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June 18, 2004
GDP 04-0028

Mr. Jack R. Strosnider
Director, Office of Nuclear Material Safety and Safeguards
Attention: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Paducah Gaseous Diffusion Plant (PGDP)
Docket No. 71-6553
Request for Renewal of Certificate of Compliance No. 6553 and Proposed Changes to the
Paducah Tiger Overpack Safety Analysis Report

Dear Mr. Strosnider:

In accordance with 10 CFR 71.38, the United States Enrichment Corporation (USEC) hereby submits this request for renewal of Certificate of Compliance No. 6553. The current Certificate of Compliance No. 6553, Revision 18, dated September 20, 2002, expires on July 31, 2004.

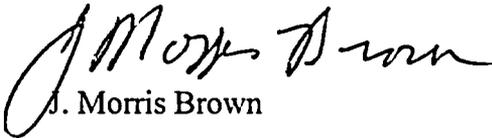
This request for renewal is based on USEC's previous Application, KY-665, Safety Analysis Report on the "Paducah Tiger" Protective Overpack for 10-Ton Cylinders of Uranium Hexafluoride (Paducah Tiger SAR), as revised through Revision 1, Change D, dated January 10, 2003 (Reference 1). USEC's previous changes to KY-665, Revision 1, have been approved by the NRC in References 2 through 6. In addition, Revision 1, Change E, is being submitted for approval to allow cylinders manufactured to the 2001 version of the ANSI N14.1 standard to be shipped in the Paducah Tiger Overpack, to revise the 48X Cylinder Material Specification Table to incorporate additional material allowed by ANSI N14.1, and to remove previously approved content that is no longer applicable. Upon approval, Revision 1, Change E will be incorporated into KY-665. Enclosure 1 to this letter provides a detailed description of Revision 1, Change E. Enclosure 2 is a copy of the revised Paducah Tiger SAR Revision 1, Change E pages with removal/insertion instructions.

USEC requests that Certificate of Compliance No. 6553 be renewed and that the revised Paducah Tiger SAR become effective 30 days from issuance of the renewed certificate.

Mr. Jack R. Strosnider
June 18, 2004
GDP 04-0028, Page 2

Should you have any questions or require additional information, please contact Mark Smith at (301) 564-3244. There are no new commitments contained in this submittal.

Sincerely,



J. Morris Brown

- References:
1. KY-665, "Safety Analysis Report on the "Paducah Tiger" Protective Overpack for 10-Ton Cylinders of Uranium Hexafluoride," as revised through Revision 1, Change D, dated January 10, 2003.
 2. Letter from E. William Brach (NRC) to Mr. James H. Miller (USEC), "Certificate of Compliance No. 6553, Revision No. 15, for the Model No. Paducah Tiger Package," dated July 15, 1999.
 3. Letter from E. William Brach (NRC) to Mr. Steven Toelle (USEC), "Certificate of Compliance No. 6553, Revision No. 16, for the Model No. Paducah Tiger Package," dated May 2, 2000.
 4. Letter from E. William Brach (NRC) to Mr. Steven Toelle (USEC), "Certificate of Compliance No. 6553, Revision No. 17, for the Model No. Paducah Tiger Package," dated July 12, 2000.
 5. Letter from E. William Brach (NRC) to Mr. James N. Adkins, Jr. (USEC) "Certificate of Compliance No. 6553, Approval of a Single Shipment for the Paducah Tiger Package," dated September 18, 2000.
 6. Letter from E. William Brach (NRC) to Mr. Steven Toelle (USEC), "Certificate of Compliance No. 6553, Revision No. 18, for the Model No. Paducah Tiger Package," dated September 20, 2002.

