Attachment 4

4.0 CONTAINMENT

4.1 Description of Containment System

The UX-30 is designed for use in conjunction with a standard 30-inch UF_6 cylinder such as the models 30B or 30C described in ANSI N14.1, Packaging of Uranium Hexafluoride for Transport. The cylinder provides the containment boundary for the package. See drawings of the cylinders in Figure 1.2-2 and 1.2-3 or ANSI N14.1.

4.1.1 Containment Boundary

Containment Vessel

The design specifications for the UF_6 cylinder are given in ANSI N14.1, and as shown in Figure 1.2-2 for the 30B or 1.2-3 for the 30C, which are taken from ANSI N14.1. These documents list the following design conditions for the cylinders:

Design Pressure:	25 psig external
	200 psig internal
Design Temperature:	-40°F to 250°F

Containment Penetrations

The 30B and 30C cylinders are penetrated in two places: the fill valve on one end and a drain plug on the other end. The performance specifications of these components are the same as for the cylinder.

Note: The 30C cylinder has a Valve Protective Cover (VPC) to provide additional assurance against water intrusion into the cylinder. However, the VPC is not part of the containment boundary for the package.

Seals and Welds

Welds on the containment vessel are as shown in Figure 1.2-2 for the 30B, and in Figure 1.2-3 for the 30C cylinder. Pipe thread seals are indicated around the valve and drain plug threads. Performance specifications for all containment welds and threads are identical to those for the cylinder.

Closure

The fill valve and drain plug are used as closure devices on the cylinder. They shall be installed (as per the requirements of ANSI N14.1-2001) using 200 - 400 ft-lbs. of torque. The valve shall have 7 - 12 threads engaged, and the plug shall have 5 - 8 threads engaged.

4.2 Containment Under Normal Conditions of Transport

4.2.1 Containment of Radioactive Material

Recycled UF_6 (produced from reprocessed spent fuel) contains uranium isotopes, primarily ^{235}U and ^{238}U, which have unlimited A_2 values, with traces of ^{232}U, ^{234}U, and ^{236}U and also includes small amounts of transuranics, principally Np and Pu, and fission products, primarily ^{144}Ce, ^{134}Cs, ^{137}Cs, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{99}Tc and ^{95}Zr and is often a Type B quantity. Using the methodology of ANSI N14.5-1997, a maximum allowable leak rate for a Type B shipment of recycled UF_6 in a 30B or 30C cylinder can be determined. Irrespective of the actual calculated leak rate, to preclude inleakage of moist air or water (the criticality safety of the package depends on excluding water from the containment system), the cylinder must have a leak rate of less than 1×10^{-7} cm^3/sec. The package evaluation in Section 2 shows that the cylinders are capable of maintaining this condition under normal and hypothetical accident conditions.

4.2.2 Containment Vessel Pressure

Containment for the UX-30 is provided by the 30B or 30C cylinders. A cylinder is filled with liquid UF_6 and cooled allowing the UF_6 to solidify. The internal pressure of a cylinder, under normal conditions of transport is less than 11 psia (see Section 3.4.2).

4.2.3 Containment Criteria

Containment of the radioactive contents depends on proper maintenance, periodic inspections, and pre-shipment inspections of the packaging. For the leakage rate test of cylinders used for recycled UF_6, the cylinder must have a measured leak rate less than 1×10^{-7} cm^3/sec. The leakage rate tests are performed per ANSI N14.5-1997 using a leak test with a test sensitivity of at least 5×10^{-8} ref-cm^3/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 x 10^{-3} ref-cm^3/sec per ANSI N14.5-1997. Specifics of the tests for meeting these requirements are found in Chapters 7 and 8.

4.3 Containment Under Hypothetical Accident Conditions

4.3.1 Containment of Radioactive Material

Using the methodology of ANSI N14.5-1997, a maximum allowable leak rate for a Type B shipment of UF_6 in a 30B or 30C cylinder can be determined. However, to preclude inleakage of moist air or water (criticality safety of the package depends on excluding water from the containment system), the package must have a measured leak rate less than 1 x 10^{-7} cm^3/sec (see Section 4.2.3).

4.3.2 Containment Vessel Pressure

Containment for the UX-30 is provided by the 30B or 30C cylinders. A cylinder is filled with liquid UF_6 and cooled allowing the UF_6 to solidify. The internal pressure of a cylinder, under hypothetical accident conditions is dependant on the temperature of the UF_6 in the cylinder. The thermal analysis (see Section 3.5.3) shows most of the UF_6 is at 117°F while a portion of the UF_6 can be assumed to be 200°F or less. For the purposes of the leak rate evaluation, the UF_6 temperature will be assumed to be 200°F. The resulting internal pressure is 51 psia [1].

4.4 None

[1] ORNL/ENG/TM-51, "Correlation of the Thermophysical Properties of Uranium Hexafluoride over a Wide Range of Temperature and Pressure", August 1994

5.0 SHIELDING EVALUATION

5.1 DESCRIPTION OF DESIGN FEATURES

The UX-30 is essentially a foam filled overpack designed to hold a 30" UF_6 cylinder. The UX-30 packaging encloses a standard ANSI N14.1 30B cylinder (or its equivalent), hereafter referred to as the cylinder. The UX-30 is a horizontal right circular cylinder, 96 inches long by 43.5 inches in diameter. A horizontal parting plane allows the top half of the UX-30 to be removed, providing easy access to the cylinder. (Refer to Section 1.2.3 for packaging contents.) Tests and analysis performed under chapters 2.0 and 3.0 have demonstrated the ability of the package to maintain its integrity under normal conditions of transport.

