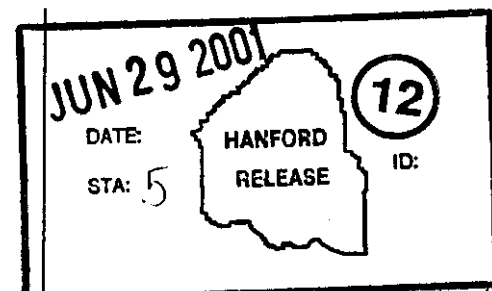


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Pea. 1 of 21. ECN **632081**Proj.
ECN

I. ECN Category (mark one) Supplemental ☐ Directed Revision ☒ Change ECN ☐ Temporary Standby ☐ Supersedeure ☐ Cancel/Void ☐		3. Originator's Name, Organization, MSIN, and Telephone No. J. Greenborg, FFS, B4-44, 376-3482		4. USQ Required? ☐ Yes ☒ No		5. Date 4/30/01	
		6. Project Title/No./Work Order No. Plutonium Finishing Plant		7. Bldg./Sys./Fac. No. PFP/234-5Z		8. Approval Designator S	
		9. Document Numbers Changed by this ECN (includes sheet no. end rev.) HNF-4436, Rev. 0		10. Related ECN No(s). N/A		11. Related PO No. N/A	
2a. Modification Work ☐ Yes (fill out Btk. 12b) ☒ No (NA Btk. 12b, 12c, 12d)		12b. Work Package No. N/A		12c. Modification Work Completed N/A		12d. Restored to Original Condition (Temp. or Standby ECNs only) N/A	
		Design Authority/Co. <u>8</u> Engineer Signature <u>8</u> Bite				Design Authority/Co. <u>8</u> Engineer Signature <u>8</u> Bite	
3a. Description of Change Revision to allow processing U-235 enriched >50% providing U-235 bulk density is greater than 1 g/cm ³ and waste remain so if flooded. Thermal Stabilization materials; U metal, Pu/U alloys, and oxides fall in this category.							
13b. Design Baseline Document? ☐ Yes ☒ NO							
1a. Justification (mark one) Criteria Change ☐ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☒ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐		14b. Justification Details Thermal Stabilization Metals and oxides are insoluble and fissile bulk density exceeds 1 g/cm ³ (1000 g/L).					



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Page 2 of 2

1. ECN (use no. from pg. 1)

632081

Design Verification
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☐ Yes

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17. Cost Impact

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Operating Specification

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Criticality Specification

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Conceptual Design Report

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Equipment Spec.

☐

Const. Spec.

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Procurement Spec.

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Vendor Information

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OM Manual

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FSAWSAR

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Safety Equipment List

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Radiation Work Permit

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Environmental Impact Statement

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Environmental Report

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Environmental Permit

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Stress/Design Report

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Interface Control Drawing

☐

Calibration Procedure

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Installation Procedure

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Maintenance Procedure

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Engineering Procedure

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Operating Instruction

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Operating Procedure

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Operational Safety Requirement

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IEFD Drawing

☐

Cell Arrangement Drawing

☐

Essential Material Specification

☐

Fac. Proc. Samp. Schedule

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Inspection Plan

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Inventory Adjustment Request

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Tank Calibration Manual

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Health Physics Procedure

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Spares Multiple Unit Listing

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Component Index

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ASME Coded Item

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Process Control Manual/Plan

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Tickler File

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Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Sign a

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Approvals

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Cog. Mgr. D. G. Satterwhite

QA N/A

Safety S. E. Nunn

Environ. N/A

Other

Orig. Eng. J. Greenberg

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Tech. Rev. R. F. Richard

CSE A. D. Wilkinson

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ADDITIONAL

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		EDT No. N/A			
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CSER 99-003, Rev. I

Criticality Mass of Uranium as Compared to Plutonium- Implications for PFP Processing Uranium

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

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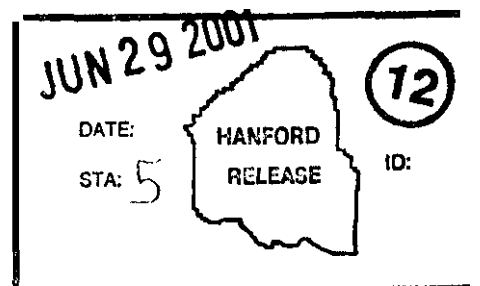
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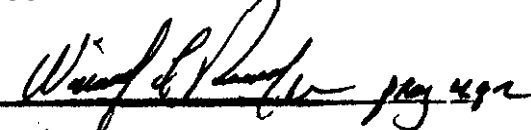
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CSER 99-003, Rev. 1 Critical Mass of Uranium as Compared to Plutonium-Implications for PFP Processing Uranium

Key Words: Plutonium Finishing Plant (PFP), fissile material, fissionable material, criticality, metal Thermal Stabilization

Abstract: The purpose of this report is to provide information to be used in the evaluation of the CSER and CPS for equipment and activities involved in thermal stabilization. It is well known that for equal mass, ^{239}Pu is more reactive than ^{235}U except at fissile material concentrations of 100 g/L to 1,000 g/L. In this range of concentrations, spheres of highly enriched 94% uranium have a lower critical mass than spheres of ^{239}Pu . Within these same limits, infinite cylinders of highly enriched uranium (^{235}U in ^{238}U) have a smaller critical diameter than infinite cylinders of ^{239}Pu . This report determines the fissile concentrations between which ^{239}Pu is more reactive than uranium (^{235}U in ^{238}U). The information can be used for the revision of CSERs and CPS's to allow processing uranium using limits developed for plutonium.

CSER 99-003, Rev. 1
Critical Mass of Uranium as Compared to Plutonium –
Implications for PFP Processing Uranium

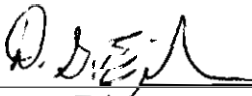
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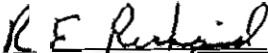
For
Fluor Hanford
In support of
Task Order No. 5240

Prepared by: 
Greenborg, Criticality and Shielding

Date: 04/30/01

Prepared by: 
D. G. Erickson, Criticality and Shielding

Date: 04/30/01

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Date: 4/30/01

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Date: 5/3/01

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1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

The Plutonium Finishing Plant (PFP) has uranium-bearing materials in storage. These materials will require stabilization. The Criticality Safety Evaluation Reports (CSER) and Criticality Protection Specifications (CPS) are in place for plutonium stabilization and may need to be modified to allow uranium stabilization.