- Enclosures:
1. United States Enrichment Corporation (USEC), Detailed Description of the Changes to KY-665, "Safety Analysis Report on the "Paducah Tiger" Protective Overpack for 10-Ton Cylinders of Uranium Hexafluoride," Revision 1, Change E.
 2. United States Enrichment Corporation (USEC) Certificate Amendment Request, Paducah Gaseous Diffusion Plant, Letter GDP 04-0028 Removal/Insertion Instructions.

cc: G. Janosko, NRC HQ
E. William Brach, NRC HQ
J. Henson, NRC Region II
B. Bartlett, NRC Resident Inspector, PGDP
D. Martin, NRC Project Manager, PGDP
R. DeVault, DOE

**United States Enrichment Corporation (USEC)
Detailed Description of the Changes to
KY-665, "Safety Analysis Report on the 'Paducah Tiger' Protective Overpack for
10-Ton Cylinders of Uranium Hexafluoride," Revision 1, Change E**

Description of Change

This change is proposed to incorporate ANSI N14.1-2001, revise the 48X Cylinder Material Specification Table, and delete specific information that is no longer applicable in the Safety Analysis Report on the "Paducah Tiger" Protective Overpack for 10-Ton Cylinders of Uranium Hexafluoride" (Paducah Tiger SAR). Therefore, USEC has determined that a change to the Paducah Tiger SAR is needed. Specifically, changes are proposed to the Paducah Tiger SAR, Revision 1, Introduction, Sections 1.3, 2.1, 2.10, 4.5, 7.4, and 8.3, to incorporate ANSI N14.1-2001 and update the specifications in Table 1.2-2. In addition, text that is no longer applicable to Sections 1.2.1.9 and 7.0 has been deleted.

Reason for Change

In order to allow 48X cylinders manufactured to the 2001 version of ANSI N14.1 to be received and shipped in the Paducah Tiger Overpack, the Paducah Tiger SAR needs to be updated to reflect the current version of the standard.

Table 1.2-2 is being revised to allow for the use of ASTM A-516 Grade 70 Steel (which is an acceptable material in the current and previous version of ANSI N14.1) in the cylinder body, semi-ellipsoidal heads, stiffening rings, skirt (cylindrical), skirt (conical), and lifting lugs. The hex head plug ANSI Standard B2.1 was corrected to B1.20.1.

The text that was previously added to Sections 1.2.1.9 and 7.0 to allow for one-round trip of cylinder PT0225 that did not have a water capacity stamp on the nameplate is no longer valid because the NRC's approval of a one time exemption for the subject cylinder expired on November 30, 2001.

Justification of the Change

SAR Chapter 1, Appendix A, Section 1.1 commits PGDP to comply with ANSI N14.1 "Uranium Hexafluoride – Packaging for Transport," 2001 edition as excepted. This change ensures that the references to ANSI N14.1 adequately address the 48X shipping cylinders that USEC is using or may use.

PGDP performed engineering evaluation (EN-C-814-03-009, Rev. 1) on the changes between the 1990 version and the 2001 version of ANSI N14.1 including Addendum 1. This evaluation is

available at the site for review. There were no nuclear safety significance differences that were identified in the transportation requirements between the former and new versions of the standard that impact the use of the Paducah Tiger Overpack.

The changes to Table 1.2-2 are made in accordance with ANSI N14.1 to allow for the use of ASTM A-516 Grade 70 steel. ANSI B2.1 was changed to ANSI B1.20.1 to reflect the correct reference standard for the threads on the hex head plug.

The NRC-approved shipping exemption for Cylinder PT0225 has been exercised and this one time activity was completed. The cylinder has been emptied and will not be refilled. Therefore, the text that was previously added to Sections 1.2.1.9 and 7.0 to allow for one-round trip of cylinder PT0225 can be deleted.

**United States Enrichment Corporation (USEC)
Certificate Amendment Request
Paducah Gaseous Diffusion Plant
Letter GDP 04-0028**

