DUKE COGEMA
STONE & WEBSTER

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Subject: Docket Number 070-03098
Duke Cogema Stone & Webster
Mixed Oxide (MOX) Fuel Fabrication Facility
Response to Request for Additional Information – MFFF Criticality Validation Report (DSER Open Item NCS-04)

References: 1) R. C. Pierson (NRC), *Draft Safety Evaluation Report on Construction of Proposed Mixed Oxide Fuel Fabrication Facility, Revision 1*, Dated 30 April 2003

2) A. Persinko (NRC), *Request For Additional Information - Mixed Oxide (MOX) Fuel Fabrication Facility Nuclear Criticality Safety*, Dated 25 June 2003

As part of the review of Duke Cogema Stone & Webster's (DCS') Mixed Oxide Fuel Fabrication Facility (MFFF) Construction Authorization Request (CAR) documented in the Draft Safety Evaluation Report (Reference 1), NRC Staff identified an open item related to Nuclear Criticality Safety. Enclosure 1 of this letter provides a response to follow on questions related to open item NCS-04, identified in Reference 2. Please note that, in the interest of ensuring appropriate reflection of weapons grade plutonium criticality experience within the U.S. Department of Energy (DOE), the enclosed responses were the subject of a detailed review on the part of a DOE expert panel, whose members are indicated in Enclosure 2. The panel has concurred with DCS' approach, and their comments have been incorporated in Enclosure 1.

Reference 2 also requested submittal of various data files in order to expedite the Staff's review of DCS' validation report. As indicated previously, the MOX Standard Review Plan states that the validation report should be maintained at DCS' facility, implying that any Staff review would take place at DCS' facility. Under the presumption that the Staff's review of the validation report would be facilitated by making the report available directly, DCS has previously submitted the original report (Parts I-III) and updated parts in response to multiple Staff questions.

Supporting data files would clearly be subject to this policy as well, as has been discussed with the Staff on several occasions. Various Staff members have visited DCS' Charlotte and Washington offices on several occasions to review detailed analyses and associated data. While DCS prefers to host such visits (pursuant to NRC policy) for the purposes of such detailed reviews, DCS agrees to provide the requested data files in hopes of facilitating timely closure of

NMSS01

this open item. DCS considers the data files to be technical information that backs up conclusions in the Construction Authorization Request (CAR), but does not consider them to be part of the CAR. The data files will be provided under a separate cover letter.

If I can provide any additional information, please feel free to contact me at (704) 373-7820.

Sincerely, Vincent Chevalier

Peter S. Hastings, P.E.
Manager, Licensing and Safety Analysis

Enclosures: (1) Response to request for Additional Information DSER Open Item on Nuclear Criticality Safety
(2) U.S. Department Of Energy expert panel membership

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Enclosure 1
Response to Request for Additional Information (MFFF Validation Report)
DSER Open Item On Nuclear Criticality Safety

The following major issues and questions have been identified during review of the MOX Validation Report (VR), submitted in January 2003. For each major issue, specific examples are provided. In addition, Question 7 describes additional information that is needed to resolve NCS-04.

NOTE: Several of these questions contain multiple parts. (Q refers to the NRC question; R refers to the DCS response.)

Q 1 For several areas of applicability (AOAs), the range of important physical and neutronic parameters covered by the chosen benchmark experiments does not adequately cover the range of parameters needed by the anticipated design applications. For each AOA, state the range of parameters for which you consider the code validated. If the parametric range exceeds that covered by the benchmark experiments, justify the extension of the AOA. This extrapolation should be consistent with your commitment to ANSI/ANS-8.1-1983 (R1988). This commitment stated that where extensions to the AOA are needed, either supplemental calculational methods or additional margin will be employed.

R The validation report revisions – Revision 3 of Part I, Revision 2 of Part II, and Revision 1 of Part III, submitted in July, 2003 – more clearly state the parametric range of each AOA. In particular, the following excerpted tables show the validated AOA for each of the five AOAs:

Enclosure 1
Response to Request for Additional Information (MFFF Validation Report)
DSER Open Item On Nuclear Criticality Safety

AOA(1) – Pu nitrate:

Table 5-1 AOA (1) – Comparison of Key Parameters and Definition of Validated AOA

Parameter	Design application	Benchmark	Validated AOA
Geometric shape	Cylinder Slab Annular cylinder Array of cylinders	Sphere Slab Array of cylinders	Cylinder Slab Annular cylinder Array of cylinders
Reflector conditions	Full water Cd/water Borated concrete	Full water Cd/water Concrete	Full water Cd[1]/water Borated concrete[2]
Chemical form	Pu nitrate solution	Pu nitrate solution	Pu nitrate solution
Pu/(U+Pu)	100 wt. %	100 wt. %	100 wt. %
Isotopic composition [wt. % ^{240}Pu]	4.0	0.54–4.67	4.0
H/Pu	100–200	85–1157	100-200
C(Pu) [g/l]	125–237	22–269	125-237
EALF [eV]	0.14–0.25[3]	0.05–0.55	0.14–0.25

1. Cadmium sheet of 0.05 cm thickness (clad in 0.1 cm stainless steel) outside of a slab tank of 4.5-9.5 cm fissile material thickness.

2 Refer to Attachment 5 for justification of validation for borated concrete.
Borated concrete (colmanite concrete) of 15 cm thickness (clad in 0.5 cm stainless steel) inside and outside of an annular tank of 7.0-7.5 cm fissile material thickness, separated from the tank by 1.8-2.0 cm conservatively assumed to be filled with water and having the following characteristics:

Colemanite concrete (density = 1.5055 g/cm^3)

Elements	Number densities [10^{24} at/cm^3]
^{10}B	1.59E-03
^{11}B	7.04E-03
Ca	4.65E-03
Fe	5.01E-04
Si	1.66E-04
H	2.17E-02
Al	1.96E-03
O	3.25E-02

Note: Only 5% of the above boron values are required to meet the conservatively modeled USL.

3 At the optimum of moderation

AOA(2) – MOX pellets, rods, and assemblies:

Table 5-2 AOA (2) – Comparison of Key Parameters and Definition of Validated AOA

Parameter	Design application	Benchmark	Validated AOA
Geometrical shape	Heterogeneous lattices, Rectangular lattices	Rectangular lattices Hexagonal lattices	Heterogeneous lattices, Rectangular lattices
Absorber / Reflector	Water	Water	Water
Chemical form	Mixed oxide	Mixed oxide	Mixed oxide
$PuO_2/(UO_2+PuO_2)$ [wt. %]	6.3	1.5–6.6	6.3
Isotopic composition [wt. % ^{240}Pu]	4.0	8–22	4.0[1]
v^m/v^f	1.9–10	1.1–10.75	1.9–10
EALF [eV]	0.1–0.66	0.08–0.91	0.1–0.66

[1] In accordance with the guidance provided in LA-12683, permissible variations of ± 4% on ^{240}Pu content are considered within the acceptable values for defining AOA for this parameter.