The package shielding is sufficient to satisfy the dose rate limit of 10CFR71.51(a) (2) which states that any shielding loss resulting from the hypothetical accident will not increase the external dose rate to more than 1000 mrem/hr at one meter from the external surface of the cask.

5.1.1 Shielding Design Features

The UX-30 has 6.19" of polyurethane foam contained between a 14 gauge stainless steel inner shell and a 12 gauge stainless steel outer shell. The 30" cylinder has a nominal ½" steel wall that has a minimum thickness of 0.312" specified in 49 CFR 173.420. See Section 1 for drawings of the 30" cylinders and the UX-30 overpack.

Table 5.1
Package Components

COMPONENT	MATERIAL	DENSITY (g/cc)	DIMENSIONAL TOLERANCE
Outer Shell	SS Type 304	7.9	Mill std
Foam	Polyurethane	0.125	nominal
Inner Shell	SS Type 304	7.9	Mill std
Cylinder	Carbon steel	7.86	Mill std

The foam density is specified in the foam specification, Appendix 8.3.1 in Chapter 8.

5.1.2 Maximum Radiation Levels

Table 5.2 gives the Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC) dose rates for the UX-30 with a 30" cylinder filled with recycled UF_6. Maximum allowable dose rates given in 10CFR71 are shown in the tables for comparison.

Table 5.2
Summary of Maximum Radiation Levels

Condition	Package Surface (mrem/hr)	1m from Surface (Transport Index) (mrem/hr)
NCT		
Calculated	1.71	0.39
Allowable	200	10
HAC		
Calculated	NA	0.62
Allowable	NA	1000

5.2 Source Specification

The UX-30 is designed to hold a 30" cylinder containing 5020 lbs. of UF_6. UF_6 is a solid at transport temperatures with a density of 5.09 g/cc. Only recycled UF_6 contains any significant sources of penetrating radiation.

5.2.1 Gamma Source

The gamma source is limited to 4.4 X 10^5 MeV Bq/kgU from fission products. These fission products are primarily ^{144}Ce, ^{134}Cs, ^{137}Cs, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{99}Tc and ^{95}Zr. The energy of the gammas from these radionuclides range from 0.5 to 0.795 MeV. The source photons are conservatively assumed to have an energy of 1 MeV. The maximum amount of UF_6 is 5020 lbs which equates to 1543 kgU. Thus, the photon activity is 6.789 x 10^8 photons/sec.

Table 5.3
Gamma Source

Photon Energy	**Intensity**
MeV	**Photons/sec**
1.0	6.789e+08

5.22 Neutron Sources

There are no significant sources of neutron radiation in the UF_6 contained in the UX-30 (Reference 5-1).

5.3 Model Specification

5.3.1 Configuration of Source and Shielding

The source is the UF_6 which fills the interior of the 30" cylinder.
The nominal dimensions of the cylinder and UX-30 shield layers are given in Table 5.4

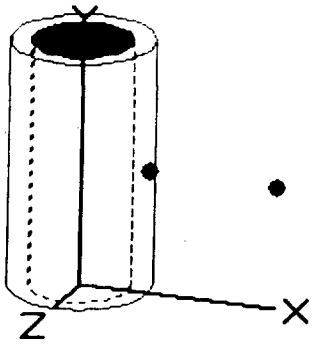
Table 5.4
Model Shielding Elements

Component	**Material**	**Dimension (in)**	
Cylinder Cavity	UF_6	29 (ID) x 76 (L)	
		Thickness (in)	
		NCT	**HAC**

Cylinder Wall	Carbon steel	0.312	0.312
Inner Shell (side)	SS 304	0.0781	0
Inner Shell (end)	SS 304	0.25	0
Foam (side and end)	polyurethane	6.1875	0
Outer Shell (side and end)	SS 304	0.1094	0

For this geometry and wall configuration, the maximum dose rate on the side will be at the mid-point of the length of the cylinder. Thus, only dose rates at these locations were calculated.

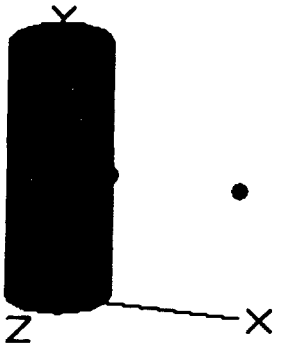
Figure 5.1
UX-30 NCT



Under NCT, the UF_6 in the cylinder is assumed to fill the cylinder interior cavity. The cylinder is surrounded by the foam overpack.

Under HAC, the overpack is conservatively ignored and dose rates from the cylinder alone are calculated.

Figure 5.2
HAC



5.3.2 Material Properties

The properties of the shield materials are given in Table 5.1.

5.4 Shielding Evaluation

5.4.1 Methods

The shielding evaluation is performed using MicroShield, a point-kernal shielding code(Ref. 5-1).

