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70-00036

SGTB:CJW
71-6294

MEMORANDUM FOR: Nancy L. Osgood, SGTB, NMSS

FROM: Carl J. Withee, SGTB, NMSS

SUBJECT: CRITICALITY REVIEW FOR REVISED UNC-2901 SHIPPING PACKAGE

I have completed my review of the revised application for amendment to the certificate of compliance for the UNC-2901 shipping package. This review used the information contained in the application by Combustion Engineering dated February 22, 1990.

The new package contents is an array of 16 stainless steel trays containing UO2 pellets. The trays are held together by a holder with nylon web belts. In addition, the array of trays is shored with wood spacers to assure a tight fit in the internal cavity of the package. These spacers are designed to assure that the pellets will remain in the trays during the hypothetical accident and were added in response to NRC questions on the previous design. Because drawing No. D-5018-2001 Rev. 1 only specifies a maximum height for the Bulk Pellet Drying Tray, a condition needs to be added to the certificate of compliance to assure that the tray array and wood spacers make a snug fit in the package cavity so that the pellets can not come out of the trays under normal or accident conditions. In addition, the applicant responded to NRC questions by dropping its request to include UO2 powder in the contents list.

The applicant used the KENO-IV computer code to calculate the reactivities of the various package configurations. A 123-group neutron cross section set was adjusted for self-shielding with the NITAWL computer code and then collapsed, using XSDRNPM, to a homogenized 16-group library based on an infinite uniform lattice of pellets.

For normal conditions, the applicant analyzed an 8x8x8 array of packages containing 145 kgs of UO2 pellets with a diameter of 0.826 cm. The package array was internally dry but reflected by water. The applicant calculated a k-eff of 0.724 $\pm$ 0.005.

For the single package analysis, the package was completely flooded and reflected by water. The applicant assumed a loading of 91 kgs UO2 with pellets of 0.826 cm in diameter. The calculated maximum adjusted k-eff was 0.8504.

For the accident case of an array of packages, the trays and internal cavity of the cask were assumed to be flooded. The space between the inner cavity and the outer package shell and the space between packages were assumed to be void to maximize the interaction between packages in the array. An array of packages 6x6x6 was analyzed. Under the hypothetical accident conditions, the applicant calculated a maximum k-eff value of 0.95291 for a loading of 97.6 kgs UO2 and a value of 0.94692 for 108.8 kgs of UO2. (The k-eff values were adjusted for bias, uncertainty, and increasing the pellet diameter to a maximum of 0.9563 cm.)

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From these data, the applicant established a minimum package loading of 104 kgs UO2.

Under the accident conditions, the applicant showed that for the fuel loading range of 104 to 145 kgs UO2 per package (or 6.5 kgs to 9.07 kgs per tray), the reactivity will increase with increasing pellet diameter up through the maximum requested diameter of 0.9563 cm. In this range, the reactivity also increases with decreasing fuel loading because the flooded packages are under moderated. To assure criticality safety, a minimum loading of 104 kgs was established. The applicant established a Transport Index of 0.5 for Fissile Class II shipments (maximum of 100 packages) and a maximum of 216 packages per Fissile Class III shipment.

The NRC staff conducted an independent analysis of the application. The staff used the KENO-Va program in the SCALE system on the Oak Ridge National Laboratory computer to calculate reactivities. A 27-group neutron cross section set was used with a spherical triangular lattice structure to simulate the pellets. The geometry of the pellet trays was modeled explicitly rather than being homogenized as in the applicant's analysis. The staff's analysis confirmed that the optimum reactivity under accident conditions was at the minimum fuel loading and the maximum pellet diameter.

For a single flooded package, staff calculated an adjusted k-eff of 0.828 for 91 kgs of UO2 and 0.815 for 104 kgs of UO2. A maximum adjusted k-eff of 0.898 (0.901 for a 123-Group calculation) was calculated for a 6x6x6 array of packages under hypothetical accident conditions. The staff's numbers are expected to be lower than the applicant's because a more explicit model of the package's internal stainless steel configuration could be made in the KENO-Va program.

The NRC staff has reviewed the applicant's nuclear and geometric data and modeling of the UNC-2901 for the normal and hypothetical accident conditions and found them to be acceptable. Independent NRC staff analysis and calculations agree with the applicant's finding that the cask will meet the requirements of 10 CFR Part 71 for criticality safety under the normal and hypothetical accident conditions.

Approval of the application is recommended.

Carl J. Withee, SGTB, NMSS

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