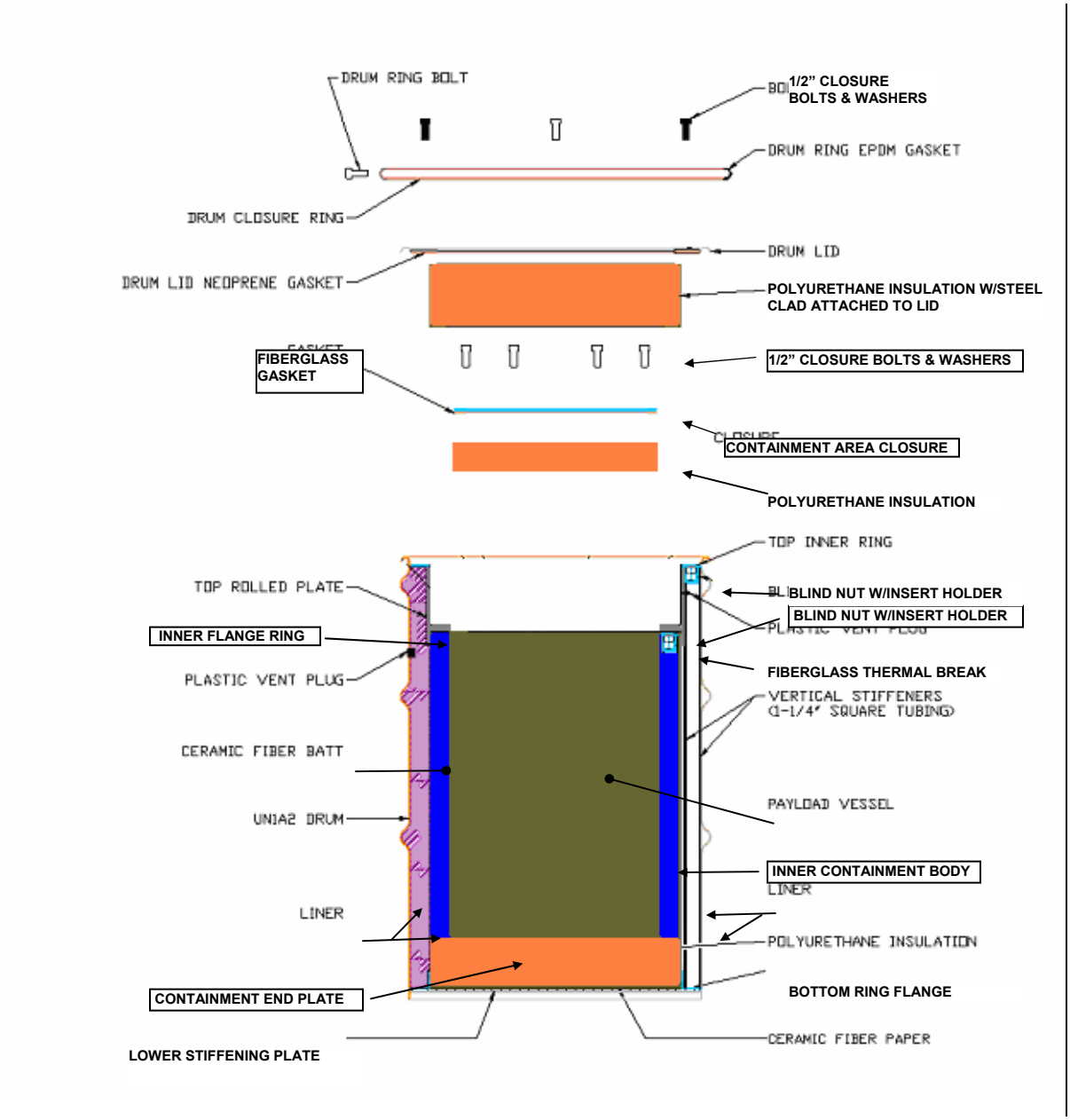



**Figure 1-1 Versa-Pac Component Illustration**

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

## *1.3 Appendices*

### 1.3.1 Versa-Pac Shipping Container Drawings, Century Industries Drawing No.

**VP-55-LD-1 & -2, VP-110-LD-1 & -2**

### 1.3.2 General Notes

### 1.3.3 SOP 6.11 – Polyurethane Closed Cell Foam Specification for Century Industries Products

### 1.3.4 SOP 6.12 – Ceramic Fiber Insulation Specification for Century Industries Products

### 1.3.5 SOP 6.13 – Structural Fiberglass Component Specification for Century Industries Products

## Table 1-1 Versa-Pac Shipping Container Gross Weights

### 55 Gallon Version – Model No. VP-55

| Component | Weight (kg) | Weight (lb) |
|---|---|---|
| Versa-Pac Shipping Container | 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 Container | 321 | 705 |
| Maximum Payload | 119 | 260 |
| **Maximum Gross Weight of Loaded Package** | 439 | **965** |