The NCT calculations for the side were performed using the cylindrical volume side shields model. For the ends, the cylindrical volume end shields model was used.

The HAC calculations for the side were performed using the cylindrical volume side shield model using only the cylinder wall as a shield. For the ends, the cylindrical volume end shields model was used, again, with only the cylinder wall used as a shield

Dose points were selected at the mid-point of the side at contact (1 cm) and at 1m and on the end at contact (1cm) and at 1m.

5.4.2 Input and Output Data

The key inputs to MicroShield are the package geometry , the materials, and the source. Two geometry models were used, the cylindrical volume side shield and the cylindrical volume end shield.
The cylindrical volume side shield model has a cylindrical source with cylindrical shell or slab shields. For the UX-30, all side shields are set as cylindrical shields. For the end shield model, the shields are slab shields. The dimensions of the model are given in Table 5.4. Dose points on the side were selected at the mid-point of the side at contact (1 cm) and at 1m. Dose points on the end were selected on the centerline of the cylinder, on contact (1cm) and at 1m.

The materials are as defined in Table 5.1. Custom material files were created for SS 304, polyurethane, and UF_6. UF_6 is transported as a solid with a density of 5.09 g/cm^3. For the MicroShield model, the maximum quantity of UF_6 (5020 lbs.) is assumed to uniformly fill the cylinder cavity with an assumed density of 2.77 g/cm^3.

The source term is defined by photon energy (1 MeV) and the activity (6.789×10^8 photons/sec).

5.4.3 Flux-to-Dose-Rate Conversion

MicroShield automatically converts photon flux to exposure rate in air (mR/hr) using the Table 11 of ICRP 51(Ref. 5-3). Exposure rate was converted to dose rate (mrem/hr) with a conservative conversion factor of 1.

5.4.4 External Radiation Levels

The dose rates under NCT and HAC are shown in Table 5.7

Table 5.7
ExternalDose Rates

Condition	Package Surface (mrem/hr)	1m from Surface (Transport Index) (mrem/hr)	MicroShield Files
NCT			
End	1.71	0.18	UX30-end.ms6
Side	1.65	0.39	UX30.ms6
HAC			
End	4.14	0.33	UX30-cylinder-end.ms6
Side	3.86	0.62	UX30-cylinder.ms6

As shown in Table 5.7, the external dose rates for the UX-30 package comply with the limits specified in 10 CFR 71.47 and 71.51.

5.5 Appendix

5.5.1 References

5-1 Terry, I.R. *Modern New Nuclear Fuel Characteristics and Radiation Protection Aspects*, Radiation Protection Dosimetry 115, 110-112, (2005)

5-2 *MicroShield,* Grove Engineering, Olney, Maryland, 2003

5-3 *Data for Use in Protection Against External Radiation*, ICRP 51, International Commission on Radiation Protection, 1987

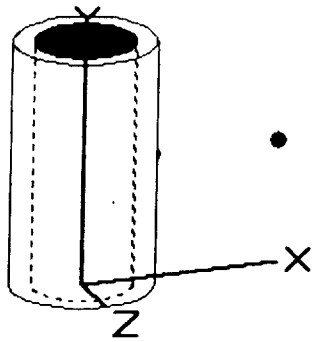
Appendix 5.5.2

MicroShield Files for UX-30

MicroShield v6.02 (6.02-00128)

Page	:1	**File Ref**	:
DOS File	:UX30.ms6	**Date**	:
Run Date	: September 17, 2008	**By**	:
Run Time	: 10:31:28 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: UX-30
Description: Recycled UF6
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions:

Height	193.04 cm	(6 ft 4.0 in)
Radius	36.83 cm	(1 ft 2.5 in)

Dose Points

A	X	Y	Z
# 1	54.815 cm	96.52 cm	0 cm
	1 ft 9.6 in	3 ft 2.0 in	0.0 in
# 2	153.815 cm	96.52 cm	0 cm
	5 ft 0.6 in	3 ft 2.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	8.23e+05 cm³	UF6	2.77
Shield 1	.198 cm	304 SS	7.9
Shield 2	15.716 cm	PolyU	0.125
Shield 3	.278 cm	304 SS	7.9
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.792 cm	Iron	7.86
Top Clad	.792 cm	Iron	7.86

Source Input : Grouping Method - User Defined Energies

Group #	Energy (Mev)	Activity Photons/sec	Volume Source Photons/sec/cm³	% Energy Activity
1	1.0	6.7890e+008	8.2529e+002	100.000

Buildup : The material reference is - Shield 3
Integration Parameters

Radial	10
Circumferential	10
Y Direction (axial)	20

Results - Dose Point # 1 - (54.815,96.52,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	2.964e+02	8.929e+02	5.463e-01	1.646e+00
Totals	**6.789e+08**	**2.964e+02**	**8.929e+02**	**5.463e-01**	**1.646e+00**

Results - Dose Point # 2 - (153.815,96.52,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	7.365e+01	2.110e+02	1.358e-01	3.889e-01
Totals	**6.789e+08**	**7.365e+01**	**2.110e+02**	**1.358e-01**	**3.889e-01**

MicroShield v6.02 (6.02-00128)