Removal/Insertion Instructions

Remove Page

Insert Page

PTO SAR

ix, 1.1-1, 1.2-6, 1.2-15, 1.3-1, 2.1-2, 2.10-1,
4.5-1, 7-1, 7.4-1, 8.3-1

ix, 1.1-1, 1.2-6, 1.2-15, 1.3-1, 2.1-2, 2.10-1,
4.5-1, 7-1, 7.4-1, 8.3-1

REVISION LOG

Date	Change	Description
7/15/99	REV 1	Initial Issue. Complete Revision of all pages.
5/02/00	A	Revised Sections 3.5.1.1, 3.5.6, 4.2.2 and 7.1.2 to increase the amount of residual UF ₆ allowed for shipment in the overpack.
7/12/00	B	Revised Sections 1.1, 1.2.1.9, and 2.1.2 to allow for the shipment of W. H. Stewart Company cylinders in the overpack.
9/18/00	C	Revised Sections 1.2.1.9, and 7.0 to allow for one round-trip shipment of cylinder PT0225 which does not have a water capacity stamped on the nameplate.
1/10/03	D	Revised Section 1.0 to delete the reference to the Portsmouth Plant and to provide more concise wording of the information contained in this Section.
RAC 04C005 (R0)	E	Revised Sections 1.1, 1.3, 2.1.2, 2.10, 4.5, 7.4, and 8.3 to address and incorporate the 2001 version of ANSI N14.1 to allow the use of cylinders manufactured to this version. Revised Table 1.2-2; 48X Cylinder Material Specification. Deleted the text added by "Change C" above since the one time activity addressed by this change was completed.

[Note: The Request for Application Change (RAC) number identified above for the Proposed Change E will be replaced by the approval date upon approval and issuance.]

1.1 Introduction

The Paducah Tiger overpacks are fabricated to transport 48X 10-ton UF₆ cylinders. The 48X cylinder is a DOT Specification 7A container [1], fabricated from low-carbon steel. The Paducah Tiger overpack, shown in Figure 1.1-1, provides protection for the 48X cylinders under normal conditions of transport and hypothetical accident conditions. The overpack completely envelopes the 48X cylinder using a removable lid that attaches to the body of the overpack. The overpack body supports the 48X cylinder. The overpack utilizes steel and aluminum plates and polyurethane foam to provide puncture protection, structural support, and thermal protection. The 48X cylinder, shown in Figure 1.1-2, is fabricated in accordance with ANSI N14.1 [2], or to an earlier version of ANSI N14.1, except as noted in Section 1.2.1.9, and is the package containment boundary.

The Paducah Tiger overpacks consist of an outer skin (also referred to as an “outer steel shell”) and an inner liner (also referred to as an “inner steel shell”) with polyurethane foam filling the space between the two shells. Both low- and high-density foams are used in the overpacks. High-density foam is used along each edge and at each corner of the lid and body. Low-density foam is used for the remainder of the overpack.

The package design incorporates rubber shock isolators for cylinder support and alignment; stainless steel breakaway plates for puncture protection; a high strength aluminum stiffening plate for both puncture protection and structural support; closure mechanisms; a tamper-indicating device; and tie-down features. These components are described in Section 1.2.1.

The 48X cylinder may contain up to 21,030 pounds of UF₆ enriched up to 4.5 wt % U-235 when filled. To be considered empty, cylinders may contain no more than 50 pounds of residual UF₆ (a heel cylinder). The isotopic content of full and heel cylinders is discussed in Section 1.2.3.

During design, a Paducah Tiger overpack prototype was built for physical testing. Results from the prototype testing were used to optimize the Paducah Tiger overpack design. To supplement the test data, computer modeling and analyses were performed. A description of the tests, and a summary of the results of the tests and analyses, are presented in Section 2.7.1. The Paducah Tiger license drawings are provided in Section 1.4. The dimensions indicated in Section 1 are generally nominal dimensions. Subsequent chapters may present dimensions that contain exact tolerances based on more detailed requirements.

These cylinders were manufactured with a nominal head thickness of 5/8-inch instead of the minimum 5/8-inch head thickness required by the 1982 version of ANSI N14.1.

A 1-inch angle drum (cylinder) valve, shown in Figure 1.2-6, is installed at one end of the 48X cylinder for filling and emptying the UF₆ from the cylinder.

The 48X cylinder valve stem and plug may be tinned with ASTM B32, alloy 50A or Sn50 solder material, or a mixture of alloy 50A or Sn50 with alloy 40A or Sn40A material, provided the mixture has a minimum tin content of 45 percent. Except for the makeup of the tinning materials, the 48X cylinder is fabricated in accordance with ANSI N14.1.

As shown in Figure 1.1-2, three stiffening rings are welded to the 48X cylinder to provide protection during handling. Four lifting lugs are attached to the outer stiffening rings for handling of the cylinder.