## Table 1-2 55 Gallon Versa-Pac 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 | ASTM-D372 , MILR 46089<br>Commercial ZZR 765, Class 2 |
| Inner Flat Pads | Neoprene Sponge Rubber | ASTM D105668SCE41,<br>ASTM 1056002C1 |
| Inner Pads | Neoprene Rubber | ASTM D-2000, SAE J200<br>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 |
| 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 | Century SOP 6.11 |
| Insulation | Ceramic Fiber Blanket/Paper | Century SOP 6.12 |
| Thermal Break | Fiberglass Band/Rings | Century SOP 6.13 |
| Nameplate | Stainless Steel | ASTM 300 Series |
| Paint | Industrial Primer (Inside Surfaces) | Industrial Grade |
| Paint | Enamel Touch Up | Industrial Grade |

## Table 1-3 110 Gallon Versa-Pac 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 | ASTM D372, MILR 46089 Commercial ZZR 765 |
| 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/Stainless Steel | ASTM A1011 |
| Plate Materials | Carbon Steel | ASTM A36 |
| Angle | Carbon Steel | ASTM A36 |
| Square Tubing | Carbon Steel | ASTM A500 |
| 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 | Century SN 6.11 |
| Insulation | Ceramic Fiber Blanket/Paper | Century SN 6.12 |
| Thermal Break | Fiberglass Band/Rings | Century SOP 6.13 |
| Nameplate | Stainless Steel | ASTM 300 Series |
| Paint | Industrial Primer (Inside Surfaces) | Industrial Grade |
| Paint | Enamel Touch Up | Industrial Grade |

## Table 1-4

## Melting Points & Auto-Ignition Temperatures for Selected Typical Packaging Materials for use within the Versa-Pac

| Material | Ignition Temperature[1,2] | | Melting Point |
|---|---|---|---|
| | (C) | (F) | (F) |
| Carbon Steel | N/A | N/A | 2500° |
| Aluminum | N/A | N/A | 1220° |
| PTFE | 530° | 986° | 621° |

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

Note for Table 1-4

1. "Physical Constants for Investigators", http://www.tcforensic.com.au/docs/article10.html, by Tony Cafe, Reproduced from "Firepoint" magazine - Journal of Australian Fire Investigators
2. "Fuels and Chemicals - Auto Ignition Temperatures", http://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html

## Table 1-5 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 | $6.2 \times 10^{-3}$ | 387 |
| U-234 (3) | $5.4 \times 10^{-1}$ | $6.2 \times 10^{-3}$ | 87 |
| U-234 (4) | $1.6 \times 10^{-1}$ | $6.2 \times 10^{-3}$ | 25 |
| U-236 (2) | Unlimited | $6.5 \times 10^{-5}$ | Unlimited |
| U-236 (3) | $5.4 \times 10^{-1}$ | $6.5 \times 10^{-5}$ | 87 |
| U-236 (4) | $1.6 \times 10^{-1}$ | $6.5 \times 10^{-5}$ | 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 for 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 for of $UO_3$, $UF_4$, $UCI_4$ 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.

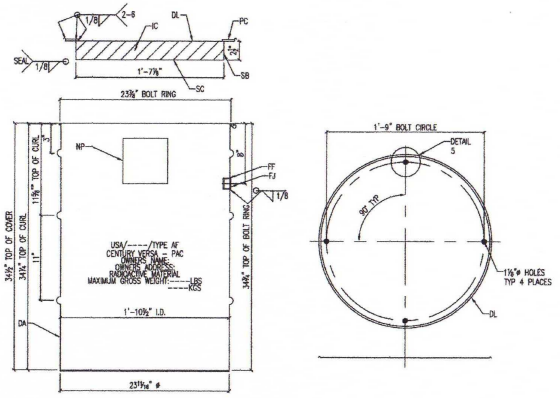
# Appendix 1.3.1
# Versa-Pac Shipping Container Licensing Drawings
# (4 Sheets)

