December 2, 2005

Mr. Hisham Shamkhani
Vice President, Logistics Engineering
Duratek, Inc.
140 Stoneridge Drive
Columbia, SC 29210

SUBJECT: AUTHORIZATION FOR SHIPMENT IN THE MODEL NO. UX-30 PACKAGE

Dear Mr. Shamkhani:

As requested by your application dated April 7, 2005, as supplemented May 16, October 6, and October 13, 2005, and pursuant to 10 CFR Part 71, Certificate of Compliance No. 9196 for the Model No. UX-30 package is amended to authorize contents and Criticality Safety Index, as follows:

Contents

Type and form of material

Uranium hexafluoride within ETTP 30" or ETTP 30B cylinders, as described in Duratek, Inc., Drawing Number C-067-005311-003, Rev. 0, and ANSI N14.1 - 2001, Figure 7, respectively. Uranium hexafluoride may be natural, enriched, or depleted in U-235. Uranium enrichment shall not exceed 5.0 weight percent U-235.

Maximum quantity of material per package

The maximum combined weight of ETTP 30" or ETTP 30B cylinder and uranium hexafluoride shall not exceed 6,620 pounds.

The maximum mass of uranium hexafluoride per cylinder shall not exceed the following:

Uranium enrichment (weight percent U-235)	Maximum UF_6 mass per cylinder (lbs)
<1%	5020
1%-5%	65

Criticality Safety Index **0.0**

The following additional conditions apply:

1. Each ETTP 30" and ETTP 30B cylinder shall be transported a single time only, from the East Tennessee Technology Park, near Oak Ridge, TN, to the Gaseous Diffusion Plant Environmental Restoration Facility, near Portsmouth, OH.

2. Each packaging containing ETTP 30" or ETTP 30B cylinders must meet the Acceptance Test and Maintenance Program of Chapter 8 of Duratek's submittal dated October 6, 2005.

3. Each packaging containing ETTP 30" or ETTP 30B cylinders shall be prepared for shipment and operated in accordance with the Operating Procedures of Chapter 7 of Duratek's submittal dated October 6, 2005.

All other conditions of Certificate of Compliance No. 9196 shall remain the same.

This authorization shall expire December 31, 2006.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

/RA/

Robert A. Nelson, Chief
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9196
TAC No. L23833

Enclosure: Safety Evaluation Report

cc: R. Boyle, Department of Transportation

The following additional conditions apply:

4. Each ETTP 30" and ETTP 30B cylinder shall be transported a single time only, from the East Tennessee Technology Park near Oak Ridge, TN, to the Gaseous Diffusion Plant Environmental Restoration Facility, near Portsmouth, OH.

5. Each packaging containing ETTP 30" or ETTP 30B cylinders must meet the Acceptance Test and Maintenance Program of Chapter 8 of Duratek's submittal dated October 6, 2005.

6. Each packaging containing ETTP 30" or ETTP 30B cylinders shall be prepared for shipment and operated in accordance with the Operating Procedures of Chapter 7 of Duratek's submittal dated October 6, 2005.

All other conditions of Certificate of Compliance No. 9196 shall remain the same.

This authorization shall expire December 31, 2006.

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SAFETY EVALUATION REPORT

Docket No. 71-9196
Model No. UX-30 Package
Certificate of Compliance No. 9196

By application dated April 7, 2005, Duratek, Inc., requested amendment of Certificate of Compliance (CoC) No. 9196 for the Model No. UX-30 package. Duratek requested temporary authorization to transport two models of DOE-owned uranium hexafluoride cylinders, identified as ETTP 30" and ETTP 30B cylinders. Although the cylinders resemble in shape and overall dimensions those authorized by the current CoC, they do not conform to all the requirements of the ANSI N14.1, "Uranium Hexafluoride - Packaging for Transport," as required by the CoC. The applicant provided an evaluation and comparison of the ETTP 30" and ETTP 30B cylinders to demonstrate that the cylinders will perform the necessary containment function as well as the ANSI N14.1 Model 30B cylinder, currently authorized for transport in the UX-30 package. In addition, the applicant provided a new criticality analysis with the proposed ETTP cylinders and contents to demonstrate that the package meets the requirements in 10 CFR Part 71 for fissile material packages. The applicant also provided thermal, containment, and shielding evaluations for the package with the new contents, to show that they are bounded by previously authorized contents.