AOA(3) – PuO_2 powder:

Table 5-1 AOA(3) Comparison of Key Parameters and Definition of Validated AOA

Parameter	Design Application	Benchmarks	Validated AOA
Geometric shape	Parallelepipeds Arrays of cylinders Spheres	Parallelepipeds Arrays of cylinders Spheres	Parallelepipeds Arrays of cylinders Spheres
Absorber/reflector	Water, Cd, Concrete	Plexiglas, air, water	Water
Chemical form	PuO_2 powder	PuO_2 in polystyrene (C_8H_8) Pu-metal in air/water	PuO_2 powder
Isotopic composition	4 wt. % ^{240}Pu	2.2 wt. % to 20.2 wt. % ^{240}Pu	4 wt. % ^{240}Pu
H/Pu	1.16 to 5.97	0 to 210	1.58 to 5.99
EALF [eV]	3.1 to 65000	1 to 10^6	94 to 1019[1]

[1] The range of EALF used in the "typical design applications" used in the S/U determination of benchmarks as shown in Table 3-3, 94-1019 eV, does not encompass the full anticipated range in the design applications, 3.1-65000 eV, as shown above. However, as shown above, the range of EALF of the benchmarks actually used (1-10^6 eV) clearly encompasses the range of the design applications. Additionally, as shown in Figure 6-2, the trend of k_{eff} as a function of EALF shows that between 94-1019 eV and the anticipated range of the calculations, 3-1-65000 eV, the changes in k_{eff} are small (less than about 0.004). Further, the full range of the benchmarks (1-10^6 eV) is well represented by data points throughout the range. Thus the use of extrapolation, as discussed in Section 5.4, is applicable.

AOA(4) – MOX powder:

Table 5-2 AOA(4) Comparison of Key Parameters and Definition of Validated AOA

Parameter	Design Application	Benchmark	Validated AOA
Geometrical shape	Parallelepipeds Spheres	Parallelepipeds Arrays of pins	Parallelepipeds Spheres
Absorber/reflector	Water	Plexiglas	Water Depleted Uranium
Chemical form	MOX powder	MOX and PuO_2 powder in polystyrene Water moderated MOX fuel pins	MOX powder
Pu/(U+Pu) composition	6.3 or 22 wt. %	1.5 to 100 wt.%	6.3 or 22 wt. %
Isotopic composition	4 wt. % ^{240}Pu	2.2 to 11.6 wt. % ^{240}Pu	4 wt. % ^{240}Pu
H/(U+Pu)	1.15 to 1.58	0[1] to 31	0.3 to 1.58
EALF [eV]	0.8 to 175	0.6 to 1740	28 to 3751

[1] Moderated arrays of fuel pins

AOA(5) – PuO_2F_2 (bounding of Pu oxalate):

Table 5-2 AOA (5) – Comparison of Key Parameters and Definition of Validated AOA

Parameter	Design application	Benchmarks	Validated AOA
Geometric shape	Parallelepipeds Arrays of cylinders Spheres	a) Parallelepipeds[1] b) Arrays of cylinders	Parallelepipeds Arrays of cylinders Spheres
Absorber/ reflector	Water, Cd, Borated concrete	a) Plexiglas, air b) Air/ water	Water, Cd, Borated concrete[2]
Chemical form	Pu compounds in water and precipitated oxalates	a) PuO_2-polystyrene mixture b) Pu-nitrate solution	PuO_2F_2 solution
Isotopic composition	4 wt. % ^{240}Pu	a) 2.2 to 18.35 wt. % ^{240}Pu b) 4.23 to 4.67 wt.% ^{240}Pu	4 wt. % ^{240}Pu
H/Pu	30 to 50	a) 0.04 to 49.6 b) 78 to 858	a) 30 to 50 b) 78 to 858
EALF [eV]	0.7 to 4.69	a) 0.685 to 4900 b) 0.135 to 0.551	a) 0.685 to 4900 b) 0.135 to 0.551

[1] a) refers to Group 1 b) refers to Group 2
[2] Justification for borated and cadmium-containing reflectors provided in Part 1 is applicable here.

In general, for AOAs (1), (2), and (5), the validated AOA is established based on a more specific (smaller) range of design application values as shown in the tables above. For AOAs (3) and (4), in which the benchmark experiments are based upon Sensitivity and Uncertainty (S/U) analysis, the validated AOA is established based on key parameter ranges of the design applications used as input to the S/U analysis as shown in Table 3-3 of Part II for AOA(3) and Table 3-7 of Part II for AOA(4). A description of the key parameters of these design applications is also presented in the tables as shown above.

It should also be mentioned that, even though the range of parameters described in the above tables is narrow, examination of the ranges of the parameters of the benchmarks as shown in the figures in Section 6 of all three report parts, show that the benchmarks often cover larger ranges. Thus, while in some cases, these larger ranges are not shown in the columns above labeled "Validated Ranges," the bias which has been accounted for in the USL of the reports actually covers experiments over this generally larger range.

Additionally, the anticipated values of the parameters for the design applications shown in Section 4 of the report parts, and shown in the column above labeled "Design Application," is representative of the vicinity of the limiting conditions in the calculations. Often, various sensitivity studies are performed over much wider ranges. In those sensitivity study cases, the reactivity is much less than the limiting case and thus code validation is not important.

In all cases, adherence to the AOA is demonstrated in the calculations for the specific NCSEs.

Q Apparent areas where the range of parameters covered by benchmarks disagrees with that covered by design applications include:

<u>AOA(1)</u>: Design applications will include cadmium and borated concrete absorbers, but there are few plutonium nitrate benchmarks with cadmium and none with borated concrete. The range of boron and cadmium absorber loading for which AOA(1) is considered valid should be described and justified.

R The usage of cadmium and borated concrete is such that the effect on the bias is small. This is shown in the revised report which provides the absorber "loading" information. For example, as shown in Table 5-2 of Part I, Table 4-1 of Part II, and as also applicable in Part III, the maximum thickness of cadmium is stated as "Cadmium sheet of 0.05 cm thickness (clad in 0.1 cm stainless steel) outside of a slab tank of 4.5-9.5 cm fissile material thickness."

For borated concrete, as shown in Table 5-2 of Part I and as applicable also to Part III, the maximum loading of the borated concrete is as follows:

Borated concrete (colmanite concrete) of 15 cm thickness (clad in 0.5 cm stainless steel) inside and outside of an annular tank of 7.0-7.5 cm fissile material thickness, separated from the tank by 1.8-2.0 cm conservatively assumed to be filled with water and having the following characteristics:

Colemanite concrete (density = 1.5055 g/cm^3)

Elements	Number densities [10^{24} at/cm^3]
^{10}B	1.59E-03
^{11}B	7.04E-03
Ca	4.65E-03
Fe	5.01E-04
Si	1.66E-04
H	2.17E-02
Al	1.96E-03
O	3.25E-02

As noted in the footnote to Table 5-2 of AOA(1), for Pu nitrate cases, no more than 5% of the above boron values are required to meet the conservatively modeled USL. For the AOA(5) case, no more than 30% of the above boron values are required to meet the conservatively modeled USL. The amount of boron over these values in the affected systems represents uncredited safety margin.