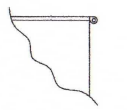
## BILL OF MATERIALS

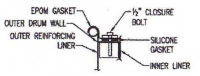
| ITEM NO. | QTY. | PART NAME | DESCRIPTION | MATERIAL |
|---|---|---|---|---|
| DA | 1 | DRUM-55 GALLON | UN1A2/X400/S MIN. | C/S |
| DL | 1 | DRUM LID | 16GA. | C/S |
| DR | 1 | DRUM RING | 12GA.-5/8ø BOLT W/1/8 SECURITY HOLE DRILLED IN THE END | C/S |
| PA | 1 | CONTAINMENT BODY | 10GA. SHEET | C/S ASTM A1011 |
| PB | 1 | CONTAINMENT END PLATE | 10GA. SHEET | C/S ASTM A1011 |
| PC | 1 | DRUM LID REINFORCING RING | 10GA. SHEET | C/S ASTM A1011 |
| PD | 1 | BLIND FLANGE | 1/2 PLATE | C/S ASTM A36 |
| PE | 1 | BOTTOM REINFORCING PLATE | 1/4 PLATE | C/S ASTM A36 |
| PF | 1 | BOTTOM PLATE RING | 3/4 PLATE | C/S ASTM A36 |
| PG | 1 | TOP PLATE RING | 5/16 PLATE | C/S ASTM A36 |
| PH | 1 | INNER FLANGE RING | 1/4 PLATE | C/S ASTM A36 |
| PI | 8 | CENTER STIFFENER RING WEB | 5/16 PLATE | C/S ASTM A36 |
| FA | 3 | INNER STIFFENING FLG. RING-CENTER | 5/16 FLAT BAR/PLATE | C/S ASTM A36 |
| FB | 1 | TOP STIFFENING RING | 5/16 FLAT BAR/PLATE | C/S ASTM A36 |
| FC | 1 | OUTER STIFFENING REINFORCING SHEET | 16GA. SHEET | C/S ASTM A1011 |
| FD | 1 | REINFORCING BACKING BAR | 1/4 FLAT BAR | C/S ASTM A36 |
| BA | 1 | HANDLE | 1/4 | C/S ASTM A36 |
| BB | 16 | INSERT HOLDERS | 1 1/4 SQ. BAR | C/S ASTM A1018 |
| BC | 1 | RETAINING RING | 1/2 PLATE | C/S ASTM A36 |
| TB | 4 | VERTICAL STIFFENERS | 1 1/4 X 1 1/4 X 5/16 SQ. TUBE | C/S ASTM A500 GRADE B |
| AA | 1 | HANDLE ANGLE | 1/8 X 1/2 X 1/2 ANGLE | C/S ASTM A36 |
| FK | 1 | CONNECTION RING | 1/4 X 1 1/2 FLAT BAR/PLATE | C/S ASTM A36 |
| SA | 1 | INNER LINER | 16GA. SHEET | C/S ASTM A1011 |
| SB | 1 | TOP PLUG WALL | 16GA. SHEET | C/S ASTM A1011 |
| SC | 1 | TOP PLUG CAP | 16GA. X 19 1/2ø SHEET | C/S ASTM A1011 |
| FE | 16 | THREAD INSERTS | 1/2-13 X .656 INT. X 3/4-10 EXT. | C/S EZ LOK#60158 OR EQUAL |
| FF | 1 | INVERTED FLAT PIPE | 1" NPT | C/S FORGING |
| FG | 28 | HEX HEAD BOLTS | 1/2-13 X 1 1/4 LONG | C/S ZINC PL. ASTM SAE J429 GRADE 5 |
| FH | 28 | LOCK WASHER | 1/2 X 5/8ø | C/S ZINC PLATED |
| FI | 5 | RATCHET VENT PLUG | 1/4 X LONG | PLASTIC |
| FJ | 1 | THREADED PIPE PLUG | 1"ø | ACETATE |
| GA | 1 | DRUM LID INNER GASKET | 3/8THICK X 19 3/8 I.D. | SILICONE RUBBER MED. DENSITY 50-70 DUROMETER |
| GB | 1 | CONTAINMENT GASKET | 1/8 | HI TEMP. HEAT RES. SILICONE COATED FIBERGLASS SLEEVE GASKET |
| GC | 1 | VESSEL BOTTOM PAD | 1/8 | NEOPRENE RUBBER 70-90 DUROMETER |
| IA | A/R | CERAMIC BLANKET | 1 1/2 | ALUMINA SILICA BLANKET PER SOP 6.12 |
| IB | 1 | PLUG INSULATOR-BOTTOM BODY | 2 3/4 - 6PCF | CI-1 POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |
| IC | 1 | PLUG INSULATOR-DRUM LID | 2 7/16 - 6PCF | CI-1 POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |

| ITEM NO. | QTY. | PART NAME | DESCRIPTION | MATERIAL |
|---|---|---|---|---|
| BD | 1 | BACKING BAR | 10GA. SHEET | C/S ASTM A1011 |
| BE | 3 | BACKING BAR | 10GA. X 2 X 9" LONG SHEET (TRIM TO SIZE) | C/S ASTM A1011 |
| ID | A/R | CERAMIC PAPER | 1/8 THICK X 24" WIDE - 10PCF | ALUMINA SILICA PAPER PER SOP 6.12 |
| IE | 1 | FIBERGLASS RING | 1/2" THICK | FIBERGLASS PER SOP 6.13 |
| IF | A/R | FIBERGLASS BANDS | 1/2" TOTAL | FIBERGLASS PER SOP 6.13 |
| PJ | 1 | CONNNECTION FLAT RING | 1/4" PLATE | C/S ASTM A36 |
| GE | 1 | BUMPER GASKET | 1/2 | NEOPRENE SPONGE |
| NP | 1 | NAME PLATE | 20GA. X 6" X 6" MINIMUM | S/S ASTM 300 SERIES |
| NOTE | 1 | (AA & BA) | FOLDING HANDLE MAY BE SUBSTITUTED IN PLACE OF AA & BA COMBINATION | MCMASTER-CARR #15625A83 OR EQUIVALENT |
| BF | 3 | CONTAINMENT PLUG RETAINING BAR | 1/4 X 1/2 X 6" LONG | C/S ASTM A36 |
| IG | 1 | CONTAINMENT INSULATION PLUG | 3" - 10PCF | CI - POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |

NOTE:
1. UNLESS NOTED WELDS ARE MADE USING THE METAL INERT GAS (MIG) METHOD IN ACCORDANCE WITH CENTURY INDUSTRIES WELDING PROCEDURES.
2. DRUM CLOSURE RING BOLT PROVIDES METHOD FOR TAMPER-INDICATING DEVICE THRU 1/8"ø HOLE IN BOLT END



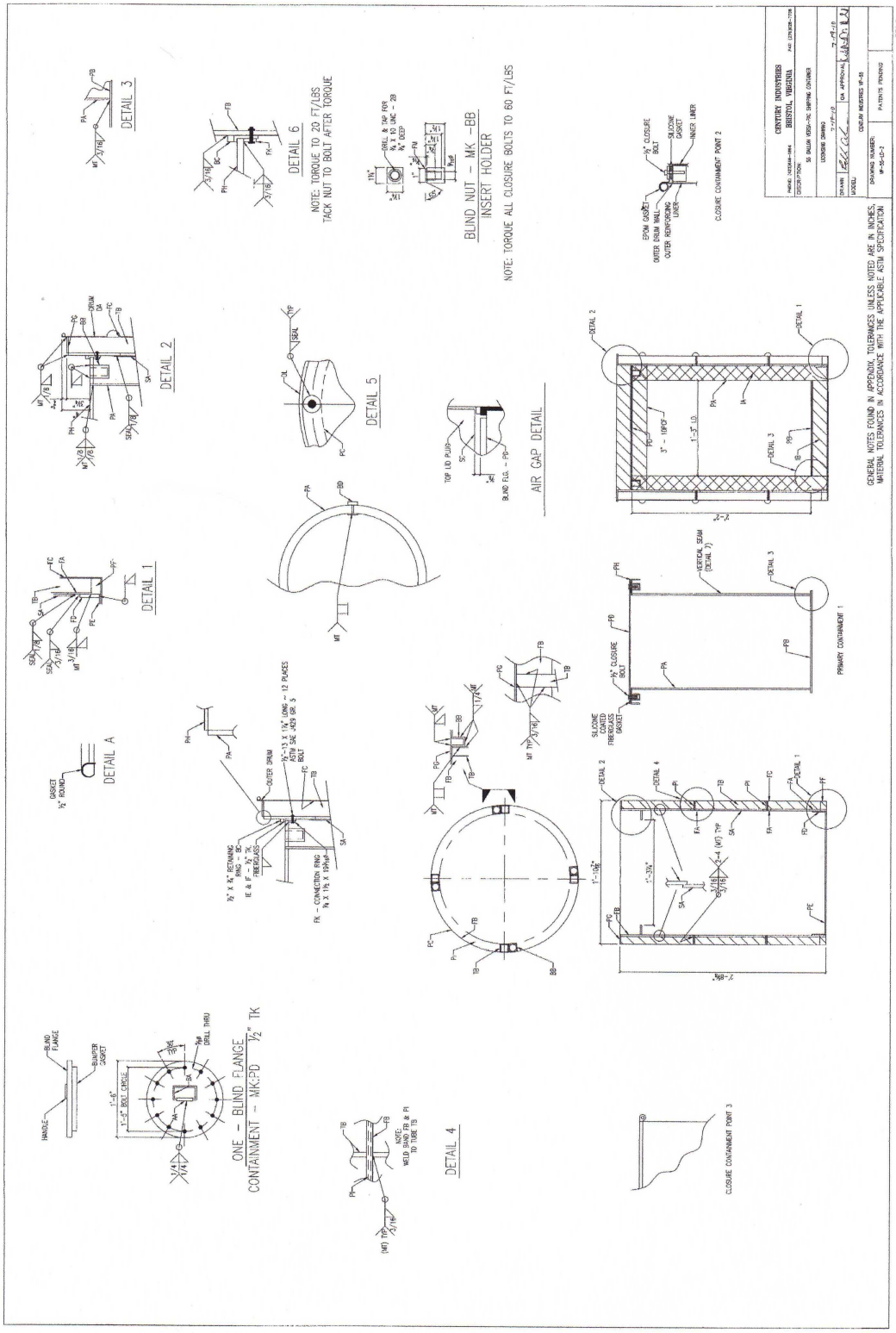




CLOSURE CONTAINMENT POINT 2

GENERAL NOTES FOUND IN APPENDIX, TOLERANCES UNLESS NOTED ARE IN INCHES, MATERIAL TOLERANCES IN ACCORDANCE WITH THE APPLICABLE ASTM SPECIFICATION

CENTURY INDUSTRIES
BRISTOL, VIRGINIA
DESCRIPTION: 55 GALLON VERSA-PAC SHIPPING CONTAINER
LICENSING DRAWING
DRAWN: 7-15-15
QA APPROVAL: 7-19-15
MODEL: CENTURY INDUSTRIES VP-55
DRAWING NUMBER: VP-55-LD-1
PATENTS PENDING
REV 4