A 1-inch hex head drain plug is installed on the cylinder at the end opposite the valve. This plug is used to drain cleaning solution from the cylinder during cleaning operations. It is screwed into a 1-inch half-coupling that is welded to the inside of the cylinder head.

1.2.2 Operational Features

The Paducah Tiger overpack is a simply designed and easily operated package with no active systems and few operational features. The primary operational features of the Paducah Tiger overpack pertain to loading and unloading the 48X cylinder into and out of the overpack. Many of these features are described in Section 1.2.1, and are shown in Figure 1.1-1. The lid of the overpack is designed to be removed as a single unit using four lifting points, two on either side of the lid. The lid is secured to the body of the overpack using eight ball lock pins that are manually installed and removed. No torque is applied to the pins. Drain ports at either end of the overpack allow the removal of any residual water that may inadvertently enter the overpack during periods of storage or use, and allow cleaning of the overpack inner liner when necessary.

Table 1.2-2 48X Cylinder Material Specification

Component	Specifications
Cylinder Body	5/8-inch Steel Plate - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5
Semi-Ellipsoidal Heads (2 ea)	5/8-inch Steel Plate - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5
Stiffening Rings (3 ea)	7/8 x 2-1/2-inch Steel Bar - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5, or ASTM A-131, Grade E normalized
Skirt, Cylindrical	5/8-inch Steel Plate - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5
Skirt, Conical	5/8-inch Steel Plate - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5
Lifting Lugs (4 ea)	1-inch Steel Plate - ASTM A-516 Grade 55, 60, 65, or 70 meeting heat treatment and supplementary requirement S5
Half Couplings (2 ea)	1-inch NPS, Class 6000, Steel - ASTM A-105 - ANSI B16.11, Threads - ANSI B57.1
Hex Head Plug	1-1/2-inch Hex Bar, Aluminum Bronze CDA Alloy 613 - ASTM B-150, Threads - ANSI B1.20.1
Seal Loops (2 ea)	1/8 or 1/4 inch diameter Steel Bar, ASTM A-36
Valve	1-inch Angle Drum (Cylinder) Valve

1.3 References

1. D. E. Edling, D. R. Hopkins, and R. L. Williams, *DOE Evaluation Document for DOT 7A Type A Packaging*, MLM-3245, DOEIDP/000S3-H1, U.S. Department of Energy, DOE Radioactive Materials Packaging Certification Office, March 1978.
2. American National Standards Institute, *American National Standard for Nuclear Materials, Uranium Hexafluoride - Packaging for Transport*, ANSI N14.1, New York, NY, 2001.

protect the 48X cylinder by providing structural and thermal protection to the 48X cylinder to ensure that it can adequately withstand both the Normal Conditions of Transport (NCT) and the Hypothetical Accident Conditions (HAC) as described in 10 CFR 71.71 and 10 CFR 71.73, respectively.

The impact of the transportation environment on the overpack design has been successfully demonstrated in the field during more than 25 years of service. All of the Paducah Tiger overpacks in service have performed satisfactorily.

The 48X cylinders are DOT Specification 7A containers (49 CFR 178.350 [2]). Cylinders are fabricated using A-516 steel subject to the requirements of ANSI N14.1 [3], or to an earlier version of ANSI N14.1, except as noted in Section 1.2.1.9.

Material specifications are presented in Table 1.2-1 for the Paducah Tiger overpack and in Table 1.2-2 for the 48X cylinder. Allowable stresses for these materials are from the ASME Boiler and Pressure Vessel Code where applicable. NRC Regulatory Guide 7.6 outlines a procedure for identifying and combining loads, classifying stresses, and comparing the stress results with the acceptance criteria. These criteria were used for normal and accident loadings to determine the acceptable stress intensities. The effects of brittle fracture, fatigue, and vibration on the 48X cylinder (i.e., the containment boundary) are addressed in the following sections. Material properties for the polyurethane foam and the various steels used in the overpack are described in Section 2.3.