The purpose of this report is to provide information to be used in the evaluation of the CSER and CPS for equipment and activities involved in thermal stabilization or other PFP operations. It is well known that for equal mass, ^{239}Pu is more reactive than ^{235}U except at fissile material concentrations of 100 g/L to 1,000 g/L. In this range of concentrations, spheres of highly enriched 94% uranium have a lower critical mass than spheres of ^{239}Pu . Within these same limits, infinite cylinders of highly enriched uranium (^{235}U in ^{238}U) have a smaller critical diameter than infinite cylinders of ^{239}Pu . This report determines the fissile concentrations between which ^{239}Pu is more reactive than uranium (^{235}U in ^{238}U). The information can then be used for the revision of CSERs and CPS's to allow processing uranium using limits developed for plutonium.

1.2 CONCLUSIONS

The conclusion obtained from comparing the reactivity of uranium (^{235}U in ^{238}U) at different fissile concentrations and enrichments in water with 100% ^{239}Pu in water at the same fissile concentrations as the uranium is that:

Uranium (^{235}U in ^{238}U) at fissile concentrations below 100 g/L (0.1 g/cm^3) OR above 1,000 g/L (1 g/cm^3) OR Uranium at enrichments up to 50 wt% ^{235}U in ^{238}U , is less reactive than an equal mass of ^{239}Pu for any concentration,

Therefore criticality safety limits established in CSERs for ^{239}Pu adequately covers uranium in the same application for ^{235}U concentrations in the range 100 g/L (0.1 g/cm^3) to 1,000 g/L (1 g/cm^3) OR for uranium enrichment of less than 50 wt% ^{235}U in ^{238}U . The uranium fissile isotope analyzed in this CSER is ^{235}U and not ^{233}U . The conclusions of this CSER are not applicable to ^{233}U .

Processing uranium enriched to greater than 50 wt% ^{235}U AND with a fissile concentrations in the range 100 g/L (0.1 g/cm^3) to 1,000 g/L (1 g/cm^3) will require additional CSER analysis to establish criticality safety limits for processing that uranium.

Consistent with the above, it is expected that most, if not all, of the uranium-bearing materials at the PFP with ^{235}U enrichment >50 wt% are suitable for processing based on existing glove box Pu limits (i.e., substituting ^{235}U content for ^{239}Pu on a gram for gram basis). See Section 4.3.

2.0 SYSTEM DESCRIPTION AND NORMAL OPERATIONS

No specific PFP system or operation is analyzed. The analysis provided is a parameter study with the results applied to all systems and operations involving uranium-bearing material

3.0 LIMITS AND CONTROLS

The limits determined by the parameter study show where uranium is less reactive than plutonium. It is conservative to substitute ^{239}Pu for ^{235}U , gram-for-gram:

1. If ^{235}U concentration is below 100 g/L or above 1,000 g/L OR
2. ^{235}U in ^{238}U enrichment is less than 50 wt% OR
3. If material is insoluble and has a fissile bulk density in excess of 1 g/cm³. These materials may include Pu/U metal alloy, corrosion products, oxidized metal, product quality oxide (See Section 4.3).

This information can be used in CSERs and CPSs to limit the uranium to allowed concentrations. Outside of the these limits, new analyses are necessary for operations with uranium.

4.0 METHODOLOGY

The first step in the analysis was to determine the upper and lower concentration where 94% enriched uranium is more reactive than 100% ^{239}Pu using critical mass handbooks. The high enrichment values (94% for ^{235}U and 100% ^{239}Pu) were chosen so that the analysis results would be bounding. PFP has some containers with uranium enrichments up to 94% as well as some plutonium with as little as 3% ^{240}Pu . The second step involved using computer analysis to find the fissile concentration crossover points.

4.1 USE OF CRITICAL MASS HANDBOOKS

The first investigation to determine the range where plutonium or uranium is the most reactive and the upper and lower concentration cross-over point involved consulting the various critical mass handbooks. Table 1 presents the results of that review for critical spheres. Similar upper and lower cross-over points were obtained for infinite cylinders. Table 1 shows the lower cross-over point to be between 100 and 200 g (fissile)/L. The upper cross-over point was found to be around 1,000 g, fissile/L. The critical masses as shown in ARH-600 are not directly comparable to those in LA-12808. The calculations performed for ARH-600 did not include bias or safety margin, whereas the calculations for LA-12808 include both. This means that the LA-12808 reported critical masses are conservative (smaller).

Table 1. Critical Mass of ^{235}U or ^{239}Pu Fully H_2O Reflected Spheres

Critical Mass, kg of Fissile Material				
Fissile Concentration	LA-I2808		ARH-600	
kg/L	^{235}U (93.5)	^{239}Pu	^{235}U (93.5)	^{239}Pu
0.1	0.89	0.77	1.0	0.87
0.2	1.25	1.33	1.4	1.5
0.3	1.82	1.90	1.9	2.15
0.4	2.26	2.41	2.5	2.8
0.5	2.77	2.84	3.0	3.4
0.6	3.32	3.44	3.6	4.0
0.7	3.60	3.77	4.2	4.6
0.8	4.22	4.36	4.8	5.2
0.9	4.80	4.68	5.4	5.6
1.0	5.3	5.02	6.0	6.0
Figure within the Reference	Fig. 6	Fig. 10	III.B.6 (93.5)-2	III.A.6.100-3
1.35	7.8	7.5	-	-
2	11.0	7.9	10.8	8.5
4	17.0	10.0	-	-
5	-	-	19.7	10.7
10	24.0	7.3	21.5	8.8
Figure within the Reference	Fig. 6	Fig. 10	III.B.9 (93.5)-2	III.A.9.100-3

While the handbook values are reasonably accurate, a detailed analysis using an approved computer code is needed to determine the exact location of the upper and lower concentration. This analysis is described in the next section.

4.2 MCNP ANALYSIS

Pairs of uranium and plutonium fissile concentrations and critical mass from the critical mass handbooks were chosen for analysis in MCNP'. The pairs were chosen on the basis that the approximate location of the upper and lower limit be surrounded. Pairs were also chosen in between and outside of the approximate location of the upper and lower concentration cross-over point.

The MCNP code provided the values of k_{eff} for each pair. Calculations of k_{eff} were made using the MCNP' version 4B code (Breismeister 1997). Quality assurance verification documentation is contained in Schwinkendorf (1998). Erickson (1998) reports MCNP4B validation activities for plutonium systems, while Ruben (1998) covers low enriched uranium

systems. The pairs and associated k_{eff} were arranged so that a straight-line interpolation of several data points could be used to determine the critical mass for each fissile concentration chosen. This analysis was performed for all 4 combinations of 94% enriched uranium and 100% ^{239}Pu spheres and infinite cylinders. **An** analysis was also performed **to** determine the critical mass as a function of fissile concentration for 50 wt%-enriched uranium.