Q AOA(2): Design applications require the use of concrete and borated shield (composition not given), whereas the benchmarks do not contain these materials. The plot of bias as a function of energy of average lethargy causing fission (EALF) (Figure 6- 6) shows a slight decreasing trend with increasing EALF. The design application range (Table 5-4) extends up to 1 eV, while the benchmark data only extends up to 0.91 eV. Because of the decreasing trend from 0.91 to 1 eV, the upper safety limit (USL) thus derived may not be conservative. In addition, the chosen benchmarks have somewhat different isotopic ranges than that assumed in the design applications.

R Table 4-2 of the revised Part II of the report shows that boron in the concrete shields is not required to be credited ("Boron shields are actually employed, but no credit for the boron is required in the safety analysis of the system."). (Section 6.2.3 of Part II will be revised in a subsequent update to reflect this information as well.) Thus no allowance in the AOA for this material is needed. The presence of boron in the affected systems represents uncredited safety margin.

The anticipated EALF values referred to (up to 1 eV) is an old estimation. Based on the latest work, the revised report in Part II Tables 4-2 and 5-4 shows that the anticipated EALF for the applications is up to 0.66 eV, now clearly within the EALF range of the benchmarks, shown as up to 0.91 eV in Tables 5-3 and 5-4.

Q AOA(3): Design applications require the use of cadmium and borated concrete, whereas the benchmarks do not include these strong absorbers. In addition, the benchmarks only cover the range up to H/Pu of 210, while design applications require up to 1900. The benchmarks only cover the range down to 1 eV, while design applications require down to 0.05 eV.

R As is the case for AOA(2), the revised Part II report shows that boron in the concrete shields is not required to be credited in the anticipated applications as shown in Table 4-1 for AOA(3) ("Boron is actually present in the concrete, but no credit is required in the safety analysis of the unit."). The validated AOA does not include cadmium as shown in the excerpted Table 5-1 above. The two cases which involve cadmium shown in the design application Table 4-1 will be treated as "out of AOA" for cadmium. Based on the latest work and the definition of the validated AOA, the validated AOA of 1.58 to 5.99 (as shown in the excerpted Table 5-1) encompasses the full range of H/Pu for all anticipated cases as shown in Table 4-1 (i.e., in the range of 1.67 to 5.97). The one case shown in Table 4-1 which goes to a H/Pu=1.16 will be treated as "out of AOA" for H/Pu.

The range of EALF for the "typical design applications" used in the S/U determination of benchmarks as shown in Table 3-3 of Part II – i.e., 94 to 1019 eV – does not encompass the full anticipated range in the design applications (i.e., 3.1 to 65000 eV) as shown previously and in Table 5-1. However, as shown in Table 5-1, the range of EALF of the benchmarks actually used (1 to 10^6 eV) clearly encompasses the range of the design applications. Additionally, as shown in Figure 6-2, the trend of k_{eff} as a function of EALF shows that between 94-1019 eV and the anticipated range of the calculations, 3.1-65000 eV, the changes in k_{eff} are small (less than about 0.004). Further, the full range of the benchmarks (1 to 10^6 eV) is well represented by data points throughout the range. Thus the use of extrapolation, as discussed in Section 5.4, is applicable.

Q AOA(4): Design applications require the use of water and concrete, whereas the benchmarks contain only plexiglass reflectors. In addition, the benchmarks only cover the range up to an H/Pu of 210, while design applications require up to 291.

R As shown in Table 4-2 of the revised Part II of the validation report, design applications do not depend upon the modeling of concrete due to the presence of a close fitting water reflector. The revised table states: "The concrete walls are conservatively modeled. However, the presence of a close fitting water reflector effectively eliminates its effect." Additionally, the selection of benchmark experiments for this AOA only depend upon the characteristics of the "typical design applications" input to the S/U process and not on the characteristics of the experiments themselves, as described in Section 5.4.

Also, the H/Pu range of the "typical design applications" upon which the validated AOA depends isH/Pu=0.3 to 1.58, as shown in the excerpted Table 5-2 of Part II above. This range completely encompasses and is consistent with the design application range which is shown in Table 5-2 as H/Pu=1.15 to 1.58.

Q AOA(5): Design applications require the use of cadmium and borated concrete, whereas the benchmarks do not include these strong absorbers. The chemical forms of plutonium for which the code is validated is also not well described. In addition, the benchmarks only cover down to 0.135 eV, while design applications must cover down to 0.1 eV. The benchmarks only cover up to an H/Pu of 858, while the design applications may extend up to 83,000; the benchmarks also do not cover the range in H/Pu from 49.6 to 78. Section 4.1 of Part III states that fissile solutions will be analyzed at optimal moderation, but calculations do not appear to be specifically limited to this in the definition of the AOA. (NOTE: The range that is required to be covered by design applications is based on the worst-case combination of values from Part III Tables 4-1, 4-2, and 5-2. There appear to be some discrepancies between the tables so the broadest range of parameters was taken.)

R As noted in Footnote 2 to Table 5-2 of the revised Part III of the validation report, the justification provided in Part I of the validation report is applicable to the anticipated design applications relevant to this AOA. The footnote states: "Justification for borated and cadmium-containing reflectors provided in Part I is applicable here.". In particular, the impact of these absorbers on the bias is small. As in the case of Part I, the borated concrete is colemanite concrete external to the relevant annular tanks. The characteristics of the concrete are provided as part of Table 5-2 in Part I (excerpted above). Only 30% of the boron in the nominal colemanite concrete is required in the conservatively modeled USL. The amount of boron over these values in the affected systems represents uncredited safety margin. Similarly, the cadmium is in the form of a thin (0.5 mm) sheet on the exterior of the relevant flat tanks as is the case for the flat tanks containing Pu nitrate discussed in Attachment 6 of Part I.

Regarding the chemical form of plutonium for which the code is validated, as shown in Table 5-2 of Part III, the validated AOA for AOA(5) is for the chemical form PuO_2F_2. As discussed in detail in Section 4.3 and 4.4 of Part III, PuO_2F_2 bounds the expected actual physical forms of Pu covered by this AOA (i.e., Pu oxalate). This is illustrated in Figure 4-12 of the report.

Regarding EALF, as shown in Table 5-2 of the revised to Part III (excerpted above), the bounding design applications cover an anticipated range of EALF of from 0.7 to 4.69 eV. As also shown in Table 5-2, based upon the benchmarks, EALF for the validated AOA is 0.685 to 4900 eV for Group 1[1] which represents the bounding range, completely covering the range of EALF found in the design applications (i.e., 0.7 to 4.69 eV).

Regarding H/Pu, as also shown in Table 5-2, the bounding design applications cover an anticipated range of H/Pu from 30 to 50. As shown in the same table, based upon the benchmarks, H/Pu for the validated AOA is 30 to 50 for Group 1, which represents the bounding range, completely covering the range of H/Pu found in the design applications. The H/Pu of 83,000 mentioned (shown in Table 4.1) is a normal condition value and

[1] In the subject table, "a" entries refer to Group 1 and "b" entries refer to Group 2

represents a normal k_{eff} of only 0.02 due to very small concentration of fissile material (0.3 g/l Pu), not relevant to validation of the code.