Page	:1	**File Ref**	:
DOS File	:UX30-end.ms6	**Date**	:
Run Date	: September 17, 2008	**By**	:
Run Time	: 10:50:51 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: UX-30
Description: Recycled UF6
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	193.04 cm	(6 ft 4.0 in)
Radius	36.83 cm	(1 ft 2.5 in)

Dose Points

A	X	Y	Z
# 1	0 cm	2.11e+02 cm	0 cm
	0.0 in	6 ft 11.3 in	0.0 in
# 2	0 cm	3.10e+02 cm	0 cm
	0.0 in	10 ft 2.2 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	8.23e+05 cm³	UF6	2.77
Shield 1	.635 cm	304 SS	7.9
Shield 2	15.716 cm	PolyU	0.125
Shield 3	.278 cm	304 SS	7.9
Air Gap		Air	0.00122
Wall Clad	.792 cm	Iron	7.86
Top Clad	.792 cm	Iron	7.86

Source Input : Grouping Method - User Defined Energies

Group #	Energy (Mev)	Activity Photons/sec	Volume Source Photons/sec/cm³	% Energy Activity
1	1.0	6.7890e+008	8.2529e+002	100.000

Buildup : The material reference is - Shield 3
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results - Dose Point # 1 - (0,2.11e+02,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	2.978e+02	9.278e+02	5.489e-01	1.710e+00
Totals	**6.789e+08**	**2.978e+02**	**9.278e+02**	**5.489e-01**	**1.710e+00**

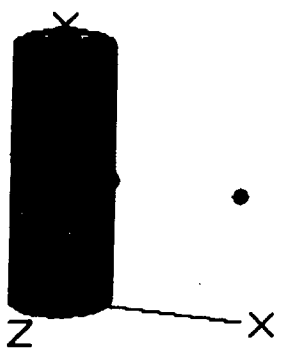
Results - Dose Point # 2 - (0,3.10e+02,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	3.430e+01	9.656e+01	6.322e-02	1.780e-01
Totals	**6.789e+08**	**3.430e+01**	**9.656e+01**	**6.322e-02**	**1.780e-01**

MicroShield v6.02 (6.02-00128)

Page	:1	**File Ref**	:
DOS File	:UX30-cylinder.ms6	**Date**	:
Run Date	: September 17, 2008	**By**	:
Run Time	: 10:39:40 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: 30" cylinder
Description: Recycled UF6
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions:

Height	193.04 cm	(6 ft 4.0 in)
Radius	36.83 cm	(1 ft 2.5 in)

Dose Points

A	X	Y	Z
# 1	38.62248 cm	96.52 cm	0 cm
	1 ft 3.2 in	3 ft 2.0 in	0.0 in
# 2	1.38e+02 cm	96.52 cm	0 cm
	4 ft 6.2 in	3 ft 2.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	8.23e+05 cm³	UF6	2.77
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.792 cm	Iron	7.86
Top Clad	.792 cm	Iron	7.86

Source Input : Grouping Method - User Defined Energies

Group #	Energy (Mev)	Activity Photons/sec	Volume Source Photons/sec/cm³	% Energy Activity
1	1.0	6.7890e+008	8.2529e+002	100.000

Buildup : The material reference is - Wall Clad
Integration Parameters

Radial	10
Circumferential	10
Y Direction (axial)	20

Results - Dose Point # 1 - (38.62248,96.52,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	8.219e+02	2.093e+03	1.515e+00	3.859e+00
Totals	**6.789e+08**	**8.219e+02**	**2.093e+03**	**1.515e+00**	**3.859e+00**

Results - Dose Point # 2 - (1.38e+02,96.52,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	1.380e+02	3.342e+02	2.544e-01	6.161e-01
Totals	**6.789e+08**	**1.380e+02**	**3.342e+02**	**2.544e-01**	**6.161e-01**

MicroShield v6.02 (6.02-00128)

Page	:1	**File Ref**	:
DOS File	:UX30-cylinder-end.ms6	**Date**	:
Run Date	: September 17, 2008	**By**	:
Run Time	: 10:33:46 AM	**Checked**	:
Duration	: 00:00:00		

Case Title: 30" cylinder
Description: Recycled UF6
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions:

Height	193.04 cm	(6 ft 4.0 in)
Radius	36.83 cm	(1 ft 2.5 in)

Dose Points

A	X	Y	Z
# 1	0 cm	194.832 cm	0 cm
	0.0 in	6 ft 4.7 in	0.0 in
# 2	0 cm	293.832 cm	0 cm
	0.0 in	9 ft 7.7 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	8.23e+05 cm³	UF6	2.77
Air Gap		Air	0.00122
Wall Clad	.792 cm	Iron	7.86
Top Clad	.792 cm	Iron	7.86

Source Input : Grouping Method - User Defined Energies

Group #	Energy (Mev)	Activity Photons/sec	Volume Source Photons/sec/cm³	% Energy Activity
1	1.0	6.7890e+008	8.2529e+002	100.000

Buildup : The material reference is - Top Clad
Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results - Dose Point # 1 - (0,194.832,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	8.643e+02	2.243e+03	1.593e+00	4.135e+00
Totals	**6.789e+08**	**8.643e+02**	**2.243e+03**	**1.593e+00**	**4.135e+00**

Results - Dose Point # 2 - (0,293.832,0) cm

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
1.0	6.789e+08	7.993e+01	1.769e+02	1.473e-01	3.260e-01
Totals	**6.789e+08**	**7.993e+01**	**1.769e+02**	**1.473e-01**	**3.260e-01**

7.0 OPERATING PROCEDURES

DOT regulations (49CFR173.417) require that handling procedures are in accordance with USEC-651, *The UF_6 Manual: Good Handling Practices for Uranium Hexafluoride* or ANSI N14.1, *Uranium Hexafluoride – Packaging for Transport*. Loading and unloading procedures for Type 30B cylinders, as provided in USEC-651, *The UF_6 Manual: Good Handling Practices for Uranium Hexafluoride*, are presented here. Proper operation of the UX-30, assuming a properly filled cylinder, is described below.

