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**Developments that are making the Versa-Pac Indeed More Versatile
(and more useful to the industry)**

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Abstract

The Versa-Pac is a certified Type AF packaging (USA NRC Certificate # USA/9342/AF-96), often used as a package for waste disposal, continuous content additions have improved the versatility of the package resulting in expanded uses for the industry.. The Versa-Pac can be used directly or in conjunction with pails, drums, or inserts, and a variety of smaller containers and vessels.

The Versa-Pac comes in two sizes, the VP-55 (i.e., 200-liter drum version) and VP-110 (i.e., 400-liter drum version). It features a patented design in combination with the drum exterior to provide enhanced structural protection to payloads under Normal Conditions of Transport and Hypothetical Accident Conditions.

Since its introduction in 2010, the Versa-Pac has been utilized mainly as a one-time use package for disposing of radioactive waste. However, the Versa-Pac package, which has the familiar simplicity of a drum, is a reusable transport package with the capability of shipping a variety of radioactive materials.

In the spirit of simplicity yet versatility, the package has experienced numerous improvements in collaboration with our customers. The latest design improvements to be licensed in February 2016 includes a new configuration designated the VP-55HC (high capacity), which includes an internal safe geometry pipe container to further increase the U-235 capacity. The pipe container is similar in design to the historic USDOT 2R vessel.

Other planned and proposed improvements include provisions include increasing the capacity of the VP-110, developing a new lighter 113-liter version of the package, and introducing content limits specific to uranium-oxides in multiple forms. This paper traces the engineering and design efforts involved in expanding the Versa-Pac's versatility.

Introduction

The Versa-Pac is a package that can be used to store, transport, or dispose of any uranium compound at any U-235 enrichment. The Versa-Pac packaging design meets all USDOT^[1], USNRC^[2], and IAEA^[3] regulatory requirements of a Type AF package. All design and licensing efforts for the Versa-Pac are aimed at providing a familiar, simple-to-use packaging that is versatile enough to meet customers' current and future needs. The drum style design of the Versa-Pac makes operations and handling of the package similar to the routine operations at any facility. The lack of content restrictions on allowable uranium compounds and wide range of allowable pre-packaging materials make the Versa-Pac ideal for a wide variety of storage, transport, and disposal needs. While the Versa-Pac currently offers a convenient design with a high degree of flexibility in the allowable contents, improvements are continually being made to the package and its license to meet the needs of all current and potential customers. Figure 1 provides a 3D rendering of the Versa-Pac package.



Figure 1 – The Versa-Pac Package

Standard Versa-Pac Design

Figure 2 provides a cross section view of the Versa-Pac design. Pre-packaged or loose contents can be directly loaded into the Versa-Pac cavity. The components of the packaging provide sufficient thermal and impact protection to assure the safe transport of the enclosed radioactive contents.