While calculations are often performed for sensitivity purposes including normal and bounding abnormal cases at optimum of moderation conditions, the bounding abnormal cases at optimum of moderation conditions calculation always provides the limiting values of reactivity. That is, from a reactivity point of view, the bounding abnormal cases represent the worst-case combination of parameters. Therefore, the comparison of parameters shown above and in Tables 5-2 depend solely on the bounding calculations in anticipated abnormal process conditions calculations shown in Table 4-2.

Q For each AOA, the apparent deficiencies need to be addressed.

R See above discussion.

Q 2 For AOA(3) and AOA(4) the design applications modeled cover a small portion of the range (especially in terms of H/Pu and EALF) stated to correspond to the anticipated design applications. Specifically, there are no design applications taken from the high H/Pu, or the high and low EALF, portions of the AOAs. In light of these results, it appears that the benchmarks may not be applicable to design applications across the entire AOA. Furthermore, the results of the sensitivity/uncertainty (S/U) study in Validation Report Part II (for AOA(3) and AOA(4)) show that the set of applicable benchmarks depends strongly on changes in the parameters of the design applications used as input to the S/U study (e.g., AOA 3-1). Therefore, for AOA(3) and AOA(4), demonstrate that the chosen benchmarks are applicable to design applications across the entire AOA, justify validating the entire range as a single AOA, or break the AOA into smaller areas and justify each of them.

R The anticipated design application parameters described in the validation report are intended to be representative of bounding application areas involving PuO_2 and MOX powders. It is understood that in some cases the design applications fall outside the validated area of applicability of the code. In those cases, DCS commits to the determination and justification of additional margin (AOA margin) consistent with the guidance provided in ANSI/ANS-8.1 or that further calculations will be performed. As noted in the 13-June-2003 letter (DCS-NRC-000144), where parameter values fall outside the validated area of applicability, DCS committed to identifying additional margin, referred to as AOA margin, in the associated calculations or NCSEs, consistent with the approach described in NUREG 6698. The required margin is typically quantified by extrapolating observed trends in the bias as a function of the parameter.

At the time the validation report was prepared, the anticipated design application parameters were based on the then-current versions of criticality calculations together with experience of Cogema engineers. Today, as more calculations have been performed, the anticipated ranges of parameters for some design applications have been more narrowly defined.

For example, the EALF shown in Table 4-1 of revision 1 of Part II for the sampling glovebox was 50 to 500 eV. However, now as calculations have been performed, the bounding EALF for this unit is as shown in Table 4-1 of revision 2 of Part II is 95 eV.

Also, the definition of the AOA in each case is based not on the anticipated design applications, but on the range of parameters of the applications used as input to the S/U analysis.

In the case of the typical design applications used by ORNL as input to the S/U methodology, while the fissile material, moderating material, and reflector material used in the "typical design application" was identical to that found in MFFF calculations, the density, PuO_2 content (in the case of AOA (4)), and water content varied among the applications. This produced a range of parameters which, nevertheless, closely matched typical bounding criticality calculations not unlike that found when selecting experiments whose characteristics had ranges which cover the ranges found in the calculations. In some cases, the S/U methodology identified different sub-sets of benchmark experiments for a given AOA. However, this is similar to the case of the traditional methodology in which benchmarks with varying parameters are grouped together for a particular defined AOA.

Q For the use of S/U methods in Part II:

A. Describe the design applications for AOA(3) and AOA(4) in sufficient detail to permit an independent confirmation of your results.

R Input files for all design applications input to the S/U analysis will be provided by separate letter.

Q B. Show that the design applications are representative of the entire range of parameters that must be covered by the AOA.

R As described in Section 5.4, the AOA is defined by the range of the parameters of the design applications used as input to the S/U technique. These parameters are shown in Table 3-3 of Part II and Table 3-7 of Part II. To the extent that actual design applications fall outside this validated range, additional AOA margin will be employed consistent with guidance provided in ANSI/ANS-8.1 or further calculations performed as committed to in Section 7.1.1.

Q C. Provide additional justification for relaxing the acceptance criterion to $c_k \leq 0.7$ for some of the design applications. VR Part II justified this based on the following: (1) the USL was determined based on non-parametric methods, which uses the minimum observed k-effective value; and (2) there were no experiments applicable only to the affected design applications (AOA 4-4-Critical and 4-4-P163). Although the USL was determined using the lowest observed k-effective, reducing the number of applicable benchmarks could result in an increase in the non-parametric margin. Although there are no experiments applicable only to AOA 4-4-Critical and 4-4-P 163, the lower correlation implies a lower degree of benchmark applicability to parts of the AOA. Given this lower degree of correlation, justify not applying additional margin to compensate for the lower correlation.

R The relaxed criteria for AOA 4-4-Critical and AOA 4-4-P163 was simply done for completeness. There are no criticality calculations anticipated involving these large masses of Pu. The fact that the critical mass for this design application is over 450 kg of Pu, as described in Section 3.6.3, suggests that the code bias associated with the much smaller masses of Pu required in criticality calculations are of minor significance.

Furthermore, as can be seen from a comparisons of the benchmarks selected by the S/U method (Part II Tables 3-8 through 3-14), there are no unique experiments identified by reducing the acceptance criteria for these two design applications. That is, reducing the c_k value did not result in any additional experiments which were not already identified in one of the other input design applications for which $c_k > 0.8$ was used. Eliminating these two design applications altogether would not affect the number of experiments identified and thus the required non-parametric margin (NPM) would not change.

Q D. Because different sets of benchmark data were found to be applicable to different design applications in AOA(3) and AOA(4), justify using the entire set of benchmark experiments identified using the S/U technique to determine the bias across the entire AOA. For instance, AOA 3-1 had 30 benchmarks found to be applicable, AOA 3-2 had 60 applicable benchmarks, and AOA 3-3 had 61 applicable benchmarks. However, all 90 experiments found applicable to one or more design applications were used to determine the USL for the entirety of AOA(3). Benchmark experiments that are shown to be inapplicable to certain portions of the AOA (such as the 60 experiments inapplicable to AOA 3-1) should not be used to validate that portion of the AOA.

R The range of "typical design applications" used to define AOA(3) and AOA(4) are all similar in their fissile material form and thus are relevant to this respective AOA. For instance, the three design applications used in AOA(3) – i.e., AOA 3-1, AOA 3-2, and AOA 3-3 – are all PuO_2 powder with varying density and water content. Thus, the three typical design applications determine the validated range for AOA(3). The three design applications (AOA 3-1, AOA 3-2, and AOA 3-3) are indeed different and are intended to span the range of parameters typical of PuO_2 powder. Thus it is not unexpected that there is some variation in benchmark experiments selected by the S/U method.