Based on the statements and representations in the application, as supplemented, the applicant has demonstrated and the staff agrees that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

1.0 GENERAL INFORMATION

1.1 Packaging

The UX-30 package is designed to transport fissile uranium hexafluoride within ANSI N14.1 standard 30 in. diameter cylinders. The UX-30 package consists of a foam filled overpack for impact and thermal protection, and the inner Model 30B cylinder that serves as the containment vessel. The overpack is a right circular cylinder construction of two stainless steel shells with the volume between the shells filled with rigid polyurethane foam. A stepped and gasketed horizontal joint permits the top half of the overpack to be removed from the base. The overall dimensions of the overpack are approximately 44 in. in diameter and 96 in. in length.

The containment vessel for the UX-30 package is normally an ANSI-N14.1 Model 30B or 30C cylinder. For this shipment authorization, the containment vessel is either an ETTP 30" or ETTP 30B cylinder. These cylinders resemble in shape and overall dimensions the standard 30B cylinder authorized by the CoC, but vary in age, gross weight, physical condition, and do not conform to all the requirements of ANSI N14.1.

The ETTP 30" cylinder is similar to the ANSI Model 30A cylinder that is no longer addressed in ANSI N14.1. The cylinder has concave-inward heads, as opposed to the convex-outward heads of standard 30B cylinders. The cylinders consist of ½ in.-thick carbon steel shells, and 3/4 in.-thick carbon steel heads. Some of the ETTP 30" cylinders have damage, such as dents and corrosion.

The ETTP 30B cylinder is similar to the standard 30B cylinder approved as authorized contents of the UX-30 overpack. However, unlike the standard 30B cylinders, the ETTP 30B are not ASME code-stamped, and historical records of their fabrication, testing, and maintenance do not exist.

1.2 Contents

The ETTP 30" and ETTP 30B cylinders contain natural, enriched, or depleted uranium hexafluoride. The maximum mass of uranium hexafluoride that can be transported in either cylinder for a U-235 weight percent enrichment lower than 1% is 5020 pounds. The maximum mass of uranium hexafluoride that can be transported in either cylinder for a U-235 weight percent enrichment between 1% and 5% is 65 pounds. The maximum U-235 weight percent enrichment of the uranium hexafluoride in any cylinder is 5%. The applicant calculated the Criticality Safety Index (CSI) for the package loaded with ETTP 30" or ETTP 30B cylinders and its contents to be 0.0.

1.3 Drawings

The applicant provided an engineering drawing of the ETTP 30" cylinder (Duratek, Inc., Drawing No. C-067-005311-003, Rev. 0). For the ETTP 30B cylinder, the applicant provided a reference to ANSI N14.1 - 2001, Figure 7, for the ANSI Model 30B cylinder, which closely resembles the ETTP 30B cylinder.

2.0 STRUCTURAL

2.1 Introduction

The amendment application requested shipment of East Tennessee Technology Park (ETTP) uranium hexafluoride (UF_6) typical 30" and 30B cylinders in the UX-30 overpack. Under the proposed shipping plan, each ETTP cylinder will be shipped only once from ETTP, near Oak Ridge, TN, to the Gaseous Diffusion Plant Environmental Restoration Facility (PORTS), located near Portsmouth, OH. However, the UX-30 overpack was designed to be used in conjunction with the standard ANSI N14.1 Model 30B cylinders described in Fig. 7 of ANSI N14.1. The ETTP 30" cylinders, as shown in Duratek Drawing No. C-067-005311-003, Rev. 0, and the ETTP 30B cylinders have the same overall outside dimensions as those of the standard ANSI N14.1 Model 30B cylinders but do not meet the requirements of ANSI N14.1 [See Figure 2.1(1)]. In order to show that the shipment of ETTP cylinders in the UX-30 overpack will provide equivalent safety as the shipment of standard ANSI N14.1 Model 30B cylinders, the applicant performed a comparison study of the structural behavior of the ETTP 30" cylinders with that of the ANSI N14.1 standard Model 30B cylinders under identical loadings, i.e., internal pressure, hypothetical side drop, and end drop impact conditions. The applicant assumed linear elastic behavior of the material and an assumed deceleration loading of 100g in the side and end drop orientations for the structural evaluation.