The 30C cylinder is identical to the 30B in all respects except for the addition of a Valve Protection Cover (hereinafter referred to as the "VPC"); therefore the loading and unloading procedures are essentially identical to the 30B. Incremental steps applicable to the 30C cylinder for the VPC are added.

7.1 Package Loading

7.1.1 Preparation for Loading

7.1.1.1 Receipt and Filling of 30B or 30C Cylinder

Receipt and filling of the cylinder shall be performed in accordance with in plant operating procedures, ANSI N14.1, and appropriate provisions of the 30C cylinder specification (Addendum 2-2004 to ANSI N14.1-2001).

7.1.1.2 Cylinder Inspection and Testing

Complete an inspection of the 30B cylinder as described in USEC 651 (or equivalent in-plant operating procedures) and ANSI N14.1 prior to insertion into the UX-30 Overpack. Any defective conditions must be corrected, and the cylinder must be recertified prior to use.

If a 30C Cylinder is being used, the VPC assembly and O-Rings shall be visually inspected for defective conditions including irregular surface conditions of the VPC, Flange, and O-rings. Any defective conditions must be corrected, and the cylinder must be re-tested in accordance with the provisions of paragraph 7.1.2.3. Defective O-Rings must be replaced with new O-Rings in accordance with the 30C cylinder

specification (Addendum 2-2004 to ANSI N14.1-2001).

Prior to filling, the cylinder will be leak tested by an air test at 100 psig. All connections and fittings will be leak tested using Carbona soapless lather or an approved equivalent (ANSI N14.5-1997 Method 5.7 Soap Bubble) with a test sensitivity of 1×10^{-3} std-cc/sec. No leakage is permitted.

7.1.1.3 Overpack Inspection

The UX-30 package must be prepared for shipment in accordance with the requirements of 10CFR71.87. Inspect base and lid of package prior to loading. The following shall be cause for further investigation or removal from service until the defective condition is satisfactorily corrected:

- Excessive distortion, warping, or other damage of the inner or outer shell preventing closure of the package or proper installation of all 10 closure pins.
- Failure of ball-lock pins to lock in place.
- Damaged alignment pins.
- Large dents (more than 0.5-inch deep).
- Damaged dust seal.
- Failed welds.
- Excessive wear of inner shell steel or rubber pads.
- The overpack base and supports are sound with no broken welds or components.
- The overpack inner and outer shells are intact with no broken welds and no holes, tears, or deformations greater than ½ inch. Visual indications of corrosion or oxidation causing a through wall pitting in two (2) or more locations within a six (6) by six (6) inch area shall be cause for the rejection of the Overpack.
- The inner liner is free of debris and standing water.
- The inner liner is intact and is not in a deteriorated or damaged condition.
- The gaskets and cylinder support pads are in place and intact and are not in a deteriorated or damaged condition.
- The gasket surfaces are free from nicks and deep scratches.
- The cover plates and welds are sound and undamaged.
- The overpack halves fit together properly without gaps.

- All vent seals/plugs are securely in place.
- The tie-down and lifting/stacking supports are in place and are not in a deteriorated or damaged condition.
- The tamper-indicating seal apparatus is undamaged.

7.1.2 Loading of Contents

PROCEDURE FOR LOADING THE 30B OR 30C CYLINDER

7.1.2.1. Prior to loading the cylinder, the inspection required in Section 7.1.1.2 and 7.1.1.3 shall be completed and documented.

7.1.2.2 The 30B or 30C UF6 cylinder is filled, tested, and handled in accordance with standard, in-plant operating procedures at the facility. As a minimum, the procedures described in USEC-651, or other equivalent in-plant procedure, ANSI Standard N 14.1, and appropriate provisions of the 30C cylinder specification (Addendum 2-2004 to ANSI N14.1-2001) shall be used.

7.1.2.3 The filled cylinder valve will be tested by leak rate testing. The test will be performed by connecting a pressure gauge manifold, which has a void volume of 55 cm^3 or less, to the valve and pressurizing the manifold volume with dry air or nitrogen.

Note: If air is used for the test, the air supply should be clean and dry. If it is not, or if the quality of the air supply is uncertain, the test should be performed with nitrogen to ensure reliable results.

The test shall be performed using a 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. The maximum sensitivity of the gauge shall be 0.1 psig.

Sensitivity at the test conditions is equivalent to the prescribed procedure sensitivity of 10^{-3} ref-cm3/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_6 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.