This variation in benchmark experiments used as input to the S/U methodology is similar to the variation in physical characteristics that occurs when benchmarks are selected in the traditional manner based upon the experiment characteristics. For example, NUREG-6698, section 2.2, discusses the selection of benchmark experiments to be "representative of the types of materials, conditions, and operating parameters found in the actual operations to be modeled." This approach to selecting parameters for benchmarks is also similar to that recommended in other works such as LA-12683.

In the case of the typical design applications used by ORNL as input to the S/U methodology, while the fissile material, moderating material, and reflector material used in the "typical design application" are identical to that found in MFFF calculations, the density, PuO_2 content (in the case of AOA (4)), and water content varied among the applications. This produced a range of parameters which, nevertheless, closely matched typical bounding criticality calculations not unlike that found when selecting experiments whose characteristics had ranges which cover the ranges found in the calculations.

In the traditional case, it is normal to use the full set of benchmark experiments to characterize the bias of the code over the range of benchmark experiments selected. NUREG-6698, section 2.4, discusses analyzing the data thus obtained.

The experiments listed for AOA(3) are those which are above the usual acceptance criteria of c_k=0.8. However, there is no absolute in the use of c_k=0.8. Reviewing the experiments selected for any of the three "typical design applications" yields c_k values in general showing a significant degree of correlation (see Tables 3-4 through 3-6 of Part II for a list of benchmark experiments selected by the S/U method for AOA (3)). Thus, all of the benchmarks selected for the particular AOA are shown to be relevant.

For each AOA, the design applications selected for the S/U analysis do not differ significantly in terms of the traditional basis for defining the AOA. The key parameters characterizing the system are highly similar for each design application. For example, the fissile material is similar, differing only in terms of density, moderator content, and reflector materials. That the S/U technique identifies differences in apparent applicability of the resulting benchmark experiments is more reflective of the sensitivity of the S/U method than it is an indicator that certain benchmarks are inapplicable. For example, the fact that similar materials, geometries, and code options are employed provides a means of benchmarking the large scale potential sources of bias which may arise from potential systematic sources of error, such as coding errors in geometry tracking. These systematic errors can be revealed even for benchmark experiments seemingly unrelated to the design application.

Q 3 Several AOAs show apparent "data clusters", or groups of experiments that appear to have a lower calculated k-effective than the rest of the benchmark experiments. This does not appear to be a statistical fluctuation, but could be indicative of systematic effects that result in increases in the bias. Justify why it is appropriate to lump these benchmarks in the bias calculation with the remaining benchmark experiments.

R The "data clusters" appearing to have a lower calculated k_{eff} than the rest of the benchmark experiments in the group only occur in AOA(3) and AOA(4). Such clustering is, in general, not unexpected and is likewise not necessarily an indication of a systematic effect. In the case of AOA(3) and AOA(4), the clusters should be included in the bias calculations for the entire groups for several reasons:

(A) As noted in Section 3.6 of the Part II, benchmark experiments for AOA(3) and AOA(4) have been identified (Section 6.1 and 6.2, respectively of ORNL/TM-2001/262) using the sensitivity and uncertainty analysis technique developed by Oak Ridge National Laboratory. As part of these sensitivity and uncertainty analyses, the "data clusters" with lower calculated k_{eff}s are directly applicable to the parametric range being validated and should therefore definitely be included in the bias calculations.

(B) As noted in Sections 6.1 and 6.2 of the Part II, the calculated SCALE 4.4a benchmark results for both AOA(3) and AOA(4) were determined to be non-normal and were analyzed statistically using the nonparametric technique described in Section 3.2.3 of the validation report. As a brief summary, the nonparametric technique determines its best estimate of bias using the smallest k_{eff} in the data set along with an applicable uncertainty margin determined as shown in Section 3.2.3. Since the smallest k_{eff} is used, the resulting bias specifically covers the entire range of values in the data set – including "data clusters" of low values.

(C) The nonparametric method (NPM) gives a very conservative estimate of bias. This can be seen in the following example. If subsets of AOA(3) and AOA(4) are taken that only contain the benchmark cases whose k_{eff}s are less than 1.00, the biases determined for the subsets should be more negative than the biases for the entire sets and thus more conservative. This is true since both the number of benchmarks and the average k_{eff}s for the subsets are less than the corresponding parent group values. For AOA(3) and AOA(4), it turns out that the k_{eff} data for both subsets are distributed normally and thus simple statistics can be applied, and the calculated average k_{eff} and uncertainties compare with the NPM results for the parent as shown in the following table. As can be seen, the NPM "k - Δk"s are more than 0.5% less than corresponding values for the subsets. This means that the treatment using the NPM method not only is applicable it is conservative and thus the approach is valid.

	Parent Group				Subsets with keff < 1.00			
Group	No. of Bench-marks	NPM k_{eff}	Uncertainty (Δk) in NPM k_{eff}*	k – Δk	No. of Bench-marks	Average k_{eff}	Uncertainty (Δk) in Average k_{eff}*	k – Δk
AOA(3)	90	0.9876	0.0031	0.9845	31	0.9947	0.00124	0.9935
AOA(4)	66	0.9881	0.0058	0.9823	13	0.9939	0.00144	0.9924

* "2σ"

Q 4 Different techniques were used to determine benchmarks for validation, in each part of the Validation Report. Part I used a comparison of neutron absorption spectra as one of several arguments to conclude that the code is validated for plutonium nitrate systems containing strong absorbers. Part III used a comparison of EALF values to conclude the code can be used for systems with different chemical forms, geometric shapes, and absorbing and reflecting materials. The justification for these methods was not sufficient. Provide further justification for these methods.

A. For Part I, justify that the similarity in neutron absorption spectra in uranium and plutonium systems implies that the bias for these systems is affected similarly by neutron absorbers. NRC calculations show that the systems are relatively insensitive to neutron absorption as compared to other nuclide-reaction pairs for the reactions considered, and therefore, the relevance of this comparison is questionable. Also, it has not been shown that the conclusions are valid for less thermal (lower H/Pu) plutonium systems.

R DCS concurs that the systems are relatively insensitive to neutron absorption in the reflector with the loading of the reflector for borated concrete as shown in Footnote 2 of Table 5-2 and as shown in the answer to question 1 above.

As described in the Part I, Attachment 5, the approach is as follows:

a. Show that the impact of the borated concrete had little effect on the bias for similar uranium-based system for which benchmarks were available. This is performed by showing that for typical quantities of boron in the reflector as shown in Footnote 2 of Table 5-2 of Part I and as listed in the uranium benchmarks in Attachment 5 for HEU-SOL-THERM-033. As shown in Table 6 of Attachment 5, the method bias is in the range of 0.004 to 0.006 regardless of whether there is boron in the reflector or not.

b. Show that the absorption spectra in the borated concrete reflector for both uranium and plutonium systems was virtually identical. This is shown in Figure 1 of Attachment 5 in which the absorption spectra in the borated concrete reflector is virtually identical regardless of whether the neutrons originate from plutonium-based or uranium-based systems.

c. Show that there was essentially no trend in the bias due to the boron in the borated concrete. This is shown in Figure 2 of Attachment 5 in which over the range of full boron content, all the way to no boron content, the bias changes by less than 0.005.