2.2 Stress Comparison Under Assumed Loadings

Structural analyses were performed by the finite element analysis methodology using the ANSYS computer code. The finite element models for the standard Model 30B cylinder and the ETTP 30" cylinder are shown in Figure 2.2[1] and Figure 2.3[1] respectively.

Internal Pressure Loading

The finite element models of the two cylinders are analyzed for an assumed arbitrary internal pressure loading of 100 psig. The stress intensity contours in the Model 30B cylinders are shown in Figure 2.4[1] and the stress intensity contours in the ETTP 30" cylinders are shown in Figure 2.5[1] for the assumed internal pressure loading. The maximum stress intensity for the model 30B cylinder is 8,525 psi and for the ETTP 30" cylinder is 5,415 psi in the head region of the cylinders. Since the thickness of the ETTP 30" cylinder head is 3/4 in. and the thickness of the Model 30B cylinder head is only ½ in., it is expected that the ETTP 30" cylinder head will have smaller stress intensities. This has been confirmed by the results of the ANSYS finite element structural analysis.

Hypothetical Drop Test Loading

For the comparative stress evaluation of the ETTP 30" and the Model 30B cylinders under hypothetical drop test loadings, both cylinders are analyzed under an assumed loading of 100g in the side and end drop orientations. Under the side drop loading, the payload inertia is only supported by the shell of the cylinder. Under the end drop loading, the payload inertia is supported by the head of the cylinder. But the payload inertia is jointly supported by the shell and the head of the cylinders in a corner drop. Thus, it is concluded that the side and the end drop orientations produce the two extreme loading conditions and have been used for the stress evaluation by the application.

For a 100g top end impact condition, the maximum stress intensity of 79,131 psi occurs in the head of the Model 30B cylinders. For the same 100g top end impact condition, the maximum stress intensity in the head of the ETTP 30" cylinders is 66,061 psi. For a 100g side impact condition, the maximum stress intensity of 74,795 psi occurs in the shell of the Model 30B cylinders. Under the 100g side impact condition, the maximum stress intensity of 71,338 psi occurs in the shell of the ETTP 30" cylinders. Table 2.1[1] summarizes the maximum stress intensities in the Model 30B cylinder and ETTP 30" cylinder under the assumed hypothetical drop loadings.

Based on the stress analyses results under identical drop loadings, it can be concluded that the ETTP 30" cylinders, transported in UX-30 overpack will undergo smaller stresses, if the materials of construction of the two types of cylinders are identical.

2.3 Effects of Material Difference and Abnormalities of ETTP Cylinders

The material of construction of the ETTP 30" cylinders is different from the Model 30B cylinders and there are a number of existing abnormalities for the ETTP cylinders. The effects on the structural capabilities of the ETTP cylinders due to material difference and abnormalities are addressed in the following subsections.

Effects of Material Difference

The ETTP 30" cylinders are fabricated from ASTM A-285 Type A material and the ANSI Model 30B cylinders are fabricated from ASTM A-516 Gr.55 material. The primary differences for the two materials are strength and ductility as summarized below:

	ASTM A-516 Gr. 55 Steel	ASTM A-285 Type A
Min. Yield Strength	S_y = 30,000 psi	S_y = 24,000 psi
Min. Tensile Strength	S_u = 55,000 psi	S_u = 45,000 psi
Min. Elongation	e = 23%	e = 27%

