



## RECENT APPROVAL OF THE UX-30 AS A TYPE B PACKAGE

**Mark Whittaker**  
EnergySolutions  
140 Stoneridge Dr.  
Columbia, SC, USA 29210

### ABSTRACT:

The UX-30 packaging has recently been authorized by USNRC as a Type B(U)F package for transport of greater than Type A quantities of recycled UF<sub>6</sub> in 30B or 30C cylinders. The contents are limited by: the quantity of uranium hexafluoride, the fission product gamma activity and the transuranic alpha activity, the hydrogen to uranium atomic ratio, and the total activity. The use of the packaging for transport of Type B quantities of uranium hexafluoride requires that the 30B or 30C cylinder containing the uranium hexafluoride meet the leak test criterion of “leak tight”. A maintenance requirement has been added to specify annual testing of 30B or 30C cylinders used for Type B quantities of reprocessed uranium hexafluoride. The USDOT has endorsed this approval and approvals have been requested in various other countries. The paper discusses the specific requirements of the newly authorized contents along with the additional leak test conditions that apply to this expanded content. The current status of endorsement by other countries is also presented.

### INTRODUCTION:

With the increasing availability of reprocessed uranium, there is a need for packages to transport the uranium hexafluoride (UF<sub>6</sub>) produced from reprocessed uranium. Since reprocessed uranium may contain greater than Type A quantities of fission products and transuranics, the Type AF UX-30 package was not authorized to transport UF<sub>6</sub> produced from reprocessed uranium. Evaluation of the Type B package criteria showed that, with certain constraints, the UX-30 would meet the Type B requirements.

EnergySolutions revised the UX-30 Safety Analysis Report (SAR) to show compliance with Type B criteria with the inclusion of reprocessed uranium as contents by incorporating certain restrictions on the additional radionuclide content of the reprocessed uranium, specifying enhanced leak testing for cylinders containing a Type B quantity of UF<sub>6</sub> contents and revising the shielding evaluation. Based on the demonstration of compliance in the revised SAR, EnergySolutions requested a revision to Certificate of Compliance (CoC) No. 9196 for the UX-30 package, specifically requesting that the contents be amended to include reprocessed uranium in the form of uranium hexafluoride (UF<sub>6</sub>) in greater than a Type A quantity.

US Nuclear Regulatory Commission (USNRC) staff reviewed the application using the guidance in NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material".

Based on the statements and representations in the application, USNRC staff agreed that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71. Thus, the UX-30 packaging was authorized by USNRC on April 14, 2009, with the issue of Revision 24 of CoC No.9196 [1], as a Type B(U)F package for transport of greater than Type A quantities of unirradiated uranium and reprocessed uranium, in the form of UF<sub>6</sub>, in 30B or 30C cylinders. The expiration date of Revision 24 is 28 February 2011.

### DESCRIPTION OF UX-30:

The package consists of two components: 1) An ANSI 14.1 standard 30B or 30C cylinder, and 2) a UX-30 overpack. The UX-30 is a horizontal right circular cylinder; 96 inches long by 43.5 inches in diameter (see Figure 1). A horizontal parting plane allows the top half of the overpack to be removed, providing easy access to the cylinder.

All exposed surfaces of the UX-30 are fabricated from ASTM A240 304 stainless steel. The space between the inner and outer overpack shells is filled with an energy-absorbing and insulating closed-cell polyurethane foam material. The foam material is a rigid closed-cell polyurethane foam with well-documented mechanical and thermal capabilities. Six inches of this foam completely encase the UF<sub>6</sub> cylinder.