The fact that the impact on the bias for uranium system showing that boron in the configuration of the benchmarks was essentially negligible is evidence that the boron has little effect. As NRC notes, the systems (either uranium or plutonium) are relatively insensitive to the levels of neutron absorption in boron used here.

As noted in Revision 3 of Part I, Attachment 5, the purpose of these three tests (impact of boron on U-nitrate, comparison of absorption spectra between U-nitrate and Pu-nitrate, and trending of the boron content with calculated bias) is to show that, from this data, there is no reason to suspect that the addition of borated concrete to the MFFF fissile systems causes a significant effect which would call into question the bias determination of the 191 boron-free benchmarks evaluated. As noted in the previous paragraph, external borated concrete has little impact on the bias of the U-nitrate systems. The absorptive effects, as evidenced by the absorption spectra for both U-nitrate and Pu-nitrate systems, appears to be the same, and there is no significant trend in the bias as the boron content is varied.

The boron content is shown in footnote 2 to Table 5-2 in Revision 3 of Part I. As can be seen by criticality calculations using these boron characteristics, the impact of the boron is small. In fact, as noted in that footnote, for AOA(1) in Part I, it is only necessary to have 5% of the boron number densities to meet a conservatively determined USL. This is additional evidence that the impact of the boron is small.

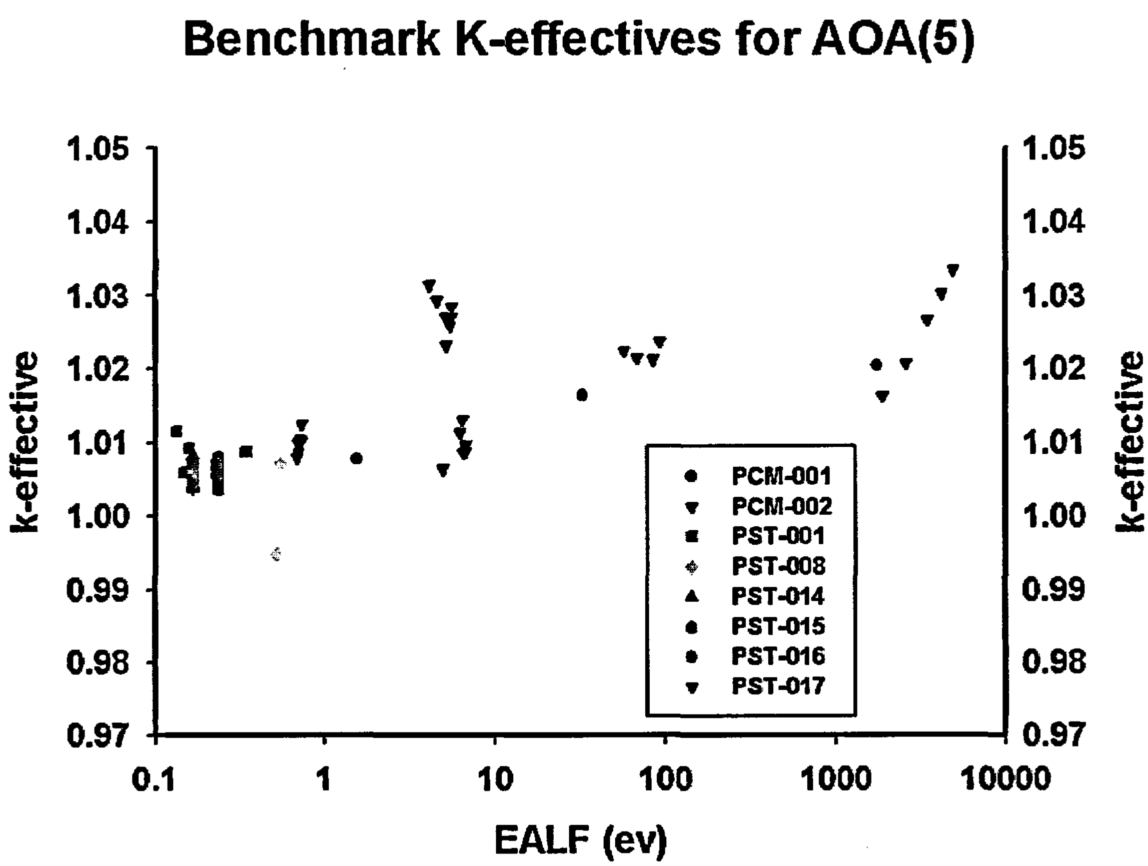
As to the question on less thermal plutonium systems (lower H/Pu), the following is presented. First, the H/Pu range, as shown in Table 5-2 in the Revision 3 of Part I, has been significantly narrowed over that of Revision 2 to $100 < H/Pu < 200$. Second, as described in Attachment 5, the cases evaluated for Pu nitrate (where Pu was substituted for uranium in the configuration of benchmark 8a) included a H/Pu case = 125. This case corresponds to optimum moderation for Pu nitrate in the MFFF AOA(1) material configuration. That is, it represents the highest, bounding k_{eff} for this configuration. Thus, less thermal systems (lower H/Pu) are not actually relevant. Additionally, a case at H/Pu=70 was also run; this is just outside of the lower AOA(1) H/Pu limit of H/Pu=100. In both cases, the neutron absorption spectra were virtually identical. As NRC states, the impact of the boron absorber in this configuration is small.

Since there exist no recognized benchmarks with boron in the reflector, it is not possible to compare code calculations with benchmark experiments, However, as it has been shown that the impact on similar uranium systems is negligible, the impact of the boron on the neutron spectra in the absorber is independent of the fissile material source, and there is no significant observable trend in the bias, there is no reason to suspect that the code bias would be adversely affected by the levels of boron analyzed. Further, the need for the boron absorber on the criticality calculations is small.

Q B. For Part III, show that a comparison of EALF values is sufficient to show a high degree of applicability between systems (i.e., that it accounts for all important nuclear effects that can influence the bias).

R In Part III, applications with Pu-nitrate, Pu-oxalate, and the PuO_2F_2 "Standard Salt" were compared based on EALF values because the only important differences for the three compounds from a nuclear consideration are the absorption and scattering cross-sections in nitrogen, carbon, and fluorine. The range of geometries, fissile material enrichments, reflectors, and other material constituents are typically the same for all three cases, and molecular effects on cross-sections of $Pu(NO_3)_2$, $Pu(C_2O_4)$, and PuO_2F_2 are not significant. Since the absorption and scattering cross-sections vary somewhat with energy, however, EALF values represent a valid basis for comparison.

This consideration is evidenced in Tables 6.1 and 6.2 in Section 6.1.2 which show that the minimum USLs for the Group 1 and Group 2 benchmarks relative to the EALF, H/Pu, and ^{240}Pu content occur for the case of the EALF parameter. Also, the following figure gives a plot of all of the benchmark data in Part III, showing that the 119 benchmark experiments covering an extensive range of EALF with no clusters of negative trend benchmarks that could indicate important alternate effects.



