SAFETY EVALUATION REPORT
Model No. CHT-OP-TU Package
Certificate of Compliance No. 9288
Revision No. 8

SUMMARY

By application dated July 17, 2007, as supplemented August 29, 2007, Columbiana Hi Tech, LLC, requested an amendment to Certificate of Compliance No. 9288, for the Model No. CHT-OP-TU package. Columbiana requested that the authorized contents be revised to allow heterogeneous uranium oxide compounds, e.g., pellets, to be shipped within the 8-inch diameter oxide (containment) vessel, provided that an internal insert is used. The applicant provided: (1) a drawing that shows the oxide vessel insert, called the pellet shipping assembly; (2) a criticality evaluation for the package to show that the fissile contents would remain subcritical under normal and hypothetical accident conditions; and (3) revised operating and maintenance instructions that address use of the pellet shipping assembly.

The contents authorized for transport in the package have been revised, as requested by the applicant. Based on the statements and representations in the application, the staff agrees that this change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

EVALUATION

GENERAL INFORMATION

The applicant requested that the certificate be amended to authorize heterogeneous uranium oxide compounds to be shipped within the 8-inch diameter oxide vessel. Previously, only homogenous powders could be shipped within the 8-inch diameter oxide vessel. Heterogeneous compounds are pellets, previously pelletized materials, or mixtures of pellets and powders. Previously, heterogeneous compounds were authorized for shipment only in the 7.5-inch or 6-inch diameter oxide vessels. This is because results of criticality analyses for heterogeneous materials in the 8-inch diameter oxide vessel were not within the upper safety limit.

Packaging

The applicant provided the design of an insert, called the pellet shipping assembly, to be used within the 8-inch diameter oxide vessel. This shipping configuration (the pellet shipping assembly within the 8-inch diameter oxide vessel) would result in a loading with nuclear reactivity similar to that of the 7.5-inch diameter oxide vessel. The insert was designed to reduce the effective cross sectional void area of the 8-inch diameter oxide vessel to that of the 7.5-inch diameter oxide vessel. The applicant submitted a drawing that shows the pellet shipping assembly (Areva NP Inc., Drawing No. 9046816, Rev. 001). The pellet shipping assembly consists of two main parts – a lower and an upper assembly, both constructed of aluminum. Pellets are placed on trays and positioned in the lower assembly. Stainless steel spacer plates are used to separate multiple stacks of trays and to limit the stack length. Aluminum spacer blocks are used for partial shipments. The upper assembly is positioned on the top assembly and may be secured with latches.

CRITICALITY EVALUATION

Design for Criticality Safety

The oxide vessel pellet shipping assembly is designed to ensure that the effective cross sectional area within the 8-inch diameter oxide vessel is reduced to a maximum of that of the 7.5-inch-diameter oxide vessel. The engineering drawing of the pellet shipping assembly specifies minimum aluminum plate thicknesses and lengths for the upper and lower assemblies. Criticality safety does not rely on the pellets remaining within the pellet shipping assembly, or remaining between pellet trays, but relies on the presence of the aluminum plates of the upper and lower assemblies to displace water moderation. The applicant presented a series of criticality calculations to show that the new loading configuration meets the requirements for fissile material packages. The approach taken by the applicant was to show that the presence of the pellet shipping assembly aluminum components was equivalent to reducing the oxide vessel diameter from 8 inches to 7.5 inches. The 7.5-inch diameter oxide vessel had previously been shown to be critically safe with pellets, for a single package and for arrays of packages under normal conditions of transport and hypothetical accident conditions. The applicant used the SCALE 4.3 code package, with the 44-group cross-section library, to perform the criticality calculations.

Single Package Analysis

To demonstrate that a single package remains adequately subcritical the applicant presented the results previously performed for pellets within the 7.5-inch diameter oxide vessel. The results (Table 6.2 of the previous application) were well within the upper safety limit. In addition, to demonstrate that significant margin exists, the applicant provided an analysis for pellets within the unsleeved (i.e., without the pellet shipping assembly) 8-inch diameter oxide vessel. The maximum k-eff for pellets within the 8-inch oxide vessel was 0.8264, including bias and uncertainty, assuming an undamaged, flooded package, and 0.8332, assuming a damaged, flooded package (p. 6.8.2-3 of the application). The single package analysis considered water within the oxide vessel, which the applicant refers to as the "off-normal condition" model. The staff agrees that the single package analysis is adequate and shows that the package meets the requirements of 10 CFR 71.55.

Arrays of Packages under Normal Conditions of Transport

For the normal conditions array, the criticality models assumed pellets with no internal water moderation, but did consider 1000 grams of polyethylene, the maximum mass of wrapping materials authorized within the oxide vessels. For the normal conditions arrays, previous results for the 7.5-inch diameter oxide vessel were within the upper safety limit (Table 6.2 of the previous application). For the unsleeved 8-inch diameter oxide vessel, the maximum k-eff was

0.6651 (Table 6.8.2-1 of the application). The analyses assumed a 5x5x5 array of undamaged packages.

Arrays of Packages under Hypothetical Accident Conditions

Previous results demonstrated that the evaluation of arrays of damaged packages was the most limiting with respect to criticality safety. For the current analysis, the applicant provided a number of analyses to show that the proposed configuration, with pellets when packaged with a pellet shipping assembly within the 8-inch diameter oxide vessel, met criticality safety requirements. The analyses considered a 4x4x3+2 array of damaged packages.