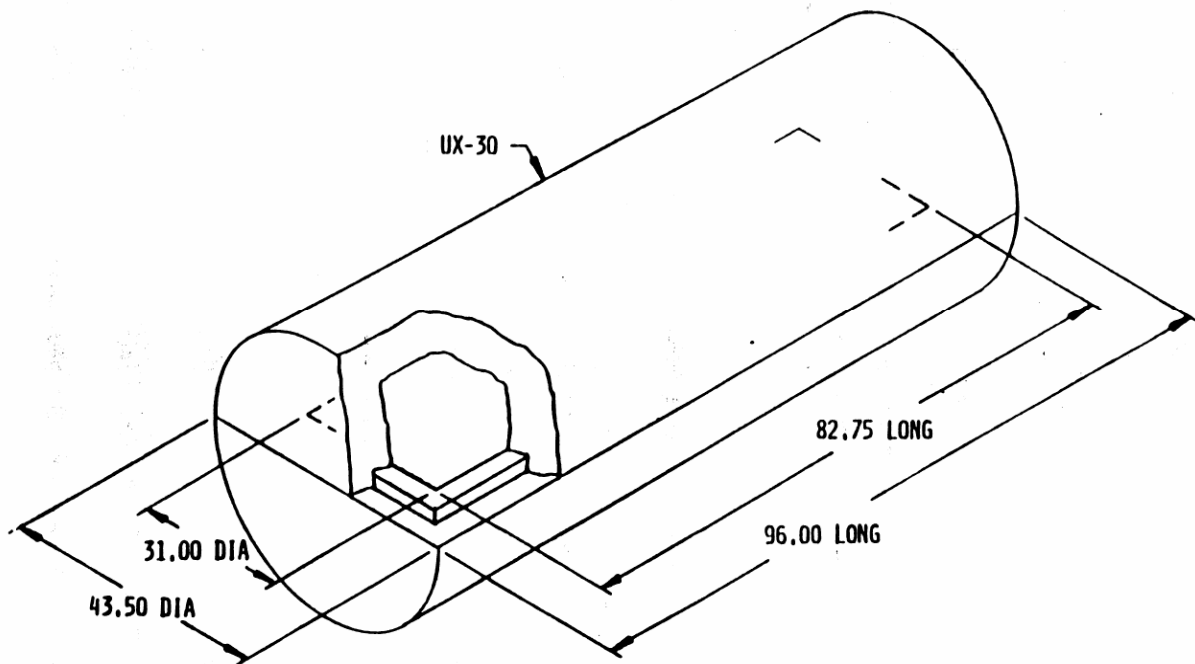


FIGURE 1  
UX-30 Package Dimensions



## **AUTHORIZED CONTENTS IN CERTIFICATE OF COMPLIANCE NO. 9196, Rev.24:**

### (1) Type and form of material

- A. Unirradiated uranium, in the form of  $UF_6$ , with a U-235 mass percentage not to exceed 5 weight percent.
- B. Reprocessed uranium, in the form of  $UF_6$ , with a U-235 mass percentage not to exceed 5 weight percent. The fission product gamma activity shall not exceed  $4.4 \times 10^5$  MeV<sup>3</sup> Bq/kgU. The alpha activity from neptunium and plutonium shall be less than  $3.3 \times 10^3$  Bq/kgU.

### (2) Maximum quantity of material per package

5,020 pounds  $UF_6$  contained in a 30B or 30C cylinder, which meets the requirements of ANSI Standard N14.1[2]. The maximum H/U atomic ratio for the  $UF_6$  is 0.088. The total activity in the package may not exceed  $10^5$  A<sub>2</sub>.

## **DEMONSTRATION OF COMPLIANCE IN THE REVISED SAR:**

### Structural and Thermal Evaluation:

The addition of reprocessed uranium as authorized contents did not affect the maximum quantity of  $UF_6$ . Thus, the addition did not change the previous structural or thermal evaluations showing the regulatory requirements were met.

### Containment Evaluation:

The use of the packaging for transport of Type B quantities of uranium hexafluoride requires that the 30B or 30C cylinder containing the uranium hexafluoride meet the leak test criterion of "leak tight". For the leakage rate test of cylinders used for recycled  $UF_6$ , the cylinder must have a measured leak rate of less than  $1 \times 10^{-7}$  cm<sup>3</sup>/sec. The leakage rate tests are performed per ANSI N14.5-1997[3] using a leak test with a test sensitivity of at least  $5 \times 10^{-8}$  ref-cm<sup>3</sup>/sec prior to first use of each cylinder, after maintenance, repair or replacement of components of the containment system, and periodically at intervals not to exceed 12 months. Pre-shipment leak tests must show no detectable leakage when performed using a leak test with a sensitivity of at least  $1 \times 10^{-3}$  ref-cm<sup>3</sup>/sec per ANSI N14.5-1997.