The computer models used in this analysis are either fully water reflected spheres of fissile material/water mix, or fully water reflected infinite cylinders of fissile material/water mix. The fissile material was conservatively assumed to be fine metal particles. System dimensions were chosen such that the critical condition was bracketed. The actual critical dimension was determined by linear interpolation. Input parameters were calculated by Excel spreadsheets; a list of input files is given in the attached table. Sample input files and the explanation of the attached spreadsheet columns are given in Appendix A.

4.3 ENRICHED URANIUM > 50 WT% ^{235}U * BEARING MATERIALS THAT CAN BE SUBSTITUTED ^{239}Pu TO ^{235}U GRAM-FOR-GRAM

Dry processing of Pu residues and Pu/U alloys (including contingencies) generally does not subject these materials to the moderation conditions identified in the previous section. Examples are:

URANIUM/PLUTONIUM METAL ALLOY TO BE PROCESSED BY THERMAL STABILIZATION

The density of these alloys typically exceeds 10 g/cm^3 . When thermally stabilized, this material is converted to oxide with bulk densities in the range of 3 to **5 g/cm³** (Moseley 1965, Felt 1967, and Barr 1971). In these forms, these materials are no more reactive than an equal mass of Pu.

Thermal stabilization materials are insoluble. When infiltrated with water, they do not mimic solutions, i.e., they do not suspend in water without a mechanism to accomplish that. At an oxide (or metal) density of 3 g/cm^3 , or more, if infiltrated with water, ^{235}U (enriched > 50 wt%) in this material would be less reactive than ^{239}Pu (2650 g/L fissile, see Figures 1 and 2). Even if this material is less than 3 g/cm^3 , any ^{235}U (enriched > 50 wt%) present will be less reactive than ^{239}Pu providing the fissile concentration of the material is at least 1 g/cm^3 (1000 g/L, see Figures 1 and 2 and Section 5.0, Results). Should this material contain an insoluble non-hydrogenous diluent (or surrogate), the reactivity is further reduced. This is demonstrated in CSER 00-001, Ad 1 (Greenborg and Erickson 2001), which examined the reactivity of plutonium in silicon dioxide (SiO_2) sand infiltrated with water.

Thermal Stabilization is a dry process. Water intrusion in this process is evaluated in the double contingency analysis of each applicable glovebox or process criticality safety evaluation

* The enrichment at which ^{235}U is more reactive than ^{239}Pu is above 50%, perhaps about 75% (visual linear interpolation of Figure 1). However, the safety basis remains 50%; the limit of the analysis.

(CSER). If the assumptions in these CSERs are consistent with the above, the limits therein should apply to EU > 50 wt% ^{235}U gram-for-gram fissile.

The H/X range in which ^{235}U (enriched > 50 wt%) is more reactive than ^{239}Pu (gram for gram) i.e., the cross over points in Figures 1 and 2, is 35 to 150 (see Figure 3; H/X vs fissile concentration in water mixtures). At the limits, < 100 g/L and > 1000 g/L, H/X is 250 and 25, respectively. These observations are a basis for evaluating criticality limits of glove box operations which process uranium bearing materials which are damp and/or are subject to limited moderation contingencies.

GLOVE BOX INVENTORIES CONTAINING LESS THAN 15 GRAMS ^{235}U IN EU > 50 wt% ENRICHED

In the professional judgment of the authors, glovebox inventories less than 15 grams ^{235}U in EU > 50 wt%, are insignificant and can be treated on a gram-for-gram substitution basis.

5.0 RESULTS

The MCNFF analysis showed that the lower concentration cross-over point for spheres of fissile isotopes ^{235}U and ^{239}Pu is at about 100 g (fissile)/L. The upper cross-over point is at about 850 g (fissile)/L. For infinite cylinders, the lower crossover point is the same as that for spheres and the upper crossover point is at about 700 g (fissile)/L. These concentration cross-over points are shown in Figures 1 and 2.

The conclusions obtained from the materials analysis of the fissile isotopes ^{235}U and ^{239}Pu are as follows:

1. Uranium enrichments of ^{235}U in ^{238}U equal to or less than 50 wt% have critical mass and dimensions larger than those containing 100% ^{239}Pu of equal moderation.
2. Uranium-235 concentration above 1,000 g/L (1 g/cm³) is less reactive than an equal mass of ^{239}Pu for the same moderation.
3. 50 to 94% enriched ^{235}U in ^{238}U , in a ^{235}U concentration of greater than 100 g/L (0.1 g/cm³) less than 1,000 g/L (1 g/cm³) requires a specific separate analysis. Exceptions are listed in Section 4.3.

6.0 REFERENCES

LA-12808 stands for N. L. Pruvost, H. C. Paxton, 1996, *Nuclear Criticality Safety Guide*, LA-12808, Los Alamos National Laboratory, Albuquerque, New Mexico.

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Figure 1. Critical Mass For Water Reflected Spheres