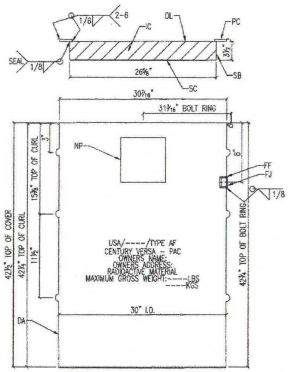

DETAIL 3
DETAIL 6
NOTE: TORQUE TO 20 FT/LBS
TACK NUT TO BOLT AFTER TORQUE
BLIND NUT – MK –BB
INSERT HOLDER
NOTE: TORQUE ALL CLOSURE BOLTS TO 60 FT/LBS
CLOSURE CONTAINMENT POINT 2
DETAIL 2
DETAIL 5
AIR GAP DETAIL
DETAIL 1
DETAIL A
DETAIL 4
ONE – BLIND FLANGE
CONTAINMENT – MK-PD ½" TK
CLOSURE CONTAINMENT POINT 3
PRIMARY CONTAINMENT 1
CENTURY INDUSTRIES
BRISTOL, VIRGINIA
GENERAL NOTES FOUND IN APPENDIX. TOLERANCES UNLESS NOTED ARE IN INCHES.
MATERIAL TOLERANCES IN ACCORDANCE WITH THE APPLICABLE ASTM SPECIFICATION
REV 6

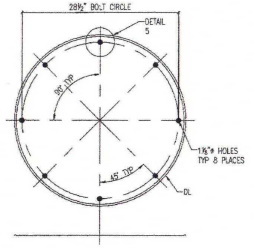
## BILL OF MATERIALS

| ITEM NO. | QTY. | PART NAME | DESCRIPTION | MATERIAL |
|---|---|---|---|---|
| DA | 1 | DRUM-110 GALLON | 16GA. UN/1A2/Y409/S MIN | C/S |
| DL | 1 | DRUM LID | 16GA. | C/S |
| DR | 1 | DRUM RING | 12GA.-⅞ø BOLT W/⅛ SECURITY HOLE DRILLED IN THE END | C/S |
| PA | 1 | CONTAINMENT BODY | 10GA. SHEET | C/S ASTM A1011 |
| PB | 1 | CONTAINMENT END PLATE | 10GA. PLATE | C/S ASTM A1011 |
| PC | 1 | DRUM LID REINFORCING RING | 10GA. SHEET | C/S ASTM A1011 |
| PD | 1 | BUND FLANGE | ½ PLATE | C/S ASTM A36 |
| PE | 1 | BOTTOM REINFORCING PLATE | ¼ PLATE | C/S ASTM A36 |
| PF | 1 | BOTTOM PLATE RING | ¾ PLATE | C/S ASTM A36 |
| PG | 1 | TOP PLATE RING | 5/16 PLATE | C/S ASTM A36 |
| PH | 1 | INNER FLANGE RING | ⅛ PLATE | C/S ASTM A36 |
| PI | 8 | CENTER STIFFENER RING WEB | 5/16 PLATE | C/S ASTM A36 |
| FA | 3 | INNER STIFFENING FLG. RING-CENTER | 5/16 FLAT BAR/PLATE | C/S ASTM A36 |
| FB | 1 | TOP STIFFENING RING | 5/16 FLAT BAR/PLATE | C/S ASTM A36 |
| FC | 1 | OUTER STIFFENING REINFORCING SHEET | 16GA. SHEET | C/S ASTM A1101 |
| FD | 1 | REINFORCING BACKING BAR | ¾ FLATBAR/PLATE | C/S ASTM A36 |
| BA | 1 | HANDLE | | C/S ASTM A36 |
| BB | 20 | INSERT HOLDERS | 1¼ SQ. BAR | C/S ASTM A1018 |
| BC | 1 | RETAINING RING | ½ PLATE | C/S ASTM A36 |
| TB | 8 | VERTICAL STIFFENERS | 1¼ X 1¼ X 5/16 SQ. TUBE | C/S ASTM A500 GRADE B |
| AA | 1 | HANDLE ANGLE | ⅛ X ½ X ½ ANGLE | C/S ASTM A36 |
| FK | 1 | CONNECTION RING | ¼ X 1¼ | C/S ASTM A36 |
| SA | 1 | LINER | 16GA. | C/S ASTM A1011 |
| SB | 1 | TOP PLUG SIDE WALL | 16GA. SHEET | C/S ASTM A1011 |
| SC | 1 | TOP PLUG CAP | 16GA. SHEET | C/S ASTM A1011 |
| FE | 20 | THREAD INSERTS | ½-13 X .656 INT. X ¾-10 EXT. | C/S EZ LOK#60158 OR EQUAL |
| FF | 1 | INVERTED FLAT PIPE FLANGE | 1" NPT | C/S FORGING |
| FG | 32 | HEX HEAD BOLTS | ½-13 X 1½ LONG | C/S ZINC PL ASTM SAE J429 GR 5 |
| FH | 32 | LOCK WASHER | ⅛ X ⅞ø | C/S ZINC PLATED |
| FI | 5 | RATCHET VENT PLUG | ¼ X LONG | PLASTIC |
| FJ | 1 | THREADED PIPE PLUG | 1"ø | ACETATE |
| GA | 1 | DRUM LID INNER GASKET | ⅛" THICK | SILICONE RUBBER MED. DENSITY 50-70 DUROMETER |
| GB | 1 | CONTAINMENT GASKET | ⅛THICK | HI TEMP. HEAT RES. SILICONE COATED FIBERGLASS SLEEVE GASKET |
| GC | 1 | VESSEL BOTTOM PAD | | NEOPRENE RUBBER 70-90 DUROMETER |
| IA | A/R | CERAMIC BLANKET | 1½ TO 2" THICK | ALUMINA SILICA BLANKET PER SOP 6.12 |
| IB | 1 | PLUG INSULATOR-BOTTOM BODY | 2⅞" THICK - 6PCF | CI-1 POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |
| IC | 1 | PLUG INSULATOR-DRUM LID | 3 7/16" THICK - 6PCF | CI-1 POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |

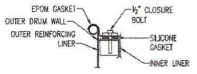
| ITEM NO. | QTY. | PART NAME | DESCRIPTION | MATERIAL |
|---|---|---|---|---|
| IE | 1 | FIBERGLASS RING | ½" TK. | FIBERGLASS PER SOP 6.13 |
| ID | A/R | CERAMIC PAPER | ⅛ THICK | ALUMINA SILICA PAPER PER SOP 6.12 |
| IF | A/R | FIBERGLASS BANDS | ½" TOTAL | FIBERGLASS PER SOP 6.13 |
| NP | 1 | NAME PLATE | 20GA. X 6" X 6" MINIMUM | S/S ASTM 300 SERIES |
| BD | 1 | BACKING BAR | 10GA. SHEET | C/S ASTM A1101 |
| BE | 3 | BACKING BAR | 10GA. SHEET | C/S ASTM A1101 |
| GE | 1 | BUMPER GASKET | ½ | NEOPRENE SPONGE |
| BF | 3 | CONTAINMENT PLUG RETAINING BAR | ¼ X ½ X 6" LONG | C/S ASTM A36 |
| IG | 1 | CONTAINMENT INSULATION PLUG | 3" - 10PCF | CI - POLYURETHANE CLOSED CELL FOAM PER SOP 6.11 |
| NOTE | 1 | (AA & BA) | FOLDING HANDLE MAY BE SUBSTITUTED IN PLACE OF AA & BA COMBINATION | MCMASTER-CARR #1S625A83 OR EQUIVALENT |

NOTE:
1. UNLESS NOTED WELDS ARE MADE USING THE METAL INERT GAS (MIG) METHOD IN ACCORDANCE WITH CENTURY INDUSTRIES WELDING PROCEDURES.
2. DRUM CLOSURE RING BOLT PROVIDES METHOD FOR TAMPER-INDICATING DEVICE THRU ⅛"ø HOLE IN BOLT END