The staff evaluated the ability of the aluminum pellet shipping assembly to retain sufficient structural integrity to assure no significant rearrangement of the aluminum material within the oxide vessel that could affect criticality safety. The staff concluded that the aluminum plates would not buckle under drop test conditions. In addition, the criticality safety of the fissile material does not rely on the pellets remaining within the pellet shipping assembly.

For the array of damaged packages, the applicant evaluated the use of an aluminum sleeve that simply reduced the diameter of the oxide vessel from 8 inches to 7.5 inches. The analyses assumed optimum moderation within the oxide vessels, considering moderation by water and 1000 grams of plastic. The models considered a 1-inch gap at the top and bottom of the oxide vessel, as well as a 1-inch gap in the middle of the oxide vessel, with the pellets within the gaps. The maximum k-eff was 0.9458 (Table 6.8.2-1), which is within the upper safety limit of 0.9473.

The applicant performed additional analyses to show that the geometry of the sleeve, or insert, was not important with respect to criticality safety. These analyses considered a right circular cylinder of aluminum, with a cross sectional area of 40 cm^2, which could be positioned within the center of the oxide vessel, or at the edge of the oxide vessel. This is equivalent to a 3.58-cm radius aluminum rod. The calculated k-eff for the case where the rod was at the center of the oxide vessel was 0.9036, and the k-eff for the rod at the edge was 0.9281, which are both within the upper safety limit. The results of the calculations were summarized in Table 6.8.2-1.

The staff reviewed the applicant's criticality analyses for the single package and arrays of packages under normal conditions of transport and hypothetical accident conditions. In addition, the staff performed confirmatory calculations for a selected group of analyses considered to be the most limiting. The staff used the SCALE 5.1 code package with the 238-group cross-section library to model and evaluate the array of damaged packages. The staff's analysis considered: (1) optimum fuel to moderator within each oxide vessel, including 1000 grams of polyethylene within each oxide vessel; (2) void between packages in the arrays; (3) the oxide vessel with a reduced diameter; and (4) a 4x4x3+2 array of packages. The staff's results were consistent with the applicant's.

Sensitivity Evaluation

A sensitivity study was performed to demonstrate that the analyses considered the most reactive pellet configuration. The pellets were evaluated over a range of diameters and pitch. This was to determine the optimum water to fuel volume ratio. The sensitivity of external moderation was also evaluated. Optimum external moderation was determined to be a water volume fraction of 0.0001; additional moderation between packages reduced the reactivity of the array. The tilting of the oxide vessels within the package, due to accident conditions, was also considered, and shown to be negligible. Neoprene pads are used within the oxide vessels to provide a snug fit for the pellet shipping assembly. The applicant demonstrated that the presence of the neoprene reduces the reactivity of the system. The staff agrees that the sensitivity analyses were appropriate for the criticality evaluation.

Benchmarking Evaluation

The applicant presented additional benchmarking information and showed that the previously determined upper subcritical limit (USL) remains valid for the sleeved, 8-inch oxide vessel. While the staff does not agree with the statement that the previously established USL remains valid due to the reduction in cross-sectional area provided by the pellet shipping assembly (p. 6.8.2-1 of the application), the staff agrees that the applicant's benchmarking assessment (p. 6.8.2-5 of the application), and determination of the USL, were adequate.

PACKAGE OPERATIONS

The applicant provided a revised Section 7.0 of the application. The package operations were revised to address the use of the pellet shipping assembly within the 8-inch diameter oxide vessel for shipment of pellets and other heterogeneous contents.

MAINTENANCE PROGRAM AND ACCEPTANCE TESTS

The applicant provided a revised Section 8.0 of the application. The maintenance program was revised to address visual inspections of the pellet shipping assembly on a periodic basis.

CONCLUSION

The Certificate of Compliance has been revised, as requested by the applicant. Based on the request the following changes were made:

Condition No. 5.(a)(2), "Description," was revised to include the pellet shipping assembly.

Condition No. 5.(a)(3), "Drawings," was revised to include the following:

> The Oxide Vessel Pellet Shipping Assembly is constructed and assembled in accordance with AREVA NP, Inc., Drawing No. 9046816, Rev. 1.

Condition No. 5.(b)(2), "Maximum quantity of material per package," was revised to authorize the new shipping configuration with the pellet shipping assembly for shipment of heterogeneous uranium compounds within the 8-inch diameter oxide vessel. In addition, the certificate was revised to clarify that the 402-pound limit per oxide vessel included all internal packaging materials (such as the pellet shipping assembly) and the radioactive contents. The revised Condition No. 5.(b)(2) reads:

5. (b) (2) Maximum quantity of material per package

The maximum allowable contents heat generation rate is 1.0 BTU/hr/ft^3 (10.3 W/m^3). The maximum weight of contents, including the uranium compounds and all packaging materials within the Oxide Vessel, is 402 pounds per 8-inch, 7.5-inch, or 6-inch diameter Oxide Vessel, and a maximum of 1608 pounds per package.

For contents described in Condition Nos. 5.(b)(1)(B), 5.(b)(1)(D), and 5.(b)(1)(F), the Oxide Vessel Pellet Shipping Assembly, as described in Condition No. 5(a)(3), must be used within the 8-inch diameter Oxide Vessel. The Oxide Vessel Pellet Shipping Assembly is not required when using the 7.5-inch, or 6-inch diameter Oxide Vessel.

Condition No. 8 of Revision No. 7 of the certificate was deleted, since the condition authorized an alternative Package Identification Number only until April 30, 2007.

Condition No. 10 of the certificate authorizes the continued use of Revision No. 7 of the certificate for approximately one year.

These changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9288,
Revision No. 8, on September 26, 2007.