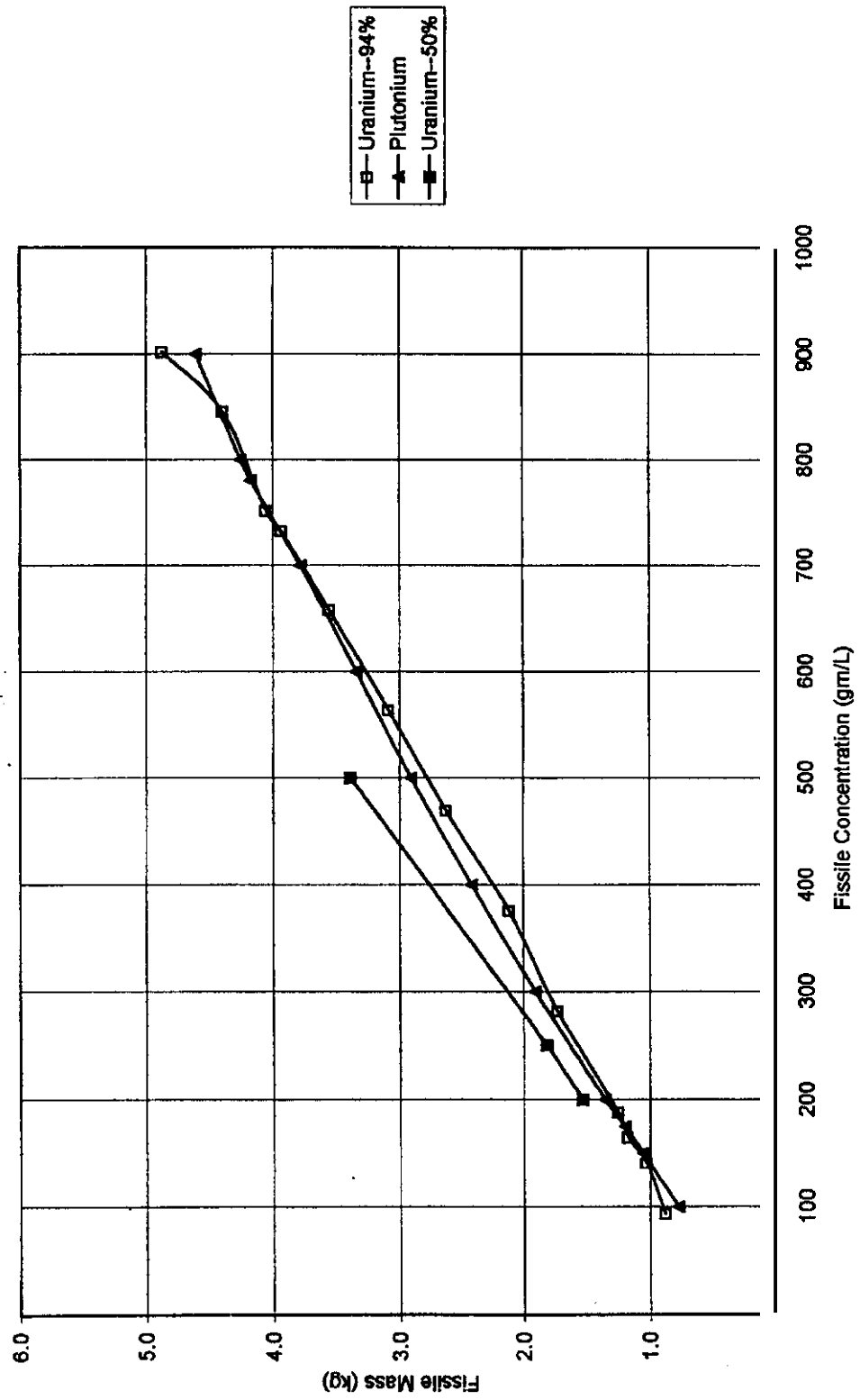


Figure 2. Critical Diameter For Water Reflected Infinite Cylinders

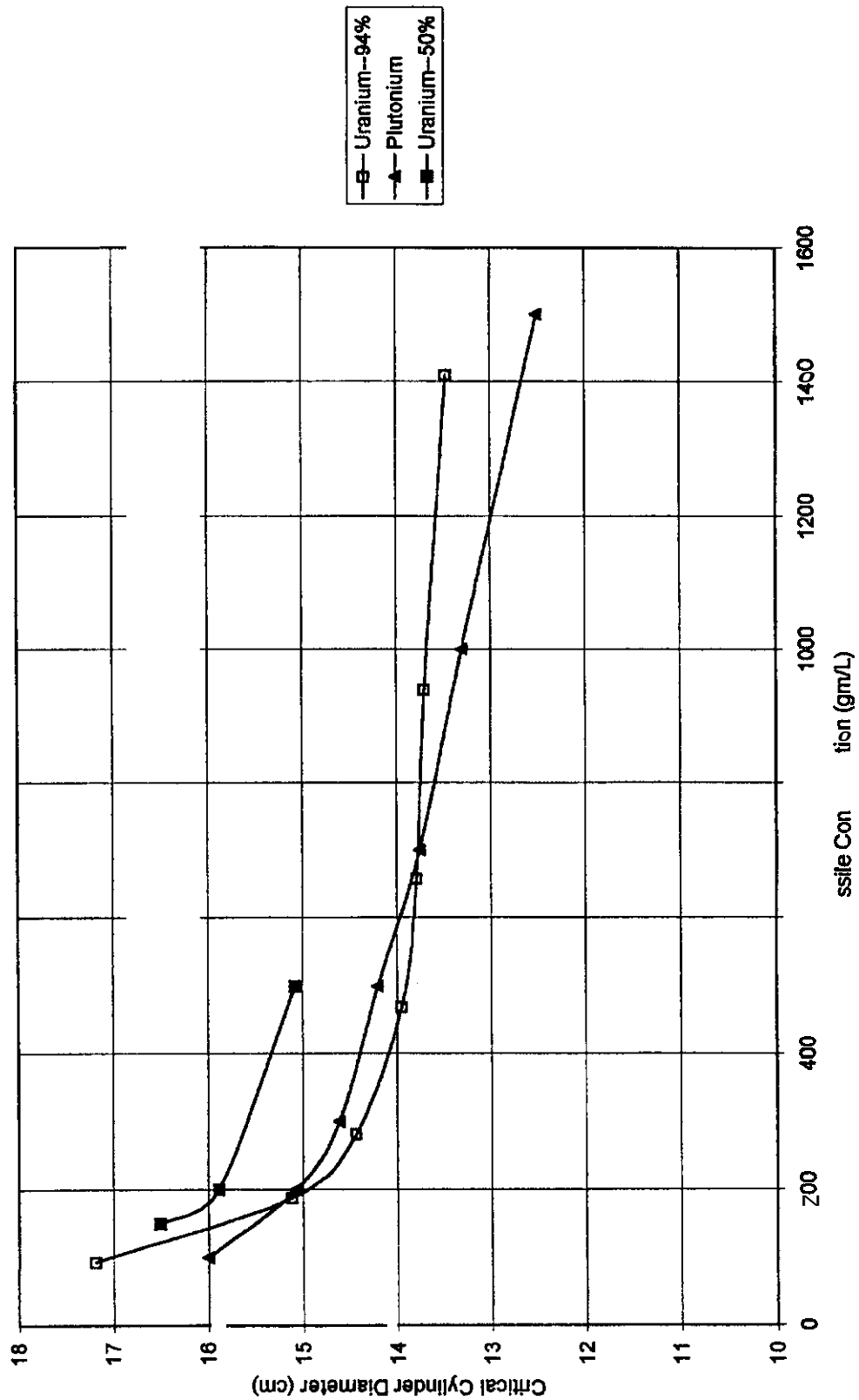
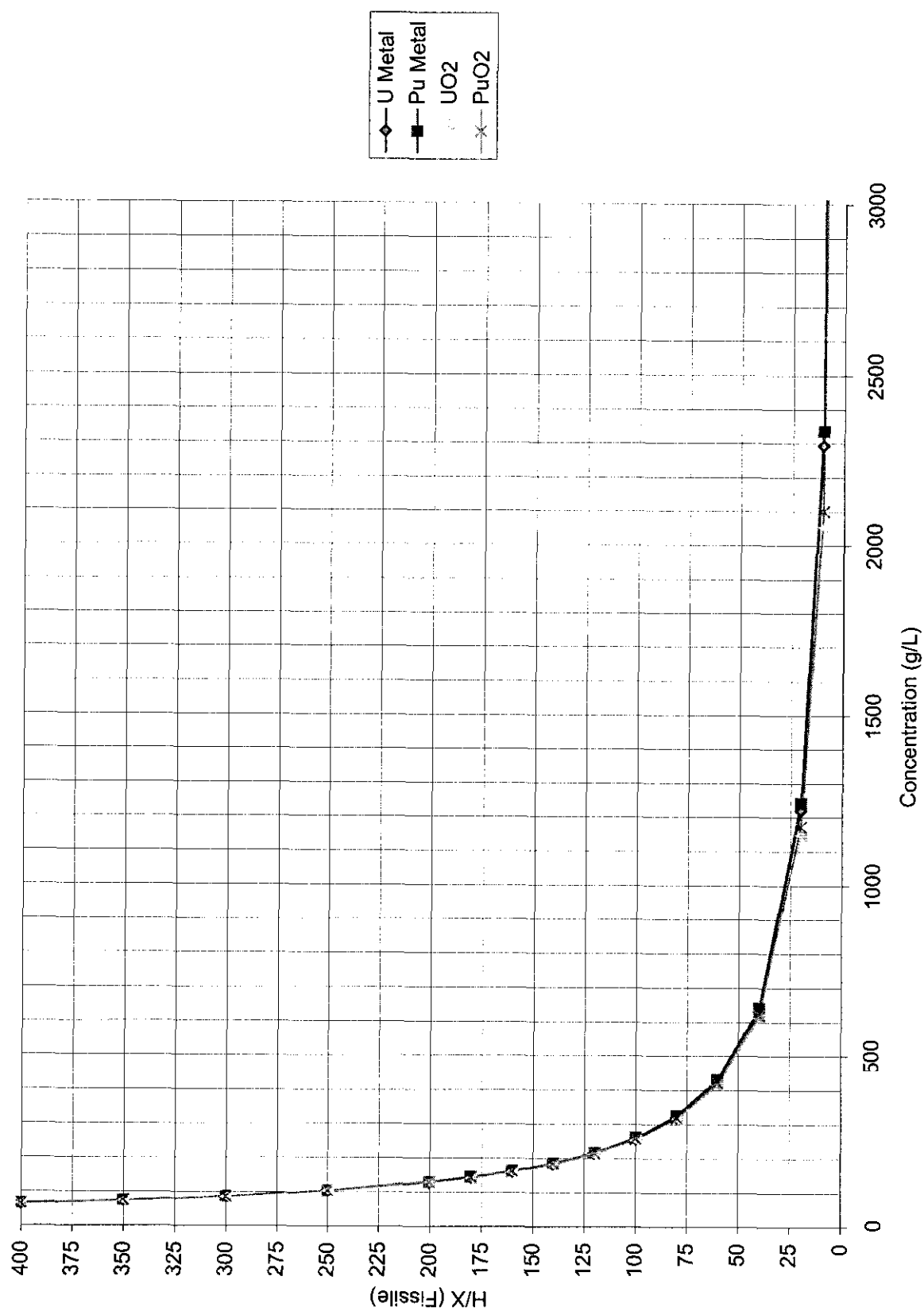