Based on the structural evaluation, it was concluded that the ETTP 30" cylinders in UX-30 overpacks will undergo smaller stresses than the standard model 30B cylinders for the same drop impact loads if the materials of construction for the two cylinders are identical. To counter balance the lower strength of the ASTM A-285 Type A material (i.e., the ductility of the A-285 Type A steel is slightly better than the A-516 Gr. 55 steel), the application has proposed to reduce the ETTP cylinder payload weight proportionally according to the ratio of the tensile strength of the two materials. The proposed approach is deemed acceptable because the impact stress is proportional to impact loads and impact loads are, in turn, proportional to the payload inertial force. However, the internal design pressure (e.g., 200 psig, Chapter 8, Table 8.1[1]) is not influenced by the payload inertia, thus, the stress induced by the internal pressure loading (e.g., estimated to be 7,000 psi for the cylinder shell) should be excluded from the material tensile stress. The maximum allowable weight for the ETTP cylinders calculated in this manner is:

Allowable ETTP cylinder gross weight = 6,420 x (45-7) / (55-7) = 5,082 lb

ETTP 30" Cylinders Containing 1% - 5% Enriched UF_6

However, based on the criticality analysis, the maximum permitted weight of UF_6 in cylinders containing 1% - 5% enriched UF_6 is 65 lbs. Assuming a maximum empty weight for an ETTP 30" cylinder of approximately 1,600 lbs, then the maximum gross weight of a cylinder contains 1% - 5% enriched UF_6 is only 1,665 lbs. This is significantly less than the calculated allowable weight of 5,082 lbs. Therefore, it can be concluded that large margins of safety exist for ETTP 30" cylinders containing 1% to 5% enriched UF_6 to be transported inside the UX-30 overpack.

ETTP 30" Cylinders Containing Less Than 1% Enriched UF_6

ETTP 30" cylinder packages containing less than 1% enriched UF_6 must meet the Normal Conditions of Transport (NCT). The NCT free drop test distance specified for package weighing less than 11,000 lbs is 4 ft. (10 CFR 71.71). The ETTP 30" cylinders containing less than 1% enriched UF_6 can be as heavy as 6,620 lbs (SAR Table 8.1). Thus, the maximum drop impact energy is:

6,620 lbs x 4 ft. = 26,480 ft-lbs

However, it has established that it is safe for ETTP 30" cylinders containing 1% - 5% enriched UF_6 and having a maximum weight of 1,665 lbs to drop 30 ft. under the hypothetical accident conditions. The total drop impact energy is:

1,665 lbs x 30 ft. = 49,950 ft-lbs > 26,480 ft-lbs

Based on the above impact energy comparison, it can be concluded that it is safe to transport ETTP 30" cylinders containing less than 1% enriched UF_6 and weight less than 6,620 pounds inside a UX-30 overpack.

Effect of Dome-Shape Recess in the ETTP 30" Cylinder Heads

A small number of ETTP 30" cylinders have a dome-shape recess, as shown in Fig. 2.17[(1)], formed in the cylinder head. To assess the effects of the dome-shape recess, the finite element model has been modified to include the recess and analyzed for the identical side and end drop loading conditions. The maximum stress intensities obtained for the model with dome-shape recess is summarized in Table 2.2[(1)] and the result shows that there are no significant effects on the maximum stress intensities due to the presence of the dome-shape recess in the head of the ETTP 30" cylinders.

Effects of Local Corrosion

Some of the ETTP 30" cylinders have a small amount of pitting corrosion on their shell. The amount of corrosion varies from cylinder-to-cylinder. During the hypothetical accident condition test loadings, the local pitting corrosion affects the stresses only in its vicinity. The stresses away from the corroded area are not affected significantly.

The reduction of shell thickness due to localized corrosion may cause the stresses to exceed the material yield stress resulting in inelastic deformation at the vicinity of the corrosion. To assess the effects of shell thinning due to corrosion, an inelastic analysis of the ETTP 30" cylinder with a pitting corrosion over an area of 1.89" long x 3.92" wide has been performed using a finite element model and methodology. It is assumed that the corrosion has reduced the thickness of the shell over this area to one half of its original thickness (i.e., ½ x ½" = 1/4"). The finite element model is shown in Figure 2.21[(1)]. The analysis of the model under the assumed side-drop loading of 100g, gives a maximum stress intensity of 37,356 psi and a total equivalent strain of 7.863%. However, the assumed 100g side drop acceleration loading is very conservative. For 100g acceleration loading, the maximum stress intensity (i.e., 71,338 psi) obtained from the baseline geometry elastic side drop analysis (e.g., the end drop stress intensity is lower) exceeds the material tensile strength of 55,000 psi. Thus, the actual side drop acceleration loading should be considerably lower than the assumed 100g acceleration loading. Packages consisting of the UX-30 overpack and Model 30B cylinders have been tested in 30-ft. side drop orientation to satisfy the requirements of 10 CFR Part 71. Assuming the maximum stress intensity for the side drop equals to the material tensile strength, the side drop acceleration loading maybe adjusted proportionally by the ratio of the maximum stress intensities as 100g x 55/71 = 77g. At this adjusted acceleration loading level, the application concludes that the actual total strain in the pitted area due to corrosion thinning may be significantly smaller than the calculated 7.863% and well below the material allowable strain.