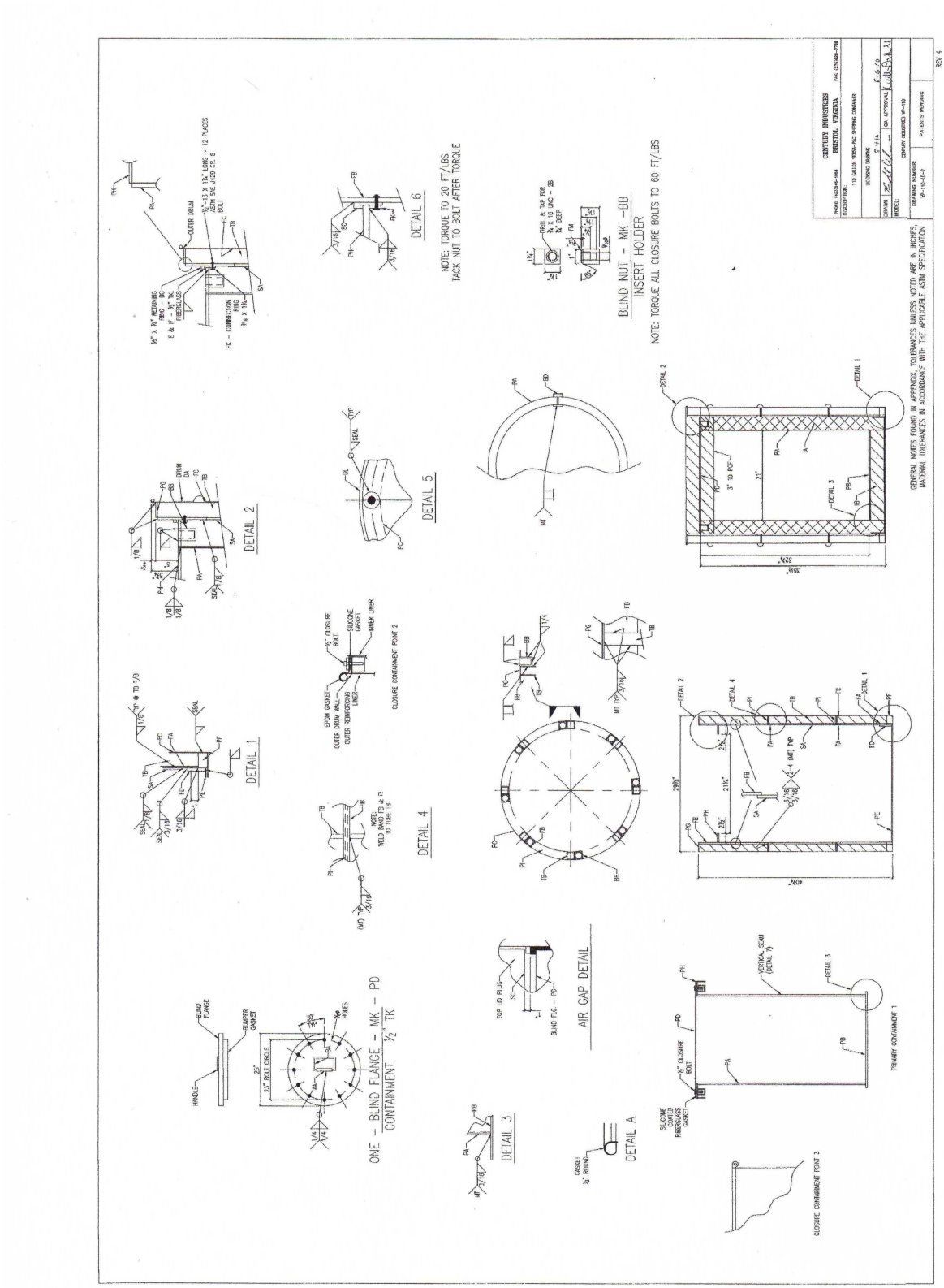

CLOSURE CONTAINMENT POINT 3




CLOSURE CONTAINMENT POINT 2

GENERAL NOTES FOUND IN APPENDIX, TOLERANCES UNLESS NOTED ARE IN INCHES, MATERIAL TOLERANCES IN ACCORDANCE WITH THE APPLICABLE ASTM SPECIFICATION

CENTURY INDUSTRIES
PHONE: 1-423-646-4864 BRISTOL, VIRGINIA FAX: (276)638-7768
DESCRIPTION:
110 GALLON VERSA-PAC SHIPPING CONTAINER
LICENSING DRAWING
DRAWN: 8-4-10 QA APPROVAL: 8-14-10
MODEL: CENTURY INDUSTRIES VP-110
DRAWING NUMBER: VP-110-LD-1 PATENTS PENDING
REV 4


ONE – BLIND FLANGE – MK – PD
CONTAINMENT ½" TK
DETAIL 1
DETAIL 2
DETAIL 3
DETAIL 4
DETAIL 5
DETAIL 6
DETAIL A
AIR GAP DETAIL
BLIND NUT – MK –BB
INSERT HOLDER
NOTE: TORQUE ALL CLOSURE BOLTS TO 60 FT/LBS
NOTE: TORQUE TO 20 FT/LBS
LOCK NUT TO BOLT AFTER TORQUE
CENTURY INDUSTRIES
BRISTOL, TENNESSEE
119 GALLON VERSA-PAC SHIPPING CONTAINER
PRIMARY CONTAINMENT 1
CLOSURE CONTAINMENT POINT 3
GENERAL NOTES FOUND IN APPENDIX. TOLERANCES UNLESS NOTED ARE IN INCHES.
MATERIAL TOLERANCES IN ACCORDANCE WITH THE APPLICABLE ASTM SPECIFICATION
REV 4

## Appendix 1.3.2 - 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.
4. NDT Personnel shall be qualified in accordance with ASNT-TC-1A. Visual personnel may be certified in addition or in lieu of ASNT-TC-1A as an AWS CWI or CAWI.
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 10 CFR 71. 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:

   MFG. By: Century Industries, USA

   S/N: ----------

   Century Versa-Pac VP-(55 or 110)

   Type AF

   Tare Wgt: ------ LB

   ------KG

   Max. Gross Wgt: ----- LB

   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 SOP's.
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: Additional stenciling of the package is at the discretion of the customer.

| | |
|---|---|
| Design ID Number: | USA/----/AF Type A (2” Letters) |
| Model Number: | Century 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.)

# Appendix 1.3.3

**Century Industries**

**Bristol, Virginia**

**Procedure Type:** Standard Operating Procedure

**Procedure No:** SOP 6.11

**Description:** CI-1 Polyurethane Closed Cell Foam Specification for Century 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 | 01/01/04 | All | Original |
| 1 | 04/11/05 | All | Update for Panels |
| 2 | 01/02/09 | All | General Update |
| 3 | 01-01-10 | 6 | Adjustment to Paragraphs 7.2.1 & 7.2.2 |
| 4 | 08-09-10 | 2 | Standard Correction Paragraph 4.5 |

APPROVALS

| | | | |
|---|---|---|---|
| 4 | | | |
| REV | QA MANAGER | OPERATIONS MGR | PRODUCTION MGR |

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the methods of installing CI-1 polyurethane foam in Century Industries products.