### Shielding Evaluation:

Since the primary shielding concern involving  $UF_6$  from reprocessed uranium is gamma radiation, EnergySolutions used the MicroShield[4] point kernel code for calculating potential external dose rates. The gamma source is limited to  $4.4 \times 10^5$  MeV Bq/kgU from fission



products, based on the limits of ASTM C 996[5]. These fission products are primarily  $^{144}\text{Ce}$ ,  $^{134}\text{Cs}$ ,  $^{137}\text{Cs}$ ,  $^{95}\text{Nb}$ ,  $^{103}\text{Ru}$ ,  $^{106}\text{Ru}$ ,  $^{99}\text{Tc}$  and  $^{95}\text{Zr}$  [6]. The energy of the gammas from these radionuclides ranges from 0.5 to 0.795 MeV. To ensure conservatism in the dose rate results, the gammas for the model source term were assumed to be at 1 MeV. With the maximum amount of  $\text{UF}_6$ , which is 5020 lbs or 1543 kg, the photon activity is  $6.789 \times 10^8$  photons/sec. In addition, the shielding model assumed that the entire cylinder was uniformly filled with  $\text{UF}_6$  having a density of  $2.77 \text{ g/cm}^3$  versus the actual  $\text{UF}_6$  density of  $5.09 \text{ g/cm}^3$ . This assumption conservatively reduces the self absorption from the  $\text{UF}_6$ . As shown in Table 1, the external dose rates for the UX-30 package comply with the limits specified in 10 CFR 71.47 and 10 CFR 71.51.

**Table 1- External Dose Rates**

Condition	Package Surface mSv/hr (mrem/hr)	1m from Surface mSv/hr (mrem/hr)
Normal Conditions of Transport		
End	0.0171 (1.71)	0.0018 (0.18)
Side	0.0165 (1.65)	0.0039 (0.39)
Allowable	2.0 (200)	NA
Hypothetical Accident Conditions		
End	0.0414 (4.14)	0.0033 (0.33)
Side	0.0386 (3.86)	0.0062 (0.62)
Allowable	NA	10 (1000)

Package Operations:

Specific requirements for leak testing of cylinders containing a Type B quantity of  $\text{UF}_6$  have been added to the loading instructions.

Pre-Shipment Leak Test:

The filled cylinder valve is tested by leak rate testing. The test is performed by connecting a pressure gauge manifold, which has a void volume of  $55 \text{ cm}^3$  or less, to the valve and pressurizing the manifold volume with dry air or nitrogen. The test must be performed using a calibrated pressure gauge, accurate within 1%, or less, of full scale. The test pressure shall be applied for at least 15 minutes. A drop in pressure of greater than the minimum detectable amount shall be cause for test failure. Sensitivity at the test conditions is equivalent to the prescribed procedure sensitivity of  $10^{-3} \text{ ref-cm}^3/\text{sec}$  based on dry air at standard conditions as defined in ANSI N14.5-1997

Alternatively, a vacuum test may be performed on the cylinder (Note: the cylinder's outer surface shall be approximately at ambient temperature and its vapor pressure below atmospheric pressure) by attaching a pigtail to the closed valve and drawing a



vacuum. The continued presence of UF<sub>6</sub> in the pigtail is an indication that the valve is not fully closed or is defective, and corrective measures shall be taken to remedy the leak as prescribed by the facility's operating procedures.

#### Acceptance Tests And Maintenance Program:

The acceptance tests and maintenance requirements were revised to describe the requirements for acceptance testing and maintenance of the UF<sub>6</sub> cylinders with Type B quantity contents.

Acceptance Tests For The 30B or 30C Cylinder Used For Transport of a Type B Quantity of UF<sub>6</sub> - The cylinder must have a measured leak rate less than  $1 \times 10^{-7}$  cm<sup>3</sup>/sec. The acceptance leak test of the 30B or 30C cylinder used for reprocessed UF<sub>6</sub> will be performed using Method A.5.4 Evacuated Envelope of ANSI N14.5-1997. The cylinder is evacuated to a 90% vacuum and then pressurized with helium to approximately 1 psig. The pressurized cylinder is placed in a sealable container connected to a helium mass spectrometer leak detector. The container is sealed and evacuated until the vacuum is sufficient to operate the helium mass spectrometer leak detector and the helium concentration in the container void is monitored. The acceptance criterion is  $1.0 \times 10^{-7}$  atm-cm<sup>3</sup>/sec of air (leaktight). The detector sensitivity must be less than or equal to  $5.0 \times 10^{-8}$  atm-cm<sup>3</sup>/sec.