Effects of the Dents

Some of the ETTP 30" cylinders have a small amount of dent in their wall (shell). Since these cylinders will be shipped inside a UX-30 overpack, the presence of small dents will not have significant effects on the structural response under any of the loading conditions analyzed. However, under the end drop loading conditions, the shell of the cylinder, which is under compressive loading, may be susceptible to buckling. To ensure that buckling is not a concern for the ETTP cylinders with dents, a buckling analysis of the cylinder with an assumed amount of dents, much larger than the actual dent, has been performed on the finite element model to determine its buckling load. The size of the dent used in the analysis is a circle of 6 inches radius and is located at the cylinder's mid length. The critical buckling stress obtained from the buckling analysis is 171,096 psi which is well below the calculated maximum stress intensity in the shell of the cylinder. Given the margin included in the calculated maximum stress intensity, and the buckling analysis, which conservatively incorporated initial defects, it is concluded that the cylinder will not buckle in the end drop condition if the maximum dent size is limited to 12 in. in any direction and that there is no sharp edge around the dent.

2.4 Conclusions

Based on the analyses presented in the ETTP 30" cylinder amendment application [(1)], it can be concluded that the ETTP 30" cylinders, can and will provide adequate margin of safety as those of the standard Model 30B cylinders when transported in a UX-30 overpack. In addition, the dome-shape recess in the cylinder head region and minor defects such as local corrosion and dents are acceptable provided that the defects met the specific limitations set in the amendment application.

2.5 References

1. Attachment 1, ETTP 30" Cylinder Amendment Application, Letter from Hisham Shamkhani to E. William Brach, Dated April 7, 2005.

2. Supplemental Submittal, Rev. 1 to Request For Amendment Of Certificate Of Compliance No. 9196 For the Model No. UX-30 Package, 30" ETTP Cylinders, dated October 13, 2005.

3.0 THERMAL

The radioactive material content of the package for this authorization is unirradiated uranium hexafluoride within ETTP 30" or ETTP 30B cylinders, with a maximum enrichment of 5.0 wt.% U-235. The maximum mass of uranium hexafluoride is 5,020 pounds for U-235 weight percent enrichments below 1%, and 65 pounds for U-235 weight percent enrichments between 1% and 5%. The decay heat of the radioactive content is negligible.

The ETTP cylinders (ETTP 30" and ETTP 30B) are essentially similar to the standard 30B cylinders authorized as contents of the UX-30 package, with some differences that do not affect the thermal performance of the package. Given the similarities between these cylinders, the staff concludes that the thermal performance of the UX-30 with the ETTP cylinders will be equivalent to that provided by the package with the standard 30B cylinders. Table 3.1-1 of the Safety Analysis Report for the UX-30 package provides the maximum temperatures predicted at various points in the package under the normal conditions of transport and hypothetical accident conditions. These temperatures are below the design limits specified for the ETTP cylinders' materials.

The staff concludes that the package, with the modified contents, meets the thermal performance requirements of 10 CFR Part 71.

4.0 CONTAINMENT

The package contents include unirradiated uranium hexafluoride, with uranium enriched in the U-235 isotope. As specified in Section 1.2, the maximum mass of uranium hexafluoride with a U-235 weight percent enrichment below 1% is 5,020 pounds, and 65 pounds for a U-235 weight percent enrichment between 1% and 5%. The radioactivity is limited to a Type A quantity per package. The containment vessel for this authorization is any of the two ETTP cylinders, as specified in Section 1.3, "Drawings," above.