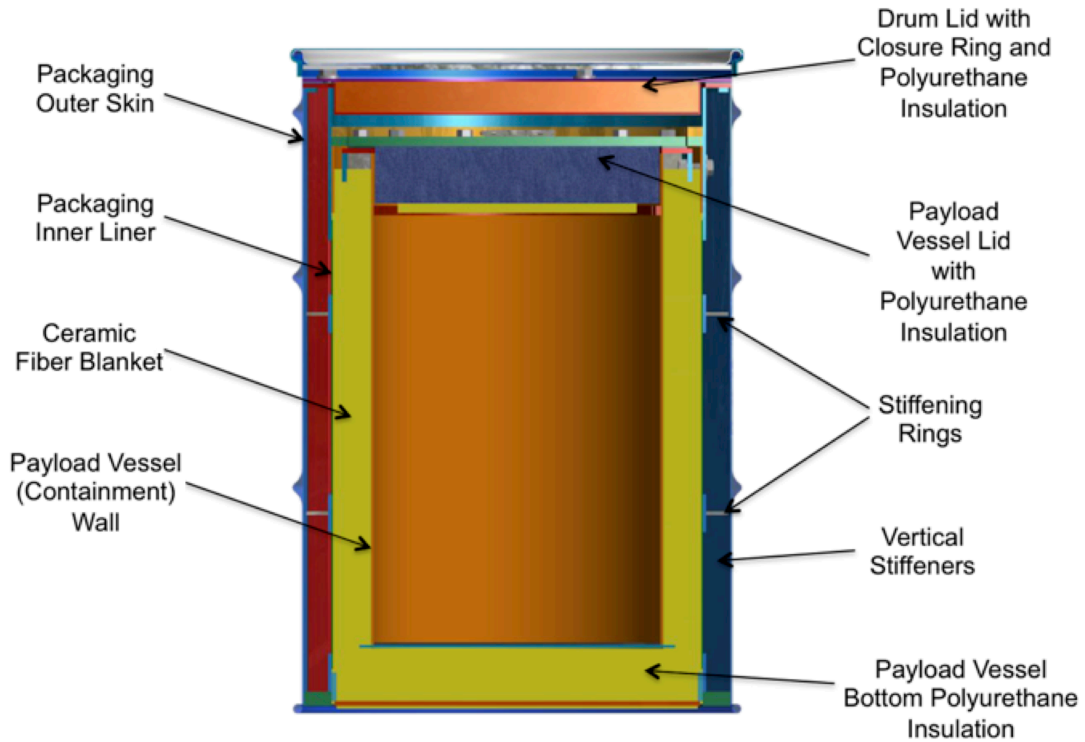


Figure 2 – Components of the Versa-Pac design

The initial license for the Versa-Pac allowed for shipping up to 350 gU235 in Uranium compounds enriched up to 100 wt%. One of the more recent improvements to the package license is the addition of a loading curve, allowing for greater quantities of U-235 to be shipped for Uranium at lower levels of enrichment. The current allowable U-235 mass payload limits for the Versa-Pac, by enrichment, are listed in Table 1. The Versa-Pac can also transport natural thorium in any form, with no limits on thorium mass.

Table 1 – Standard Versa-Pac Design Allowable Payloads by Enrichment

Wt.% U-235	Mass U-235 (g)	Mass U (g)
5	580	11,600
10	470	4,700
20	410	2,050
100	350	350

Versa-Pac High Capacity Design

To increase the payload capacity of the Versa-Pac, the option to use the “High Capacity” configuration was added to the package license. By restricting the radioactive contents in the package to a 5-inch inner diameter pipe, the U-235 mass limits for the package increase significantly. For this configuration, the radioactive contents are loaded into the licensed 5-inch pipe container design that is closed with a simple screw-on cap similar to the historic USDOT 2R vessel. This 5-inch pipe can then be loaded into a standard Versa-Pac package, with or without any additional shoring. The 5-inch pipe used in the High Capacity configuration of the Versa-Pac package is shown in Figure 3.