Figure 3. H/X vs Fissile Concentration in Water Mixtures



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APPENDIX A MCNP ANALYSIS

Input and output file names consist of a letter, “r” for the spherical cases and “c” for the cylindrical cases, a sequence number, and a letter, “u” for uranium cases and “p” for plutonium cases. Input files have a “.inp” extension, outputs a “.out” extension.

A1.0 MCNP Input

For the spherical systems, MCNP input data was calculated in the spreadsheet of Table A1-3. Starting point was the chosen fissile concentration, in grams per liter (column B), and the total fissile mass in the system (column C). Columns D and E are the enrichments, in weight percent, of ^{235}U in uranium and ^{239}Pu in plutonium, respectively. The metal volume fractions (columns F and G) of the water-metal mix were determined by dividing the heavy metal concentration by the appropriate metal density (and applying conversion factors as necessary). Water volume fractions (columns H and I) were calculated by subtracting the metal fraction from 1. Overall density of the water-metal mixes (columns J and K) were calculated by multiplying the component volume fraction by the appropriate component density and summing. The volume of the water-metal mix (column L) was calculated by dividing the metal mass (column C) by the metal concentration (column B) and applying the appropriate unit conversions. From the volume of the sphere, the radius of the fissile mix can be calculated (column N). The outer radius of the reflector region (column O) was obtained by adding 100 cm to the radius of the fueled region (column N). The metal masses (columns P, Q, and T) were calculated by multiplying the mix volume (column L) by the metal concentration (column B) and an appropriate factor derived from the enrichments of columns D and E. Hydrogen and oxygen masses (columns R, S, U and V) were calculated by multiplying the mix volume (column L) by the water volume fraction (column H or I), by the density of water, and finally by the weight fraction of oxygen or hydrogen in water.

For cylindrical systems, MCNP input data was calculated in the spreadsheet of Table A1-4. Starting point was the desired fissile concentration, in grams per liter (column B). Column C is the cylinder radius of that particular case. Columns D and E are the enrichments, in weight percent, of ^{235}U in uranium and ^{239}Pu in plutonium, respectively. The metal volume fractions (columns F and G) of the water-metal mix were determined by dividing the metal concentration by the appropriate metal density (and applying conversion factors as necessary). Water volume fractions (columns H and I) were calculated by subtracting the metal fraction from 1. Overall density of the water-metal mixes (columns J and K) were calculated by multiplying the component volume fraction by the appropriate component density and summing. The metal densities (columns L, M, and P) were calculated by multiplying the metal concentration (column B) by an appropriate factor derived from the enrichments of columns D and E. Hydrogen and oxygen densities (column N, O, Q and R) were calculated by multiplying the water volume fraction (column H or I) by the density of water, and finally by the weight fraction of oxygen or hydrogen in water.

The typical input file for a plutonium-water sphere with a water reflector is shown in Table A1-1. The italicized portions of this file change with the case being analyzed, with the

new data taken from the spreadsheet of Table **AI-3**. The first two lines are the case title and comment cards—values from columns B through D are used to identify the case. The value in line 4 is the overall mix density from column J or K for uranium or plutonium system, respectively. The two variables in lines 7 and 8 are the outside radii of the fuel and reflector regions, from columns N and O. The variables in lines 10 and 11 are the masses of the elements in the fuel mix, given by columns P through S for uranium systems, and columns T through V for plutonium systems.

