



September 6, 2005
GDP 05-0033

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, Certificate No. 6553
Proposed Administrative Changes to the Paducah Tiger Overpack Safety Analysis Report

Dear Mr. Strosnider:

The United States Enrichment Corporation (USEC) herein submits for NRC review and approval a change to KY-665, Revision 1, "Safety Analysis Report on the 'Paducah Tiger' Protective Overpack for 10-Ton Cylinders of Uranium Hexafluoride." This report is incorporated by reference in Certificate of Compliance No. 6553 for the Paducah Tiger Overpack (PTO). As a result, USEC requests that the NRC issue a revision to Certificate of Compliance No. 6553.

The proposed administrative change to the PTO Safety Analysis Report (SAR) updates the SAR references to reflect changes made to 10 CFR 71 by NRC that were intended to ensure its compatibility with IAEA Transportation Standard TS-R-1. This request will also delete a reference made to a DOT regulation reference that is not relevant to the PTO. Enclosure 1 to this letter provides a detailed description of the change. The actual revised PTO SAR pages are provided in Enclosure 2 with the Removal/Insertion Instructions.

Any questions regarding this matter should be directed to Stephen R. Cowne at (270) 441-6796. There are no new commitments contained in this submittal.

Sincerely,

Steven A. Toelle
Director, Nuclear Regulatory Affairs

NMSSO1

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- 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.
 2. United States Enrichment Corporation (USEC) Certificate Amendment Request, Paducah Gaseous Diffusion Plant, Letter GDP 05-0033 Removal/Insertion Instructions.

cc: J. Henson, NRC Region II
B. Bartlett, NRC Senior Resident Inspector - PGDP
D. Martin, NRC Project Manager - PGDP

Enclosure 1 to GDP 05-0033

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

Description of Change

The proposed administrative changes will revise the Paducah Tiger Overpack (PTO) Safety Analysis Report (SAR), Revision 1, reflecting changes recently made to the Code of Federal Regulations by the Nuclear Regulatory Commission and the Department of Transportation. It will also correct a typographical error associated with a source reference. The proposed changes are identified below. The italicized information is that extracted from the PTO SAR with changes identified.

1. Section 2.0, "Structural Evaluation," second paragraph, is revised from the old Section number 71.13 to Section 71.19.

The evaluation summarizes the results of analyses and tests performed to demonstrate that the Paducah Tiger shipping package satisfies the requirements for a Type AF package as specified in 10 CFR 71.19.

2. Section 4.2.1, "Containment of Radioactive Material," paragraph 1, is revised from reference 10 CFR 71, Appendix A, Section IV(a) to Section IV.b.

The A_2 is determined by applying the methodology given in Appendix A, Section IV.b, of 10 CFR 71.

3. Section 6.1, "Discussion of Results," paragraph 2, of the criticality evaluation references 49 CFR 173.417, Table 6 that was renumbered to Table 3 in the revisions to 49 CFR. This reference will be deleted since the source of the referenced information is a number based on the UF₆ purity specifications.

The hydrogen to uranium atomic ratio (H/U) of 0.088 corresponds to 0.5% impurity, with all the impurity being Hydrogen Fluoride (HF).

Reason/Justification for Change

1. This change in Section 2.0 is made to reflect the renumbering of the old Section 71.13 to the new Section 71.19.

2. This change corrects an apparent typographical error associated with the source reference for the calculation of the A_2 quantity for a cylinder and the renumbering of 10 CFR 71, Appendix A. In the old version of Appendix A, Section IV(a) addressed the A_1 value for Special Form Radioactive Material not the A_2 value for Normal Form Radioactive Material that is transported in the PTO. Special Form Radioactive Material is defined in 10 CFR 71.4 and means radioactive material that satisfies the following conditions: (1) it is either a single solid piece or is contained in a sealed capsule that can only be opened by destroying the capsule, (2) the piece or capsule has at least one dimension not less than 5 mm (0.2 in), and (3) satisfies the test requirements of 10 CFR 71.75. Normal Form Radioactive Material is radioactive material that has not been demonstrated to be special form radioactive material. USEC ships normal form radioactive material, not special form radioactive material, in a Paducah Tiger Overpack. Section IV(b) of Appendix A for normal form radioactive material was redesignated as IV.b by the NRC's Final Rule, RIN 3150-AG71, revising 10 CFR 71, dated January 26, 2004.
3. The source of the maximum hydrogen to uranium atomic ratio is a calculation based on the purity specification of UF_6 . The currently approved PTO SAR references a table that was intended for use with 30-inch cylinder overpacks. That table was revised to Table 3 in the revised 49 CFR 173.417; however, the PTO addresses overpacks for the 48-inch 48X cylinder; therefore, the reference provided is not relevant. The hydrogen to uranium atomic ratio of 0.088 was derived from the UF_6 purity specification, ASTM C 787, "Standard Specification for Uranium Hexafluoride for Enrichment, and ASTM C 996, "Standard Specification for Uranium Hexafluoride Enriched to Less Than 5% ^{235}U ," requiring the minimum UF_6 concentration to be not less than 99.5 grams per 100 grams of sample to limit the potential hydrogen content for nuclear criticality safety. The maximum hydrogen content for the associated contaminant would be provided by hydrogen fluoride for UF_6 . The H/U ratio is a function of the purity of the UF_6 product stream and is independent of the size of the cylinder in use. This deletion of a non-relevant reference does not modify the basis for the associated criticality safety determination as the hydrogen to uranium atomic ratio used remains the same.