7.1.2.4 If the 30C cylinder has been filled, the VPC shall be installed over the valve using the locator pin.

Note: The VPC is a component of the 30C cylinder and is unit-specific, with the same serial number as the cylinder. The VPC shall not be transferred to any other cylinder. Prior to installation of the VPC, it shall be verified that the serial numbers on the VPC and 30C cylinder are the same.

Prior to installation of the VPC a silicone-based lubricant shall be applied to the VPC O-rings

Prior to installation, the VPC bolts shall be lubricated with a polytetrafluorethylene (PTFE) - based lubricant. The six bolts tightened to a finger tight condition, followed by a tightening procedure using a calibrated torque wrench, where each bolt shall be tightened to 30 foot pound (+5/-0 tolerance). Bolt tightening sequence shall be a star pattern, followed by rotational and reverse rotational tightening until stable at final toque value.

Note: Inspection for deposits on the valve and boss/coupling shall be accomplished per the procedure set forth in paragraph 7.1.2.8 prior to installing the VPC.

7.1.2.5 The VPC shall be leak tested prior to each shipment by a pressure drop test (ANSI Standard N14.5-1997 Method A.5.1 Gas Pressure Drop) having a sensitivity of 1 x 10^{-3} std-cc/sec or less. The annulus between the VPC o-rings will be pressurized through the test port with dry air or nitrogen using a pressure gauge manifold, which has a total void volume including the annulus of 55 cm^3 or less.

Note: If air is used for the test, the air supply should be clean and dry. If it is not, or if the quality of the air supply is uncertain, the test should be performed with nitrogen to ensure reliable results.

The test shall be performed using a 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. The maximum sensitivity of the gauge shall be 0.1 psig.

Note: A soap-bubble test cannot be used for testing the VPC because of the configuration of the VPC and its O-rings.

7.1.2.6 The cylinder shall be weighed using the procedures and standards outlined in USEC-651, or other equivalent in plant operating procedure, to assure that the capacity of the cylinder has not been exceeded.

7.1.2.7 The cylinder shall be allowed to cool until the vapor pressure of the cylinder is below atmospheric pressure.

7.1.2.8 Prior to loading into the UX-30 Overpack, the valve port and valve boss/coupling shall be inspected for solid deposits. Solid deposits around the valve port or valve boss/coupling indicate a leak condition, and the cylinder shall not be loaded into the overpack. Corrective measures shall be taken to remedy the leak as prescribed by the facility's operating procedures. If the valve port and valve boss/coupling are free of solid deposits, the cylinder may be loaded into the Overpack.

7.1.2.9 A tamper-indicating seal shall be installed on the 30B cylinder prior to loading it into the Overpack.

Note: On the 30C cylinder the tamper-indicating seal shall be installed on the VPC.

PROCEDURE FOR LOADING THE OVERPACK

7.1.2.10 The inspection required by Section 7.1.1.2, 7.1.1.3, and 7.1.2 shall be performed and documented prior to loading the UX-30 Overpack with a 30B or 30C cylinder.

7.1.2.11 Before loading, the UF_6 inside the cylinder shall be completely solidified.

7.1.2.12 The UX-30 lower half shall be resting in its shipping and handling cradle.

7.1.2.13 Using a suitable crane, the cylinder shall be carefully placed in the lower half of the UX-30. The cylinder valve shall be located at the top of the overpack, intersecting a vertical plane through the overpack centerline, on either side of the enclosure.

NOTE: IF A STANDARD 30-B CYLINDER IS BEING TRANSPORTED, ENSURE THAT THE VALVE COVER ("VALVE PROTECTOR") IS REMOVED PRIOR TO SHIPMENT.

NOTE: THE VPC ON THE 30C CYLINDER SHALL NOT BE REMOVED PRIOR TO SHIPMENT

7.1.2.14 Place the upper half of the UX-30 onto the lower half.

7.1.2.15 Secure the upper half of the Shipping and Handling Cradle. Tighten as required.

7.1.2.16 Install the 10 ball-lock pins in their receptacles, thereby securing the two package halves together.

CAUTION: ENSURE EACH PIN IS PROPERLY INSTALLED. VERIFY THAT THE PUSH-BUTTON IS IN THE NORMAL, RETRACTED POSITION WHEN RELEASED (NOT STUCK IN THE "IN" POSITION). VERIFY THAT THE PIN IS LOCKED IN

PLACE (CANNOT BE REMOVED BY TUGGING ON THE PIN OR LANYARD). BALL-LOCK PINS NOT OPERATING PROPERLY SHALL BE REMOVED FROM SERVICE.

7.1.2.17 Install the two standard tamper-indicating seals in their proper positions. Install the bolt plugs in the optional lid lifting lugs as shown in the General Arrangement Drawings, Appendix 1.4.1.

7.1.3 Preparation for Transport

7.1.3.1 The UX-30 is now ready for shipment.

7.1.3.2 Perform the following inspections of the overpack after placement of the lid:

Perform a radiation survey of the package per the requirements of 10 CFR 71.47. Contamination levels on the external surfaces of each package shall be kept as low as practicable. The level of non-fixed radioactive contamination shall meet the requirements of 10 CFR 71.87(i).

Ensure that labeling and placarding requirements of DOT regulations, as defined in 49 CFR 172, are met.