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 Century Industries.

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 compressive strength between 80 and 300 psi dependant upon the foam strength required by the product specifications.

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-ºF.

4.4 Flame Retardancy

Testing was performed in accordance with ASTM E84 and meet the minimum requirements.

4.5 Water Absorption and Moisture Content

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

4.6 Chloride Content

Leachable chloride content shall be less than 100 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 two component; rigid polyurethane system that produces a 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. It should be formulated to combine the following desirable combination of processing and foam properties:

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% flame retardant formulation.

6.2.4 Adjust temperature of container to be foamed.

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

6.2.10 Trim excess foam form 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 to 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 Adjust the mold temperature.

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.

6.3.8 Watch for abnormalities.

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

6.3.10 Once the foam has cured, cut to 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.

6.4 Mold Fabrication Foam Procedure – Cutting

6.4.1 Cutting: After curing, each bun will be cut on the wire saw to the required foam panel shape per the instructions provided by the Production Supervisor. Each individual panel shape and orientation will have a unique letter identification assigned to it such as TR (Top Right), TL (Top Left), ET (End Top), EB (End Bottom) and SRB (Side Right Bottom), Etc.

6.4.2 Each shape that is cut will be marked with the Bun Number and the 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 foam samples of each resin batch, meet the leachable chloride content requirement of less than 100 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 100 ppm.

## 8.0 Attachments

8.1 Production Foam Record

8.2 Panel Foam Density Record

# Century Industries UF-1 Production Foam Record

Date: _____ Time: _____ Pour No: _____

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

| Chemical | LBS | Grams | Description |
|---|---|---|---|
| "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**

| | |
|---|---|
| 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: _____

# Appendix 1.3.4

**Century Industries**

**Bristol, Virginia**

**Procedure Type:** Standard Operating Procedure

**Procedure No:** SOP 6.12

**Description:** CI-1 Ceramic Fiber Insulation Specification for Century 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 | 01/01/04 | ALL | Original |
| 1 | 07/03/08 | 2 | Density and Thickness |
| 2 | 06/15/09 | 2 | Addition of Higher Density Materials |
| 3 | 12/12/09 | 2, 3 & 4 | Adjustment to Text and Record Adjustment |

APPROVALS

| | | | |
|---|---|---|---|
| 3 | | | |
| REV | QA MANAGER | OPERATIONS MGR | PRODUCTION MGR |

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the ceramic fiber materials used in Century Industries products

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 Century Industries products.

3.0 BASIC PHYSICAL PROPERTIES

3.1 Paper

Density = 8-10 lbs/$ft^3$

Thickness = 1/8 in.

Thermal Conductivity = Btu-in/hr/$ft^2$ °F (ASTM C 201)

3.2 Blanket

Density = 6, 8 & 12 lb/$ft^3$

Thickness = 0.5 to 3 in.

Thermal Conductivity = Btu-in./hr./$ft^2$/°F (ASTM C 201)

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.

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 in which the insulation was installed.

6.0 Attachments

6.1 Ceramic Fiber Installation Record

## Century Industries CI-1

## Ceramic Fiber Installation Record

**Ceramic Fiber Paper**

| Package Serial Number | Density | Thickness | Manufacturer/Product | Lot/Batch No. |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Ceramic Fiber Blanket**

| Package Serial Number | Density | Thickness | Manufacturer/Product | Lot/Batch No. |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Production Signature: _____ Date: _____

QA Signature: _____ Date: _____

# Appendix 1.3.5

**Century Industries**

**Bristol, Virginia**

**Procedure Type:** Standard Operating Procedure

**Procedure No:** SOP 6.13

**Description:** Structural Fiberglass Component Specification for Century 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 | 11/10/08 | ALL | Original |
| 1 | 12/12/09 | 4, Paragraph 4.1 | Storage Requirement Completion |

APPROVALS

| | | | |
|---|---|---|---|
| 1 | | | |
| REV | QA MANAGER | OPERATIONS MGR | PRODUCTION MGR |

1.0 PURPOSE

1.1 The purpose of this procedure is to describe the structural fiberglass component materials used in Century Industries products

2.0 SCOPE

2.1 The scope of this specification shall cover material requirements for the structural fiberglass components utilized in Century Industries 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] | $2.6 \times 10^6$ psi | Full Section |
| Modulus of Elasticity >4"[1] | $2.5 \times 10^6$ 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/$^o$F | C177 |
| **Electrical** | | |
| Arc Resistance, LW | 120 Seconds | D495 |
| **Flammability** | | |
| Tunnel Test | 25 Maximum | E84 |
| Flammability | Self Extinguishing | D635 |

LW – Lengthwise CW – Crosswise

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.

**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.