The containment criteria for the standard Model 30B cylinders authorized by the CoC, under both normal conditions of transport and hypothetical accident conditions, are those specified in ANSI N14.1. These criteria include the following:

7. Routine operational inspections for physical damage, defects, or leakage, performed prior to sampling, withdrawal, filling, or shipping.

8. Periodic inspections and tests. Cylinders are required to undergo hydrostatic and air leak tests every 5 years, in addition to internal and external inspections.

In order to demonstrate that the ETTP 30" and 30B cylinders provide a containment performance similar to that provided by the standard Model 30B cylinder, the applicant states that ETTP cylinders will undergo, to the extent possible, periodic and routine inspections that are comparable to those performed for the Model 30B cylinder under the ANSI N14.1 standard. Additionally, the applicant will implement compensatory measures that provide additional assurance that containment of the radioactive material will be maintained. These compensatory measures include:

1. Replacing valves on ETTP 30" cylinders with plugs.

2. Each ETTP cylinder will only be shipped a single time.

3. Implementing additional safety features during shipment, as detailed in the ETTP Transportation Plan.

Physical tests performed on the UX-30 package, with the Model 30B cylinder, were used to confirm that the containment system would not be damaged under hypothetical accident conditions. Since the dimensions, maximum weights, and construction materials of the ETTP are comparable to those of the standard ANSI N14.1, Model 30B, the applicant concluded that the ETTP cylinders would withstand the regulatory tests and maintain containment of its contents. In addition, criticality safety of the requested contents does not rely on the containment system remaining leak tight to water. The staff agrees that the containment system of the package, with the ETTP cylinders, is adequate to meet the containment requirements of 10 CFR 71.43(f) for Type AF packages.

5.0 SHIELDING

The package does not include radiation shielding. The contents of the package include uranium hexafluoride with uranium that may be enriched in the U-235 isotope. The material is unirradiated, and does not need shielding to meet the dose rate limits in 10 CFR 71.47.

6.0 CRITICALITY

The applicant revised the Safety Analysis Report (SAR) for the Model No. UX-30 to incorporate 30-in. uranium hexafluoride (UF_6) cylinders that have not been certified to be in compliance with ANSI N14.1, "Uranium Hexafluoride Packaging for Transport." These cylinders include ETTP 30" cylinders, most of which are similar to the previous ANSI N14.1 model "30A" cylinders, and ETTP 30B cylinders, which are configured similarly to the standard 30B cylinder transported in the UX-30 but do not comply with ANSI N14.1. Cylinders containing UF_6 enriched between 1 and 5 weight-percent U-235 are limited to 65 pounds of UF_6.

The applicant revised the criticality analysis for the Model No. UX-30 to consider single units and arrays of ETTP 30" and ETTP 30B UF_6 cylinders. All models considered water in-leakage resulting in a homogeneous mixture of UO_2F_2, with uranium enrichment of 5 weight-percent U-235, and water.

For all criticality analyses, the applicant used the CSAS25 module of the SCALE 4.4 code package, with KENO V.a and the 238-group ENDF/B-V cross-section library. KENO V.a is a three-dimensional Monte Carlo multi-group neutron transport code used by the SCALE system to calculate k_{eff}. This code is a standard in the nuclear industry for performing criticality analyses.

The applicant's single unit model of the ETTP 30" cylinder consisted of various geometric configurations of a UO_2F_2 solution within a fully reflected cylinder with flat heads, shortened to its axial centerline length. Ignoring the concave head of the ETTP 30" cylinder conservatively allows for closer reflection of the fissile material from the cylinder walls and external water reflector. The cylinder wall thickness was reduced from the nominal 0.5 in. to 0.2031 in. Figure 1 of Attachment 2 to the Duratek letter dated October 6, 2005, shows the three geometries considered for the ETTP 30" single unit model, of which configuration (c), with the cylinder on end and the fissile material accumulated in one end of the cylinder, was the most reactive.