Note that the loaded UX-30 package may only be handled via the shipping cradle or a sling placed underneath the package

7.2 Package Unloading

7.2.1 Receipt of Package from Carrier

7.2.1.1 Inspect the exterior of the overpack for possible damage:

- The overpack inner and outer shells are intact with no broken welds and no holes, tears, or deformations greater than ½ inch. Visual indications of corrosion or oxidation causing a through wall pitting in two (2) or more locations within a six (6) by six (6) inch area shall be cause for the rejection of the Overpack.
- The cover plates and welds are sound and undamaged.
- The overpack halves fit together properly without gaps.
- The tie-down and lifting/stacking supports are in place and are not in a deteriorated or damaged condition.
- The tamper-indicating seal apparatus is undamaged.

Document any damage observed. Complete the receiving report as required by facility operating procedures.

7.2.1.2 Note that the loaded UX-30 package may only be handled via the shipping cradle or a sling placed underneath the package.

7.2.2 Removal of Contents

7.2.2.1 Break the tamper indicating seals.

7.2.2.2 Remove the 10 ball-lock pins from the perimeter of the UX-30.

7.2.2.3 Release the package from the base shipping and handling cradle. Remove the bolt plugs from the lid lifting lugs, if lid lugs are present. If lid lift clips are present, install 4 lifting pins in upper half of shipping cradle.

7.2.2.4 Remove the lid from the package.

7.2.2.5 Remove the payload cylinder.

7.2.2.6 Remove the 30B cylinder security seal (which is on the VPC on the 30C cylinder).

Note: The VPC is a component of the 30C cylinder and is unit-specific, with the same serial number as the cylinder. The VPC shall not be transferred to any other cylinder.

7.2.2.7 Prior to unloading the cylinder, cylinder shall be inspected and weighed as required by USEC 651 or equivalent in plant operating procedures.

7.2.2.7 The UF_6 cylinder is emptied and handled in accordance with standard, in- plant, operating procedures at the facility. As a minimum, the procedures described in USEC-651 or equivalent in plant operating procedures, and ANSI Standard N14.1, shall be used.

7.3 Preparation of an Empty Package for Transport

7.3.1 Visually inspect the overpack prior to each use. The following shall be cause for further investigation or removal from service until the defective condition is satisfactorily corrected:

- Excessive distortion, warping, or other damage of the inner or outer shell preventing closure of the package and proper installation of all 10 closure pins.
- Failure of ball-lock pins to lock in place.
- Damaged alignment pins.
- Large dents (more than 0.5-inch deep).
- Damaged dust seal.
- Failed welds.
- Excessive wear of inner shell steel or rubber pads.

7.3.2 The UX-30 lower half shall be resting in its shipping and handling cradle.

NOTE: IF A STANDARD 30-B CYLINDER IS BEING TRANSPORTED, ENSURE THAT THE VALVE COVER ("VALVE PROTECTOR") IS REMOVED PRIOR TO SHIPMENT.

NOTE: THE VPC ON THE 30C CYLINDER SHALL NOT BE REMOVED PRIOR TO SHIPMENT

7.3.3 Place the upper half of the UX-30 onto the lower half. Ensure that all requirements of 49 CFR 173.428 for Empty Radioactive Materials Packaging are met.

CAUTION: ENSURE EACH PIN IS PROPERLY INSTALLED. VERIFY THAT THE PUSH-BUTTON IS IN THE NORMAL, RETRACTED POSITION WHEN RELEASED (NOT STUCK IN THE "IN" POSITION). VERIFY THAT THE PIN IS LOCKED IN PLACE (CANNOT BE REMOVED BY TUGGING ON THE PIN OR LANYARD). BALL-LOCK PINS NOT OPERATING PROPERLY SHALL BE REMOVED FROM SERVICE.

7.3.4 Secure the upper half of the Shipping and Handling Cradle. Tighten as required.

7.3.5 The empty UX-30 is now ready for transport.

7.3.6 Note that the UX-30 package may only be handled via the shipping cradle or a sling placed underneath the package.

7.4 Other Procedures

Not Applicable

7.5 Appendix

Not Applicable

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

8.1 Acceptance Tests

ACCEPTANCE TESTS FOR THE 30B OR 30C CYLINDER:

- Acceptance Tests For The 30B Cylinder – Designed and Manufactured per ANSI N14.1 (appropriate edition), "Uranium Hexafluoride – Packaging for Transport". Acceptance tests for the 30B cylinder shall be in accordance with ANSI N14.1 (appropriate edition).

- Acceptance Tests For The 30B Cylinder – Designed and Manufactured per ANSI N14.1 – 1995, "Uranium Hexafluoride – Packaging for Transport" and ISO 7195:1993(F), "Packaging of Uranium Hexafluoride (UF_6) for Transport". Acceptance tests for the 30B cylinder shall be in accordance with ANSI N14.1 – 1995 and ISO 7195:1993(F).

- Acceptance Tests For The 30C Cylinder - Designed and manufactured in accordance with Addendum 2-2004 to ANSI N14.1-2001.