Table A1-1. MCNFF Input For A Water Reflected Sphere.

```

Case r10p.inp

critical concentration homogeneous sphere Pu
c conc 800 mass 4.20
c

1 1 -1.75968 -1 imp:n=1
2 2 -1.00 1 -2 imp:n=1
3 0 2 imp:n=0

1 so 10.78177 $ fuelregion
2 so 110.7818 $ reflectorregion

ml 94239.50 -4200.00 101.50 -563.758
-4474.55

mtl lwtr.01t
m2 1001.50 2 8016.50 1
mt2 lwtr.01t
mode n
kcode 1000 1 10
ksrc 0 0 0
print 40 50
prdmp 3j 3
ctme 10

```

The typical cylindrical geometry input file—in this case, a uranium system—is shown in Table AI-2 below. The case identifiers in lines 1 and 2 come from columns B through D of the spreadsheet in Table **AI-4**. The variable in line 4 is the overall fuel **mix** density from column J or K, for uranium or plutonium systems, respectively. The variable in line 8 is the radius of the fuel region, from column C. The variables of lines 13 and 14 are the elemental densities from columns L through O for uranium systems, and columns P through R for plutonium systems.

Table A1-2. MCNP Input for a Water Reflected Infinite Cylinder

```

Case clu.inp

c conc 100 dia = 13
c
1 1 -1.094751 -1 2 -3 imp:n=1
2 2 -1.00 1 2 -3 -4 imp:n=1
3 0 -2 : 3 : 4 imp:n=0

1 cz 6.50 $ fuel region
*2 pz -50.00
*3 pz 50.00
4 cz 106.50 $ reflector region

m1 92235.50 -0.09400 92238.50 -0.0060
1001.50 -0.111307 8016.50 -0.883444
mt1 lwtr.01t
m2 1001.50 2 8016.50 1
mt2 lwtr.01t
mode n
kcode 1000 1 10
ksrc 0 0 0
print 40 50
prtmp 3j 3
ctme 10

```

A-4

[illegible]

Table A1-4. Spreadsheet to Obtain MCNP Input for Water Reflected Infinite Cylinders.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
5	critical water-reflected infinite cylinders																
6																	
7	molecular weights																
8	U-235	235.0439															
9	U-238	238.0508															
10	Pu-239	239.0522															
11	H	1.0079															
12	O	15.9994															
13																	
14																	
15																	
16																	
17	case																
18	design																
19	c1	100	6.50	94	100	0.005249	0.005040	0.994751	0.994980	1.094751	1.094980	0.094000	0.090000	0.111307	0.893444	0.100000	0.111330
20	c2	100	7.50	94	100	0.005249	0.005040	0.994751	0.994980	1.094751	1.094980	0.094000	0.090000	0.111307	0.893444	0.100000	0.111330
21	c3	100	8.50	94	100	0.005249	0.005040	0.994751	0.994980	1.094751	1.094980	0.094000	0.090000	0.111307	0.893444	0.100000	0.111330
22	c4	300	6.50	94	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.282000	0.018000	0.110132	0.874120	0.300000	0.110202
23	c5	300	7.50	94	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.282000	0.018000	0.110132	0.874120	0.300000	0.110202
24	c6	300	8.50	94	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.282000	0.018000	0.110132	0.874120	0.300000	0.110202
25	c7	500	6.50	94	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.470000	0.030000	0.108958	0.864796	0.500000	0.108074
26	c8	500	7.50	94	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.470000	0.030000	0.108958	0.864796	0.500000	0.108074
27	c9	500	8.50	94	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.470000	0.030000	0.108958	0.864796	0.500000	0.108074
28	c10	1000	6.50	94	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.940000	0.080000	0.108021	0.841486	1.000000	0.108255
29	c11	1000	7.50	94	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.940000	0.080000	0.108021	0.841486	1.000000	0.108255
30	c12	1000	8.50	94	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.940000	0.080000	0.108021	0.841486	1.000000	0.108255
31	c13	1500	6.50	94	100	0.078740	0.075805	0.921280	0.924395	2.421280	2.424395	1.410000	0.090000	0.103084	0.818176	1.500000	0.103435
32	c14	1500	7.50	94	100	0.078740	0.075805	0.921280	0.924395	2.421280	2.424395	1.410000	0.090000	0.103084	0.818176	1.500000	0.103435
33	c15	1500	8.50	94	100	0.078740	0.075805	0.921280	0.924395	2.421280	2.424395	1.410000	0.090000	0.103084	0.818176	1.500000	0.103435
34	c16	200	7.4000	94	100	0.010489	0.010081	0.986501	0.986919	1.986501	1.986919	0.188000	0.012000	0.110720	0.878782	0.200000	0.110768
35	c17	200	7.5000	94	100	0.010489	0.010081	0.986501	0.986919	1.986501	1.986919	0.188000	0.012000	0.110720	0.878782	0.200000	0.110768
36	c18	200	7.6250	94	100	0.010489	0.010081	0.986501	0.986919	1.986501	1.986919	0.188000	0.012000	0.110720	0.878782	0.200000	0.110768
37	c19	700	8.7500	94	100	0.036745	0.035282	0.963255	0.964718	1.963255	1.964718	0.658000	0.042000	0.107783	0.855472	0.700000	0.107947
38	c20	700	8.8750	94	100	0.036745	0.035282	0.963255	0.964718	1.963255	1.964718	0.658000	0.042000	0.107783	0.855472	0.700000	0.107947
39	c21	700	7.0000	94	100	0.036745	0.035282	0.963255	0.964718	1.963255	1.964718	0.658000	0.042000	0.107783	0.855472	0.700000	0.107947
40	c22	300	7.2000	50	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.150000	0.150000	0.110132	0.874120	0.300000	0.110202
41	c23	300	7.3000	50	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.150000	0.150000	0.110132	0.874120	0.300000	0.110202
42	c24	300	7.4000	50	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.150000	0.150000	0.110132	0.874120	0.300000	0.110202
43	c25	500	7.0000	50	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.250000	0.250000	0.108958	0.864796	0.500000	0.108074
44	c26	500	7.1250	50	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.250000	0.250000	0.108958	0.864796	0.500000	0.108074
45	c27	500	7.2500	50	100	0.026247	0.025202	0.973753	0.974798	1.473753	1.474798	0.250000	0.250000	0.108958	0.864796	0.500000	0.108074
46	c28	400	8.0000	50	100	0.020987	0.020161	0.979003	0.979839	1.379003	1.379839	0.200000	0.200000	0.108545	0.869458	0.400000	0.108638
47	c29	400	8.2500	50	100	0.020987	0.020161	0.979003	0.979839	1.379003	1.379839	0.200000	0.200000	0.108545	0.869458	0.400000	0.108638
48	c30	400	8.5000	50	100	0.020987	0.020161	0.979003	0.979839	1.379003	1.379839	0.200000	0.200000	0.108545	0.869458	0.400000	0.108638
49	c31	1000	8.0000	50	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.500000	0.500000	0.108021	0.841486	1.000000	0.108255
50	c32	1000	8.2500	50	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.500000	0.500000	0.108021	0.841486	1.000000	0.108255
51	c33	1000	8.5000	50	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.500000	0.500000	0.108021	0.841486	1.000000	0.108255
52	c34	300	7.0000	50	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.150000	0.150000	0.110132	0.874120	0.300000	0.110202
53	c35	300	7.1000	50	100	0.015748	0.015121	0.984252	0.984879	1.284252	1.284879	0.150000	0.150000	0.110132	0.874120	0.300000	0.110202
54	c36	1000	7.5000	50	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.500000	0.500000	0.108021	0.841486	1.000000	0.108255
55	c37	1000	7.7000	50	100	0.052493	0.050403	0.947507	0.946597	1.947507	1.946597	0.500000	0.500000	0.108021	0.841486	1.000000	0.108255