Maintenance Program for 30B or 30C Cylinders Used For Transport of a Type B Quantity of UF<sub>6</sub> - The cylinder must have been tested within 12 months prior to shipment to demonstrate a measured leak rate less than  $1 \times 10^{-7}$  cm<sup>3</sup>/sec. The acceptance leak test of the 30B or 30C cylinder used for reprocessed UF<sub>6</sub> will be performed using Method A.5.4 Evacuated Envelope of ANSI N14.5-1997. The cylinder will be evacuated to a 90% vacuum and then pressurized with helium to approximately 1 psig. The pressurized cylinder is placed in a sealable container connected to a helium mass spectrometer leak detector. The container is sealed and evacuated until the vacuum is sufficient to operate the helium mass spectrometer leak detector and the helium concentration in the container void is monitored. The acceptance criterion is  $1.0 \times 10^{-7}$  atm-cm<sup>3</sup>/sec of air (leaktight). The detector sensitivity must be less than or equal to  $5.0 \times 10^{-8}$  atm-cm<sup>3</sup>/sec.

#### **COMPETENT AUTHORITY ENDORSEMENT:**

EnergySolutions submitted a request for endorsement of the USNRC approval to the US Department of Transportation (USDOT) on 6 August 2009. The USDOT endorsement states; "This certifies that the radioactive material package design described has been certified by the Competent Authority of the United States as meeting the regulatory requirements for a Type B(U)F packaging for fissile radioactive material as prescribed in the regulations of the International Atomic Energy Agency and the United States of America." [7]

Endorsements of the USDOT certification have been requested in other countries by various UX-30 users. A majority of countries that received a request for endorsement have approved use of



the UX-30 as a Type B(U)F package. Some countries have approved use with specific restrictions or granted limited approval for use as a Type AF package. The current status of endorsement is shown in Table 2

**Table 2 – Endorsement Status**

<u>Country</u>	<u>Certificate</u>	<u>Expiration</u>
Belgium	RIS/8.3USA.9196.10.074	28/02/2011
Canada	CDN/E150/-96 Rev 18	02/02/2011
France	F/837/X (with specificities) or F/838/X	both 15/10/2010
Germany	D/5426/B(U)F-96 Rev.0	28/02/2011
Netherlands	NL/0229/AF-96 Rev. 2	28/02/2011
Russia	RUS/2332/B(U)F-96T Rev. 3	28/02/2011
Sweden	2009/4568	28/02/2011
United Kingdom	USA/9196/B(U)F-96(1) Issue 1	28/02/2011
Korea	ROK/0005/B(U)F-96 (Rev.5)	28/02/2011

EnergySolutions plans to request a renewal of the USNRC certificate before the end of 2010 and intends to request USDOT endorsement on receipt of the renewed USNRC certificate.

**CONCLUSION:**

The UX-30 package is authorized by the USNRC and USDOT for the shipment of Type B quantities of reprocessed uranium in the form of UF<sub>6</sub>. With the endorsement by additional countries, the UX-30 can be used for international shipments of reprocessed uranium in the form of UF<sub>6</sub>.

**REFERENCES:**

1. USNRC Certificate of Compliance 9196, Revision 24, April 14, 2009, Washington, DC
2. ANSI N14.1-2001, “American National Standard for Nuclear Materials – Uranium Hexafluoride – Packaging for Transport”, 2001
3. ANSI N14.5-1997, “American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment,” 1997
4. MicroShield
5. ASTM C 996 - 04 “Standard Specification for Uranium Hexafluoride Enriched to Less Than 5 % <sup>235</sup>U”, 2004
6. ASTM C1295 -05, Standard Test Method for Gamma Energy Emission from Fission Products in Uranium Hexafluoride and Uranyl Nitrate Solution, 2005
7. Competent Authority Certification For A Type B(U)F Fissile Radioactive Materials Package Design Certificate USA/9196/B(U)F-96, Revision 27, 2009