Q C. For Part III, state what difference in EALF values is considered sufficient to demonstrate applicability between cases considered. Part III, Section 4.3.2, states that differences that are less than 2% constitute good agreement. Section 4.3.3 states that a 20% difference constitutes good agreement. In several cases, the energy of the design applications falls outside the range of experimental data (Tables 4-6, 4-7, and 4-8). Also, state why the validation is acceptable when a large difference in EALF values is observed (in the low H/Pu range, with H/Pu ≤50).

R Sections 4.3.2 and 4.3.3 were not intended to suggest an inconsistency in acceptable EALF differences. In either case, the small variation in EALF shows that the systems behave similarly. As can be seen from the trend plot provided as the response to

Question 4B (note that a factor of three in this plot is less than one half of one of the plotted divisions on the EALF axis), the variation in bias as a function of EALF is very low so that even differences as much as a factor of three or more would be sufficient to demonstrate applicability of experimental results to applications. This small variation as a function of EALF is also the reason for the acceptability of the validation with the (apparently) large differences in EALFs.

Additionally, and in response to the final question here, Table 5-2 of Part III has been revised (Revision 1) to significantly reduce the parameter ranges below H/Pu of 50 so that 30 < H/Pu < 50. Therefore, variations in EALF for H/Pu below that range are no longer relevant.

Q D. For Part III, justify the density used for PuO_2F_2, since the theoretical crystal density is not used (as stated in Footnote 5 to Table 4-3).

R As noted in Footnote 5 to Tables 4-3 and 4-4 of Part III, PuO_2F_2 is used as a "standard salt" bounding media to cover actual nitrate and oxalate salt solutions in criticality studies in MFFF operations. PuO_2F_2 does not actually occur in any MFFF operation and this treatment is conservative provided that the density of the fissile material is no less than the fissile material density of the actual salt solution being modeled at the same H/Pu ratio. (Note that the neutron absorption cross-sections in fluorine which occur in PuO_2F_2 are less than or equal to those in carbon and nitrogen occurring in Pu oxalate and Pu nitrate.) It is thus not necessary to use the maximum PuO_2F_2 theoretical density of 6.5 gm/cm^3, since lower values will meet the fissile material density requirement. MFFF applications are based on a PuO_2F_2 maximum density of 4.187 gm/cm^3, which yields higher Pu densities than (the H/Pu) equivalent Pu-oxalate and Pu-nitrate solutions. Note also Figure 4-1 in Section 4.3, which shows that the k_∞ of the PuO_2F_2 "standard salt" (with its assigned 4.187 gm/cm^3 maximum theoretical density) has k_∞ equal to or higher than Pu-oxalate and Pu-nitrate solutions.

Further validity of the use of a maximum density of 4.187 gm/cm^3 for PuO_2F_2 is shown in Figures 4-12 through 4-14 in Section 4.4 of Part III, where plots of k_{eff} versus H/Pu and C(Pu) are given for infinite slabs of "standard salt" solutions and comparable results for different solutions of Pu-nitrate and Pu-oxalate. As shown in the plots, the "standard salt" solutions give k_{eff}s that are equal to or greater than the values for the nitrate and oxalate cases over the entire parameter range, and for H/Pu < 100 [or C(Pu) values > 0.2] give results that increasingly exceed the oxalate and nitrate values by more than 1%.

Q 5 In Part I, Section 3.1, what is the relationship between the calculational uncertainty Δk_s and the statistical Monte Carlo uncertainty σ_k. Does $\Delta k_s = \sigma_k$, $2\sigma_k$, $3\ \sigma_k$, or some other factor?

R Calculational uncertainties are two times the statistical Monte Carlo standard deviation of the average k-effective, that is $\Delta k_s = 2\sigma_k$.

Q 6 There is no mention of non-parametric margin (NPM) for data that is not normally distributed in Part III. The USLSTATS output claims that: (1) the data is normally distributed, but also (2) that the normality test may be unreliable due to the lack of data. The histogram in Figure 6-1 shows a double-humped distribution, indicating that a non-parametric method may be necessary. Justify the basis for the conclusion that the data is normally distributed, or else apply non-parametric techniques to compute the USL.

R As noted in the USLSTATS output, while the data tests normal, the normality test may be unreliable due to lack of data. Additionally, as stated, there is a double-humped distribution shown in Figure 6-1 of Part III. This data is used to determine the USL for Group 1 (H/Pu<50).

In accordance with the methodology provided in NUREG-6698, DCS analyzed the data for Group 1 (H/Pu<50). The Non-Parametric Method (NPM) described in NUREG-6698 (and also described in Part II of the MFFF validation report) was applied to the Group 1 data.

The Group 1 data consists of 32 PuO_2 benchmark experiments as described in the report. Using equation (32) in NUREG-6698 (also shown in Eq. 3.3 of Part II), the first step is to determine the percent confidence that a fraction of the population is above the lowest observed value. With 32 data points, the value of equation (32) is 80.6%. Using Table 2.2 in NUREG 6698 (also shown in Table 3-1 of Part II), the NPM margin for 32 points is NPM=0.01 (1%).

The smallest k_{eff} value of the 32 data points is above 1. According to the NPM methodology in NUREG-6698, when the smallest k_{eff} value is greater than 1, then the NPM value K_L becomes:

$$K_L=1-S_P-NPM$$

Where S_P = the square root of the pooled variance.

Using the methodology described in Section 2.4.1 of NUREG-6698, equation (7) provides a method for determining the pooled variance. Using this method, with the set of 32 Group 1 data points, the square root of the pooled variance (S_p) is 0.0044. Therefore, the equation above gives K_L=1-0.0044-0.01= 0.9806. With 5% administrative margin as applied elsewhere in the validation report, the USL for Group 1, using the NPM methodology would therefore be USL=0.9806-0.05=0.9306, statistically the same and virtually identical to the value previously used in Part III for Group 1 (0.9328) based upon the standard statistical methodology (USLSTATS) which, of course, assumed normality. Using either method, the USL is above a value of 0.9300 which is applied in the calculations.

Q 7 During the January 2003 meeting on NCS open issues, it was agreed that the normal condition k-effective limit would not be part of the design basis, but the methodology for determining the normal condition margin was part of the design basis. Describe in detail how the k-effective limit for the normal condition will be determined.

R All criticality applications in the design of the MFFF show that the abnormal conditions cases are bounding – by an appreciable equivalent margin in k_{eff} – over the normal condition cases. DCS does not plan to establish a k_{eff} limit for normal conditions. Should an application arise in the future in which the k_{eff} of a normal condition case approaches or exceeds the k_{eff} of the corresponding abnormal condition case, DCS will assure that the AOA for the normal condition case is within the AOA of the validated analytical methodology or else will establish an appropriate additional safety margin for the normal case to ensure that the USL is not violated during credible conditions.