A2.0 MCNP Results

Spherical system results are tabulated in the spreadsheet shown in Table **A2-1** and shown graphically in Figure –1. The MCNP-calculated k_{eff} and standard deviation for uranium and plutonium systems *are* given in columns F through I. The critical mass at a given concentration was calculated by straight-line interpolation between the mass data points closest to a k_{eff} of 1, and is reported in columns K through M. Note that the uranium results in columns K and L are corrected for enrichment and report the mass of ^{235}U . The results are repeated in columns O through T for ease of plotting-note again that the uranium concentration has been corrected for enrichment.

Cylindrical system results are tabulated in the spreadsheet shown in Table **A2-2** and shown graphically in Figure1. The calculated k_{eff} and standard deviation for uranium and plutonium systems are given in columns E through H. The critical diameter at a given concentration was calculated by straight-line interpolation between the data points closest to a k_{eff} of 1, and is reported in columns J through L. The results are repeated in columns O through T for ease of plotting.

Table A2-1. MCNP Output For Water Reflected Spheres

S	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Critical Reflected HMA-Water Spheres																				
1	14	case	HMA conc	U-235 wt%	U-235 conc	HMA mass	U	kg	U-235	kg	U-235	kg	U-235	kg	U-235	kg	U-235	kg	U-235	kg
2	15	14	100	94	94.0	0.75	0.94704	0.00245	0.9470	0.00237	0.9470	0.00237	0.9470	0.00237	0.9470	0.00237	0.9470	0.00237	0.9470	0.00237
3	16	15	100	94	94.0	0.85	0.96070	0.00220	0.9607	0.00220	0.9607	0.00220	0.9607	0.00220	0.9607	0.00220	0.9607	0.00220	0.9607	0.00220
4	17	16	100	94	94.0	0.95	1.00436	0.00234	1.0043	0.00234	1.0043	0.00234	1.0043	0.00234	1.0043	0.00234	1.0043	0.00234	1.0043	0.00234
5	18	17	175	94	184.5	1.20	0.96026	0.00217	0.9603	0.00217	0.9603	0.00217	0.9603	0.00217	0.9603	0.00217	0.9603	0.00217	0.9603	0.00217
6	19	18	175	94	184.5	1.30	0.97086	0.00235	0.9709	0.00235	0.9709	0.00235	0.9709	0.00235	0.9709	0.00235	0.9709	0.00235	0.9709	0.00235
7	20	19	200	94	188.0	1.20	0.96726	0.00232	0.9673	0.00232	0.9673	0.00232	0.9673	0.00232	0.9673	0.00232	0.9673	0.00232	0.9673	0.00232
8	21	20	200	94	188.0	1.30	0.96453	0.00212	0.9645	0.00212	0.9645	0.00212	0.9645	0.00212	0.9645	0.00212	0.9645	0.00212	0.9645	0.00212
9	22	21	200	94	188.0	1.40	1.01315	0.00243	1.0131	0.00243	1.0131	0.00243	1.0131	0.00243	1.0131	0.00243	1.0131	0.00243	1.0131	0.00243
10	23	22	700	94	733.2	3.80	0.98051	0.00237	0.9805	0.00237	0.9805	0.00237	0.9805	0.00237	0.9805	0.00237	0.9805	0.00237	0.9805	0.00237
11	24	23	700	94	733.2	4.00	0.98729	0.00231	0.9873	0.00231	0.9873	0.00231	0.9873	0.00231	0.9873	0.00231	0.9873	0.00231	0.9873	0.00231
12	25	24	700	94	733.2	4.20	1.00087	0.00251	1.0010	0.00251	1.0010	0.00251	1.0010	0.00251	1.0010	0.00251	1.0010	0.00251	1.0010	0.00251
13	26	25	800	94	752.0	4.00	0.98517	0.00237	0.9852	0.00237	0.9852	0.00237	0.9852	0.00237	0.9852	0.00237	0.9852	0.00237	0.9852	0.00237
14	27	26	800	94	752.0	4.20	0.99632	0.00237	0.9963	0.00237	0.9963	0.00237	0.9963	0.00237	0.9963	0.00237	0.9963	0.00237	0.9963	0.00237
15	28	27	800	94	752.0	4.40	1.00277	0.00248	1.0028	0.00248	1.0028	0.00248	1.0028	0.00248	1.0028	0.00248	1.0028	0.00248	1.0028	0.00248
16	29	28	800	94	752.0	4.60	1.01621	0.00222	1.0162	0.00222	1.0162	0.00222	1.0162	0.00222	1.0162	0.00222	1.0162	0.00222	1.0162	0.00222
17	30	29	800	94	752.0	4.80	0.98356	0.00237	0.9836	0.00237	0.9836	0.00237	0.9836	0.00237	0.9836	0.00237	0.9836	0.00237	0.9836	0.00237
18	31	30	300	94	282.0	1.70	0.96356	0.00237	0.9636	0.00237	0.9636	0.00237	0.9636	0.00237	0.9636	0.00237	0.9636	0.00237	0.9636	0.00237
19	32	31	300	94	282.0	1.80	0.96511	0.00225	0.9651	0.00225	0.9651	0.00225	0.9651	0.00225	0.9651	0.00225	0.9651	0.00225	0.9651	0.00225
20	33	32	300	94	282.0	1.90	1.00854	0.00229	1.0085	0.00229	1.0085	0.00229	1.0085	0.00229	1.0085	0.00229	1.0085	0.00229	1.0085	0.00229