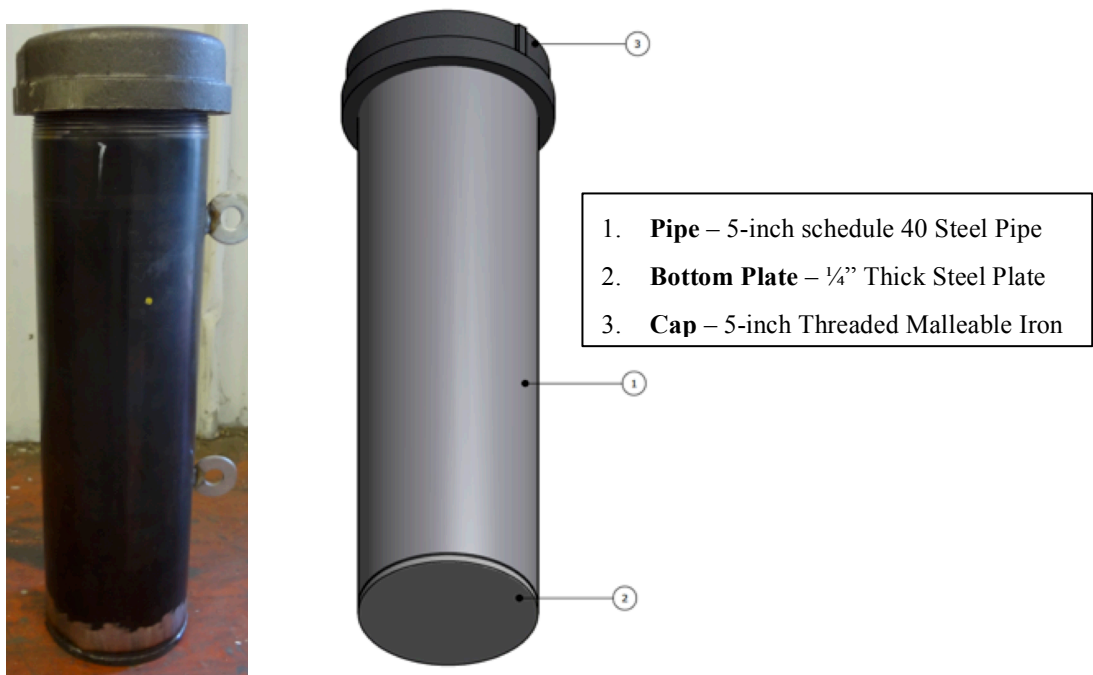


Figure 3 – High Capacity Versa-Pac 5-inch Pipe Container Design

While the Versa-Pac packaging still provides all of the required thermal and impact protection for the radioactive contents in the payload, the 5-inch pipe restricts the fissile contents to a smaller, non-spherical geometry. Restricting the geometry of the fissile contents allows for a significantly larger quantity of U-235 to be loaded into a single package. The pipe container design was drop tested independently to show the USNRC^[2] and IAEA^[3] regulatory requirements were met for Hypothetical Accident Conditions of a fissile package. Due to the thermal protection design of the packaging and the resultant low internal temperature, no additional thermal tests were required for the pipe container design. Shoring may be used and is recommended for the pipe secure fitting in the cavity, but is not a license requirement. The safety case assessment increased the allowable U-235 mass payload limits by enrichment for the High Capacity Versa-Pac configuration; mass limits are listed in Table 2.

Table 2 – High Capacity Versa-Pac Design Allowable Payloads by Enrichment

Wt.% U-235	Mass U-235 (g)	Mass U (g)
5	1,065	21,300
10	1,605	16,050
20	1,215	6,075
100	695	695

Future Licensing Changes and Additions

In the spirit of simplicity yet versatility, continuous content assessments have expanded the capability of the package without changing the packaging design. Future developments will include evaluating content densities and crediting contents configurations. The assessment of content specifications allow for an optimized payload for the content type. Crediting content density, such as the reduced density of UO₂ powder as compared to the current content evaluation of U-metal, will result in an increase in the quantity of material per package. Evaluating the content configuration, such as research reactor fuel element geometry, in conjunction with packaging design changes can further optimize the package and versatility of uses. Additionally, packaging enhancements to the thermal performance of the package can allow for the assessment of slightly irradiated or low specific activity material.

For fissile packages, the engineering analyses are based around the criticality safety assessment of the package, and assurance of compliance to USNRC^[2] and IAEA^[3] regulatory requirements. If packaging changes are incorporated, then the impact to structural and thermal basis is assessed. For minor changes, the approved safety analysis may be bounding and no changes to the license are required. However, any revision to the package design or engineering basis would then require revision of the safety analysis report and amendment to the license. For the Versa-Pac, the base certificate is approved by the USNRC and thus license amendments begin with the USNRC review.

Continuous improvements of the Versa-Pac package, through the assessment of content specifications and package enhancements, allows for an optimized payload, often resulting in an increase in the quantity of material per package and the uses of the package.

Conclusions

The Versa-Pac package design provides a highly versatile storage, transport, and disposal option for a wide variety of customers and applications. Recent improvements to the Versa-Pac license have provided additional flexibility to the allowable contents for the package. Additional improvements to the package are consistently being made to meet current customer needs and to meet the needs of the nuclear industry in the future.

References

1. United States Department of Transportation (USDOT), Title 49, Code of Federal Regulations Part 173, Subpart I - Class 7 (Radioactive) Materials, 2016.
2. United States Nuclear Regulatory Commission (USNRC), Title 10, Code of Federal Regulations Part 71 – Packaging and Transportation of Radioactive Material, 2016.
3. International Atomic Energy Agency, (IAEA), "Regulations for the Safe Transport of Radioactive Material," IAEA Safety Standard SSR-6, 2012.