As noted in the meeting minutes of the January 2003 meeting (page 4), DCS committed to providing a description of its methodology for determining normal condition margin rather than a limit. The detailed approach for determining the k_{eff} margin for normal conditions was described in DCS-NRC-000127, dated 11 February 2003 (no response to this letter has been received). (The text in Section 6.1.4.2 is consistent with the methodology DCS has committed to use to ensure compliance with the regulatory requirement that under all normal and credible abnormal operations, potential criticality events are highly unlikely.) This approach is repeated below for completeness.

In particular, all potential credible criticality events in the MFFF will be shown to be highly unlikely to occur. Thus, the only question is that of the USL value for demonstrating that the events are highly unlikely. As the definition of event sequences will ensure that all normal and credible abnormal scenarios are addressed, and criticality will be demonstrated to be highly unlikely for all scenarios, then evaluating compliance with the bounding "abnormal" USL will ensure subcriticality within that limit for all normal and credible abnormal events. The evaluation of the event sequence inherently considers the operating margin for determination of highly unlikely. Operations are rarely expected to be conducted at the subcritical value.

For instance, if a subcritical mass value is calculated for the system, and compliance with that mass limit is controlled by a set of controls that are less than highly unlikely to fail, additional operating margin in the mass parameter will be necessary to ensure that multiple failures are necessary before an accidental criticality is possible. It would be very difficult to show that the accident sequence is highly unlikely if normal operation allowed that system to operate near the subcritical mass value. Conversely, if the set of controls used to limit the mass parameter value are highly unlikely to fail, then additional safety margin is not necessary.

Further, the determination of the parameter limit for normal operation of the system is based on the amount of operating margin in the controlled parameter necessary to demonstrate criticality is highly unlikely, and not based on an arbitrary additional k_{eff}

margin. Basing operating margin on an arbitrary k_{eff} margin will not ensure that the credible accident sequences are highly unlikely, but evaluating the available operating margin during the accident sequence evaluation will ensure that the events are highly unlikely.

Finally, imposing a normal-operation USL would not result in any additional safety margin being achieved. DCS maintains, therefore, that the value of USL at the point of where an event is at abnormal conditions, along with demonstrating that the event is highly unlikely, is appropriate and consistent with the regulation. DCS plans to implement the use of a single USL of 0.95 (exclusive of biases and uncertainties) in combination with a demonstration that all credible criticality events be shown to be highly unlikely.

DCS will determine the additional safety margin needed for normal operations to ensure that the USL is not violated during credible abnormal conditions in the NCSEs. Additional safety margin for normal operations is typically based on the type of control used to demonstrate double contingency and highly unlikely. This is explained in the following examples:

1. Passive engineered controls – These controls involve vessel dimensions, spacing for storage units, and other passive design features. The criticality safety analysis of these systems considers all credible changes in the design feature to ensure that the system will remain subcritical in a credible abnormal event. For example, items like corrosion, manufacturing tolerances, properties of materials of construction, fissile material concentration, fissile material composition, and reflectors are considered at the worst-case upset condition to ensure that the system will remain subcritical for any credible abnormal event. Thus in this case, no additional safety margin is required to ensure that the USL is not exceeded during normal or credible abnormal conditions.

   If the k_{eff} at the worst-case conditions is greater than the USL for worst-case conditions and an active engineered control is necessary to prevent encountering these worst-case conditions, it is not possible to control the system with passive design features; consequently active or administrative IROFS are necessary.

2. Active engineered controls – These controls involve the active control of a criticality parameter necessary to ensure that exceeding credible abnormal conditions meets the requirements of the double contingency principle. The establishment of the limits for these active engineered controls must consider the following: the ability of the control to maintain the parameter within established limits; tolerances and uncertainty in measuring equipment; response times and lag times for equipment; and other factors that are important to ensuring that the active engineered control can maintain the criticality parameter below the limiting value of the controlled parameter.

It is necessary to demonstrate that the system design is robust and considers that all operational concerns are addressed regarding the components in the active engineered control. This will most likely lead to setting the limit to which the parameter is controlled to a value lower than calculated by the criticality safety analysis (as is typical in establishing safety and operating limits, alarm values and setpoints, etc., for engineered controls). In the case of using active engineered controls to limit the value of a parameter, DCS will demonstrate that, using failure detection or other means, sufficient safety margin exists such that the potential criticality events are highly unlikely.

3. Administrative controls – Administrative controls involve an operator performing a function that ensures that a criticality parameter limit is not exceeded. When establishing an operating limit for a criticality controlled parameter that is administratively controlled, the operation must be examined to ensure that there is sufficient margin between the operating limit and the credible abnormal limit established by the criticality safety analysis. For purposes of establishing double contingency and demonstrating that potential criticality events are highly unlikely when administrative controls are involved, it is necessary to demonstrate that multiple errors would be necessary before the parameter limit is exceeded. The amount of safety margin necessary depends greatly on the type of process, quantity of material being processed, form of the material being processed, etc. In any case, credit is taken, and thus the additional safety margin established, for the difference between the operating limit and the credible abnormal limit when establishing double contingency protection and determining an event is highly unlikely. The margin will be shown in the NCSEs.

Enclosure 1
Response to Request for Additional Information (MFFF Validation Report)
DSER Open Item On Nuclear Criticality Safety

Q Data Needs:

To enable an efficient and effective review of the Validation Report, the following additional information is needed:

For Part II:

1. The KENO-Va output decks, and "*.sdf" files, used in the S/U analysis.

a. Output decks: Contain the model information (echoes the input deck) needed for the staff to understand the benchmark model. While input decks have been submitted, they are in KENO-VI format, which cannot be used by the SCALE 5 S/U sequences. The output decks also contain statistical information that can be used to test adequate convergence of the direct and adjoint cases.

The files used by ORNL to establish the benchmarks for Part II will be provided separately.

b. SDF files: These are used by the SCALE 5 S/U sequences to generate correlation coefficients and integral parameters. While they can be generated from the KENO-Va input decks, running the cases will be very time consuming, and having these files will significantly expedite the analysis.

The SDF files (*.42) used by ORNL to establish the benchmarks for Part II will be provided separately.

2. The SCALE input decks for all design applications. These cases are not described in full detail in the VR. While there is some information provided, this is not sufficient to enable staff to reconstruct the results to compare with benchmarks.

The input files for the typical design applications as identified in Table 3-3 of Part II for AOA(3) and Table 3-7 of Part II for AOA(4) will be provided separately.

For Part III:

1. Electronic version of the input decks for the design applications (sensitivity studies) used in the MOX VR Part III.

The input files for the sensitivity studies as described in Section 4 of Part III for AOA(5) will be provided separately.

2. Electronic versions of the input decks for any benchmark experiments not included in the CD-ROMS provided for Parts I and II.

Input files for all benchmark experiments in part III were included in the CD-ROMS provided for Parts I and II.

Enclosure 2
US Department of Energy Expert[1] Panel Membership

NAME	AFFILIATION
Doug Outlaw	Science Applications International Corp
John Miller	Los Alamos National Laboratory
Frank Motley	Los Alamos National Laboratory
Bob Taylor	Westinghouse Safety Management Systems

[1] Total experience of panel represents approximately 37 years of Pu criticality experience.