The qualification of the Paducah Tiger overpack is demonstrated by analysis together with actual testing of a prototype model. Stress limits were obtained from the ASM International Metals Handbook [4] and were followed wherever appropriate and possible for all load cases except free drops, the penetration test, and the fire test, which use stress limits developed in the evaluations as described in Sections 2.6 and 2.7. The maximum calculated stress intensity, which combines general shear and general bending stress from sustained loads, is limited to the specified minimum yield stress of the material.

2.10 References

1. L. J. Hansen and C. King, Protective Packaging, Inc., *Engineering Evaluation and Test Report (EETR) of Paducah Tiger for Shipment of Enriched UF₆ (10-Ton Cylinder)*, Tacoma, WA.
2. U. S. Department of Transportation, *Specifications for Packaging*, 49 CFR 178, Washington, DC, 1996.
3. American National Standards Institute, *American National Standard for Nuclear Materials, Uranium Hexafluoride – Packaging for Transport*, ANSI N14.1, 2001.
4. ASM International, *Metals Handbook*, Volume No. 1, *Properties and Selection of Metals*, 8th Edition.
5. W. R. Holman and R. T. Langland, *Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers Up to Four Inches Thick*, NUREG/CR1815, UCRL-53013, June 15, 1981.
6. Battelle Columbus Laboratory, *Structural Alloys Handbook*, Volume 1, p. 12, Columbus, OH, 1981.
7. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, *Rules for Construction of Nuclear Power Plants*, Section III, Division 1, New York, NY, 1995.
8. U.S. Nuclear Regulatory Commission, *Regulatory Guide 7.6, Design Criteria for the Structural Analysis Shipping Cask Containment Vessels*, March 1978.
9. LS-DYNA, Version 940, KBS2 Inc., Burr Ridge, IL.
10. W. R. Pedigo, et al, AEC Research and Development Report KY-500, *Testing of Ten-Ton Uranium Hexafluoride Cylinders*, Union Carbide Corporation Nuclear Division, Paducah, Kentucky, October 22, 1965

4.5 References

1. American National Standards Institute, *American National Standard for Nuclear Materials, Uranium Hexafluoride - Packaging for Transport*, ANSI N14.1, New York, NY, 2001.
2. K. T. Ziehlhe and C. R. Barlow, *Rupture Testing of UF₆ Transport and Storage Cylinders*, K/SS-504.

7.0 Operating Procedures

This chapter outlines the procedures for conducting the receiving inspection of the Paducah Tiger overpack, loading and unloading the overpack, and preparing the overpack for transport following loading or unloading. These procedures represent the minimum requirements to ensure safe and reliable operation of the overpack in accordance with this SAR and its Certificate of Compliance.

The Paducah Tiger overpack is designed to transport the 48X 10-ton UF₆ cylinder. The overpack provides thermal and impact protection of the cylinder in the normal conditions of transport and in the hypothetical accident conditions. Safe transport of the UF₆ requires that the cylinder be in good condition prior to transport in the overpack. Consequently, these procedures address the inspection and handling of the cylinder to the extent required for safe transport in the overpack. In preparation for transport, the cylinder must conform to ANSI N14.1 [1] which contains standards for inspecting and repairing the 48X cylinder.

7.4 References

1. American National Standards Institute, *American National Standard for Nuclear Materials, Uranium Hexafluoride - Packaging for Transport*, ANSI N14.1, New York, NY, 2001.

8.3 References

1. American National Standards Institute, *American National Standard for Nuclear Materials, Uranium Hexafluoride - Packaging for Transport*, ANSI N14.1, New York, NY, 2001.
2. American Society for Testing and Materials, *Apparent Density of Ridge Cellular Plastics*, ASTM D 1622, Philadelphia, PA.
3. American Society for Testing and Materials, *Compressive Properties of Ridge Cellular Plastics*, ASTM D 1621, Philadelphia, PA.
4. American Society for Testing and Materials, *Tensile Properties of Ridge Cellular Plastics*, ASTM D 1623, Philadelphia, PA.
5. American Society for Testing and Materials, *Shear Test in a Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores*, ASTM C 273, Philadelphia, PA, 1991.
6. American Society for Testing and Materials, *Water Absorption of Ridge Cellular Plastics*, ASTM D 2127, Philadelphia, PA.