April 16, 2004

Mr. Peter S. Hastings
Licensing Manager
Duke Cogema Stone & Webster
P.O. Box 31847
Mail Code FC12A
Charlotte, NC 28231-1847

SUBJECT: MIXED OXIDE (MOX) FUEL FABRICATION FACILITY NUCLEAR CRITICALITY SAFETY - REVIEW OF VALIDATION REPORT

Dear Mr. Hastings:

The purpose of this letter is to inform Duke Cogema Stone & Webster (DCS) on the status of the U.S. Nuclear Regulatory Commission's (NRC's) review of the Criticality Safety Validation Report, Rev. 3, submitted October 10, 2003, as well as information presented during the in-office review of December 17-19, 2003, (documented in the January 8, 2004, summary) and your letter of February 12, 2004, as part of the staff's review of the Mixed Oxide Fuel Fabrication Facility Construction Authorization Request (CAR). We have concluded that the validation of AOA(3) for $PuO_2$ powders is sufficient to support NRC approval of the requested Upper Subcritical Limit (USL) of 0.9345. With regard to AOA(4) for MOX powders, we have concluded that an additional 1% margin in $k_{eff}$ is needed to provide reasonable assurance that calculations involving mixed oxide powders are adequately subcritical. This has the effect of reducing the allowable USL for AOA(4) from 0.9349 to 0.9249.

The basis for these conclusions is provided in Enclosure 1. If you have any questions, please contact me at 301-415-6522.

Sincerely,

/RA/

Andrew Persinko, Sr. Nuclear Engineer
Special Projects Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket: 70-3098
cc: J. Johnson, DOE
H. Porter, SC Dept. of HEC
J. Conway, DNFSB
D. Curran, Esq.,DCS
L. Zeller, BREDL
G. Carroll, GANE
D. Silverman, Esq., GANE

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**MOX Validation Report-**
**Staff Conclusions**

Nuclear Regulatory Commission (NRC) staff has completed its review of Part II, of your Validation Report, Rev. 3, submitted October 10, 2003, as well as information presented during the in-office review of December 17-19, 2003, (documented in the January 8, 2004 summary) and DCS's letter of February 12, 2004. This information regarded the computer code validation for area(s) of applicability AOA(3) and AOA(4), covering $PuO_2$ and mixed oxide (MOX) powders, respectively. Based on this review, the staff has concluded that the validation of AOA(3) for $PuO_2$ powders is sufficient to support NRC approval of the requested Upper Subcritical Limit (USL) of 0.9345. With regard to AOA(4), the staff has concluded that an additional 1% margin in $k_{eff}$ is needed to provide reasonable assurance that calculations involving mixed oxide powders are adequately subcritical. This has the effect of reducing the allowable USL for AOA(4) from 0.9349 to 0.9249.

Among the 59 benchmark experiments analyzed for AOA(4), 17 consisted of $PuO_2$-polystyrene compacts with 100wt% Pu-content (from the PU-COMP-MIXED-002 benchmark set), and 4 consisted of MOX-polystyrene compacts with a very low energy of average lethargy causing fission (EALF) (from the PU-8 benchmark set). The information submitted attempted to demonstrate that the 17 experiments with 100wt% Pu-content were acceptable for validating design applications involving MOX powder (with 6.3 and 22wt% Pu-content). The staff has reviewed this and has found that the justification for making this conclusion is not sufficient. In particular, the models used in the $^{238}U$-removal study were constructed at 30wt% Pu-content and the study did not consider the increased effect of $^{238}U$ at 22wt% Pu-content. Also, this study concluded that removal of the $^{238}U$ resulted in a change in $k_{eff}$ of approximately 8% (at 30wt% initial content), but did not justify the conclusion that this was not significant. Moreover, the justification based on a comparison of the $^{239}Pu$ fission spectra did not account for the fact that other nuclides and reactions besides $^{239}Pu$-fission are increasingly important in the low-Pu regime (such as $^{239}Pu$ and $^{238}U$ absorption and $^{238}U$ fission). Because of this, the staff could not conclude that the 17 benchmarks in the PU-COMP-MIXED-002 set are applicable to a validation of MOX powder systems covered by AOA(4).

DCS has committed to the non-parametric technique discussed in NUREG/CR-6698, in order to determine the USL when benchmarks are not normally distributed, which is the case for AOA(4). Applying this technique to the 38 remaining benchmarks results in a non-parametric margin of 1% in $k_{eff}$, which is the basis for our conclusion.