The applicant's single unit model for the ETTP 30B cylinder consisted of a full length 30B cylinder in an orientation and with a fissile material geometry similar to that of model (c) for the ETTP 30" cylinder, except with convex heads. This model was more reactive than the ETTP 30" cylinder models and was therefore used as the basic unit in the subsequent array models. In both the ETTP 30" and ETTP 30B models, the volume fraction of water in the solution, and also the height of solution in the cylinder, were varied to find the optimum level of moderation. In all single unit cases, the maximum k_{eff} was less than 0.62.

The applicant's array model consisted of the most reactive unit from the single package analysis, with reflected conditions on six sides to create an infinite array of packages, with the fissile material solution in adjacent packages configured for maximum neutron interaction. The array model also included the 12-gauge and 14-gauge liners of the UX-30 overpack, but did not take credit for the spacing between packages provided by the foam between the two liners, conservatively overestimating the damage from the hypothetical accident conditions tests. This model was found to be most reactive with no interstitial moderation and with no water inside the package external to the fissile solution. The maximum resulting k_{eff} + 2σ for an infinite array of damaged UX-30 packages was 0.8360.

The applicant selected a group of critical experiments involving low enriched uranyl fluorides from which to benchmark the SCALE 4.4 code for this application. These experiments involved systems of UF_4 and UO_2F_2, enriched from 1 to 6 weight percent U-235, and either unreflected or reflected by polyethylene, paraffin, or water. Table 1 of Attachment 2 summarizes the determination of the area of applicability defined by these experiments. The upper subcritical limit determined from the benchmark analysis is 0.932, which is greater than the maximum calculated k_{eff} of the system.

The staff performed confirmatory criticality calculations using the CSAS25 criticality analysis sequence in the SCALE 5 code system, along with the 238-group neutron cross section set. The staff modeled the most reactive infinite array case from the applicant's criticality analysis using assumptions similar to those used by the applicant. The results of the staff's confirmatory criticality analysis agreed with the applicant's results, with respect to both the maximum calculated k_{eff} and the degree of moderation which produced the maximum k_{eff}.

The applicant has shown and the staff agrees that the Model No. UX-30 package containing ETTP 30" or ETTP 30B cylinders meets the criticality safety requirements of 10 CFR 71.55 and 71.59, when limited to 65 pounds of UF_6, enriched to no more than 5 weight percent U-235.

7.0 PACKAGE OPERATIONS

The applicant provided supplemental package operations for shipment of the ETTP cylinders. These operations are intended to supplement the package operations specified for the Model No. UX-30 package, as defined in Chapter 7 of the safety analysis report. The supplemental operations replace those sections of the procedures which are not applicable to the shipment of the ETTP cylinders. These sections include removing provisions for filling the cylinder (since the ETTP cylinders are already filled in their current condition), and revising those sections applicable to ANSI N14.1-compliant cylinders. The revised package operations also specify that each ETTP cylinder is to be transported only once, from the ETTP facility near Oak Ridge, TN, to the Gaseous Diffusion Plant Environmental Restoration Facility, located near Portsmouth, OH.

The revised package operations include requirements for ETTP-cylinder specific periodic inspections prior to shipment, and requirements and procedures for performing ETTP-cylinder specific pre-shipment inspections. In addition, the applicant proposed specific operational controls for the shipment of these cylinders. Table 7.1 of the application lists elements of the Transportation Plan.

8.0 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The applicant provided acceptance tests for the ETTP cylinders. These acceptance tests assure that the conditions of the cylinders, including the conditions of any dents and corrosion in the cylinders, do not exceed the conditions assumed in the structural analysis. Among these bounding conditions are: dents should be smooth and cannot exceed 12 in. in length or width, and any localized corrosion or pitting spots may not decrease the shell or head thickness to less than 0.20 in.

The applicant provided a maintenance program for the ETTP cylinders. The maintenance program is performed according to Table 4.1 of the application.

CONCLUSIONS

The applicant provided an evaluation of the Model No. UX-30 package with the ETTP 30" and 30B cylinders. Based on the statements and representations in the application, as supplemented, the applicant has demonstrated and the staff agrees that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued on December 2, 2005.