- Acceptance Tests For The 30B or 30C Cylinder Used For Reprocessed UF_6 – in addition to the tests listed above, the cylinder must have a measured leak rate less than 1×10^{-7} cm^3/sec. The acceptance leak test of the 30B or 30C cylinder used for reprocessed UF6 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 1.0×10^{-7} atm-cm^3/sec of air (leaktight). The detector sensitivity must be less than or equal to 5.0×10^{-8} atm-cm^3/sec.

ACCEPTANCE TESTS FOR THE UX-30:

The following acceptance tests are for the UX-30

8.1.1 Visual Inspections and Measurements

8.1.1.1 See Appendix 8.3.1 for acceptance criteria and inspections associated with polyurethane foam manufacturing.

8.1.1.2 Prior to the first use of the package, the following inspection shall be performed:

Dimensional compliance with the drawings referenced in the Certificate of Compliance.

Verify that the packaging is free of cracks, pinholes, or defects that could reduce the effectiveness of the package.

Verify that the packaging is marked in accordance with 10 CFR 71.85 (c).

8.1.2 Weld Examinations

Prior to the first use of the package, a visual inspection of all welds to AWS D1.1 shall be performed.

8.1.3 Structural and Pressure Tests

None.

8.1.4 Leakage Tests

None.

8.1.5 Component and Material Tests

Prior to the first use of the package, an assembly test showing proper operation of closure interface and all ball-lock pins shall be performed.

8.1.5 Shielding tests

None.

8.1.7 Thermal Tests

None.

8.2 Maintenance Program

MAINTENANCE PROGRAM FOR THE 30B OR 30C CYLINDER:

- Maintenance Program For The 30B Cylinders Manufactured per ANSI N14.1 (appropriate edition), "Uranium Hexafluoride – Packaging for Transport".
    - Maintenance of the 30B Cylinders shall be performed in accordance with ANSI N14.1 (appropriate edition).
- Maintenance Program For The 30B Cylinders Manufactured In Accordance With ANSI N14.1–1995, "Uranium Hexafluoride – Packaging for Transport" and ISO 7195:1993(F), "Packaging of Uranium Hexafluoride (UF6) for Transport".

- Maintenance of the 30B Cylinders shall be performed in accordance with ANSI N14.1 - 1995 and ISO 7195:1993(F).

- Maintenance Program for the 30C Cylinder.

  - Maintenance of the 30C Cylinder shall be performed in accordance with Addendum 2-2004 to ANSI N14.1-2001.

- Maintenance Program for 30B or 30C Cylinders Used For Reprocessed UF_6 –

  - In addition to the maintenance requirements listed above, the cylinder must be tested annually to demonstrate a measured leak rate less than 1×10^{-7} cm^3/sec. The acceptance leak test of the 30B or 30C cylinder used for reprocessed UF6 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 1.0×10^{-7} atm-cm^3/sec of air (leaktight). The detector sensitivity must be less than or equal to 5.0×10^{-8} atm-cm^3/sec.

MAINTENANCE PROGRAM FOR THE UX-30:

8.2.1 Structural and Pressure Tests

8.2.1.1 Visual inspection of all welds shall be carried out annually by personnel qualified in accordance with AWS D1.1 and /or AWS D1.6, or an equivalent international standard .

8.2.1.2 Excessive accumulations of dirt, oil, and other debris shall be removed from the inner and outer surfaces after each use.

8.2.1.3 The dust seal and all rubber pads shall be inspected every 6 months for wear. The dust seal shall be replaced when excessive wear renders the seal ineffective.

8.2.1.4 Inner and outer surfaces shall be inspected for penetrations every 6 months. If any skin failure is observed, these may be repaired using a suitable stainless steel welding procedure. Care should be taken to avoid application of heat for an excessive duration, causing the package to change shape.

8.2.2 Leakage Tests

None.

8.2.3 Component and Material Tests

None.

8.2.4 Thermal Tests

None.

8.2.5 Miscellaneous Tests

8.2.5.1 The following inspections shall be performed to verify acceptability of the foam:

Plastic overpack foam-filling-hole plugs should be removed every 12 months to allow inspection of foam condition for indications of foam deterioration (e.g., presence of solid foam on inside of plug). Verify tight fit of plug after replacement (plug should not turn freely by hand).

Overpacks are to be weighed every 12 months to determine if water has leaked into the overpack. A weight gain of more than 25 pounds per base or lid is reason for rejection (per USEC-651, "Uranium Hexafluoride: A Manual of Good Handling Practices", DOE Field Office, Oak Ridge).

8.2.5.2 In addition to the requirements of Section 7.1.1.3 to check the ball-lock pins before each use, the pins shall also be checked for proper operation annually.

This annual check shall consist of at least:

1. Depressing the push button and verifying the ball locks operate properly and that the push button retracts when it is released.
2. Inserting each pin into a receptacle on the UX-30 and verifying that it properly locks into place
3. Cleaning each pin by wiping it down with a clean cloth and, if necessary, lubricating it with a clean lightweight oil such as WD-40.

Malfunctioning ball-lock pins identified during this annual maintenance shall be immediately removed from service.

8.3 APPENDIX

8.3.1 Polyurethane Foam Specification ES-M-170

(Proprietary)

Appendix 8.3.1

Polyurethane Foam Specification ES-M-170

(Not Included in Public SAR)

Attachment 3

FIGURE WITHHELD UNDER 10 CFR 2.390