Enclosure 2 to GDP 05-0033

**United States Enrichment Corporation (USEC)
Certificate Amendment Request
Paducah Gaseous Diffusion Plant**

United States Enrichment Corporation (USEC) Certificate Amendment Request Paducah Gaseous Diffusion Plant Letter GDP 05-0033 Removal/Insertion Instructions	
Remove Page	Insert Page
PTO SAR	
ix, 2.1, 4.2-1, 6.1-1	ix, 2.1, 4.2-1, 6.1-1

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.
8/13/04	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.
RAC 05C015 (R0)	F	Revised Section 2.0 to reflect Type AF package requirements in renumbered paragraph 71.19. Revised Section 4.2.1 to correct the A ₂ methodology reference to 10CFR71, Appendix A, Section IV.b. Revised Section 6.1 by deleting the source reference for H/U ratio.

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

2.0 STRUCTURAL EVALUATION

This chapter provides a structural evaluation of the Paducah Tiger overpack with a 48X 10-ton UF₆ cylinder (“48X cylinder” or “cylinder”) under normal conditions of transport and hypothetical accident conditions. The Paducah Tiger overpack is qualified by physical testing [1] and by analysis to ensure that it complies with the requirements of 10 CFR 71.73(c).

This evaluation summarizes the results of analyses and tests performed to demonstrate that the Paducah Tiger shipping package satisfies the requirements for a Type AF package as specified in 10 CFR 71.19.

4.2 Requirements for Normal Conditions of Transport

4.2.1 Containment of Radioactive Material

The A_2 quantity for uranium enriched to 5 wt % is specified as unlimited in 10 CFR 71, Table A-1. Therefore, if a full 48X cylinder has an activity less than an A_2 quantity, then the package is considered a Type A package. However, the A_2 quantity for a cylinder containing only a heel must be calculated. The A_2 is determined by applying the methodology given in Appendix A, Section IV.b, of 10 CFR 71.

In a UF_6 cylinder, the buildup of uranium daughter products occurs over time. These must be considered as part of the cylinder contents since some uranium and uranium daughter products remain in the cylinder as part of the UF_6 heel after the UF_6 has been unloaded (e.g., ThF_6 requires a higher temperature than the UF_6 to be drawn off).

The daughter products present in the heel occur from the decay of U-235, U-236, and U-238. The concentration of the heel mixture assumes that all the daughter products remain in the cylinder. This is conservative, since some of the daughter products are drawn off with the UF_6 . The mass quantities in the heel are also conservative, because it is assumed that a full 50-pound heel remains, when, in actuality, heels are typically 20 to 30 pounds. The result of these assumptions is a higher concentration of daughter products in the heel than would generally occur.

The data presented in Table 4.2-1 show that the individual isotopes in the UF_6 heel have activities much less than an A_2 quantity, and that the curie content of the mixture (2.72 curies) is much less than the A_2 value of the mixture (5.11 curies). Since the cylinder, with a heel, contains less than an A_2 quantity of material, it is demonstrated that the heel cylinder (containing up to 50 pounds of UF_6 heel) is a Type A package. Since this analysis is conservative, it is not likely that a build-up of any daughter products in the cylinder from repeated cycles causes the activity of the heel to exceed an A_2 quantity.

6.1 Discussion and Results

For criticality control, the Paducah Tiger relies upon the following features:

- specification of maximum H/U ratio, or equivalently, minimum UF₆ purity,
- impact absorption by the protective overpack, which prevents damage to the 48X cylinder sufficient to cause water in-leakage or reduction of package volume under normal and accident conditions, and
- thermal protection of the 48X cylinder by the overpack, which prevents damage to the 48X cylinder that could cause the contents to leak out or water to leak in.

Purity control is provided in accordance with ASTM C787 [1] and ASTM C996 [2] which requires a minimum 99.5% UF₆ purity. The maximum hydrogen to uranium atomic ratio (H/U) of 0.088 corresponds to 0.5% impurity, with all the impurity being hydrogen fluoride (HF). The drop, puncture, and fire testing described in Chapter 2 demonstrates that the containment provided by the 48X cylinder is not breached. Consequently, water will not leak in, nor will the contents leak out, under accident conditions. The testing also demonstrates that the overall dimensions of the overpack will remain essentially the same, so that the spacing assumed in modeling an array of packages is valid for both normal and accident conditions.

A criticality evaluation for 10-ton cylinders is provided in ORNL/TM-11947.[3] . This evaluation is directly applicable to the 48X cylinder and Paducah Tiger overpack. The report evaluates K_{eff} using the SCALE4 computer code system for an infinite array of packages with optimum interspersed moderation, and identifies the worst case to be $K_{\text{eff}} = 0.768 \pm 0.002$. The worst case calculation is summarized in Table 6.1-1. An infinite array of damaged or undamaged packages remaining subcritical corresponds to a transport index for criticality control of zero.