21	34	33	300	94	282.0	2.00	1.02319	0.00223	1.0231	0.00223	1.0231	0.00223	1.0231	0.00223	1.0231	0.00223	1.0231	0.00223	1.0231	0.00223
22	35	34	300	94	282.0	2.10	1.02986	0.00250	1.0299	0.00250	1.0299	0.00250	1.0299	0.00250	1.0299	0.00250	1.0299	0.00250	1.0299	0.00250
23	36	35	300	94	282.0	2.20	0.98981	0.00238	0.9898	0.00238	0.9898	0.00238	0.9898	0.00238	0.9898	0.00238	0.9898	0.00238	0.9898	0.00238
24	37	36	300	94	470.0	2.70	0.98081	0.00237	0.9808	0.00237	0.9808	0.00237	0.9808	0.00237	0.9808	0.00237	0.9808	0.00237	0.9808	0.00237
25	38	37	500	94	470.0	2.80	1.00103	0.00237	1.0010	0.00237	1.0010	0.00237	1.0010	0.00237	1.0010	0.00237	1.0010	0.00237	1.0010	0.00237
26	39	38	500	94	470.0	2.90	1.00602	0.00238	1.0060	0.00238	1.0060	0.00238	1.0060	0.00238	1.0060	0.00238	1.0060	0.00238	1.0060	0.00238
27	40	39	500	94	470.0	3.00	1.01848	0.00227	1.0185	0.00227	1.0185	0.00227	1.0185	0.00227	1.0185	0.00227	1.0185	0.00227	1.0185	0.00227
28	41	40	500	94	470.0	3.10	1.02854	0.00220	1.0285	0.00220	1.0285	0.00220	1.0285	0.00220	1.0285	0.00220	1.0285	0.00220	1.0285	0.00220
29	42	41	150	94	141.0	0.70	0.88147	0.00245	0.8815	0.00245	0.8815	0.00245	0.8815	0.00245	0.8815	0.00245	0.8815	0.00245	0.8815	0.00245
30	43	42	150	94	141.0	0.80	0.92203	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248
31	44	43	150	94	141.0	0.90	0.92203	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248	0.9220	0.00248
32	45	44	150	94	141.0	1.00	0.97549	0.0022	0.9755	0.0022	0.9755	0.0022	0.9755	0.0022	0.9755	0.0022	0.9755	0.0022	0.9755	0.0022
33	46	45	150	94	141.0	1.10	1.00399	0.00245	1.0040	0.00245	1.0040	0.00245	1.0040	0.00245	1.0040	0.00245	1.0040	0.00245	1.0040	0.00245
34	47	46	400	94	378.0	2.30	1.01114	0.00238	1.0111	0.00238	1.0111	0.00238	1.0111	0.00238	1.0111	0.00238	1.0111	0.00238	1.0111	0.00238
35	48	47	400	94	378.0	2.40	0.98011	0.00245	0.9801	0.00245	0.9801	0.00245	0.9801	0.00245	0.9801	0.00245	0.9801	0.00245	0.9801	0.00245
36	49	48	600	94	584.0	3.20	1.00141	0.00217	1.0014	0.00217	1.0014	0.00217	1.0014	0.00217	1.0014	0.00217	1.0014	0.00217	1.0014	0.00217
37	50	49	600	94	584.0	3.30	0.98217	0.00237	0.9822	0.00237	0.9822	0.00237	0.9822	0.00237	0.9822	0.00237	0.9822	0.00237	0.9822	0.00237
38	51	50	700	94	693.0	3.80	1.00154	0.00248	1.0015	0.00248	1.0015	0.00248	1.0015	0.00248	1.0015	0.00248	1.0015	0.00248	1.0015	0.00248
39	52	51	700	94	693.0	4.50	0.98367	0.0022	0.9837	0.0022	0.9837	0.0022	0.9837	0.0022	0.9837	0.0022	0.9837	0.0022	0.9837	0.0022
40	53	52	900	94	846.0	4.80	0.98274	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228
41	54	53	900	94	846.0	4.90	0.98274	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228	0.9827	0.00228
42	55	54	400	50	200.0	4.50	1.09146	0.00219	1.0915	0.00219	1.0915	0.00219	1.0915	0.00219	1.0915	0.00219	1.0915	0.00219	1.0915	0.00219
43	56	55	400	50	200.0	5.00	1.15895	0.00224	1.1590	0.00224	1.1590	0.00224	1.1590	0.00224	1.1590	0.00224	1.1590	0.00224	1.1590	0.00224
44	57	56	400	50	200.0	5.50	1.13429	0.00224	1.1343	0.00224	1.1343	0.00224	1.1343	0.00224	1.1343	0.00224	1.1343	0.00224	1.1343	0.00224
45	58	57	500	50	250.0	6.00	1.1158	0.00219	1.1158	0.00219	1.1158	0.00219	1.1158	0.00219	1.1158	0.00219	1.1158	0.00219	1.1158	0.00219
46	59	58	500	50	250.0	6.50	1.08985	0.00209	1.0899	0.00209	1.0899	0.00209	1.0899	0.00209	1.0899	0.00209	1.0899	0.00209	1.0899	0.00209
47	60	59	500	50	250.0	7.00	1.06053	0.00213	1.0605	0.00213	1.0605	0.00213	1.0605	0.00213	1.0605	0.00213	1.0605	0.00213	1.0605	0.00213
48	61	60	400	50	200.0	3.00	0.98563	0.00218	0.9856	0.00218	0.9856	0.00218	0.9856	0.00218	0.9856	0.00218	0.9856	0.00218	0.9856	0.00218
49	62	61	400	50	200.0	3.50	1.03987	0.00209	1.0399	0.00209	1.0399	0.00209	1.0399	0.00209	1.0399	0.00209	1.0399	0.00209	1.0399	0.00209
50	63	62	400	50	200.0	4.00	1.00898	0.00231	1.0090	0.00231	1.0090	0.00231	1.0090	0.00231	1.0090	0.00231	1.0090	0.00231	1.0090	0.00231
51	64	63	1000	50	500.0	7.00	1.00581	0.00208	1.0058	0.00208	1.0058	0.00208	1.0058	0.00208	1.0058	0.00208	1.0058	0.00208	1.0058	0.00208
52	65	64	1000	50	500.0	8.00	1.03187	0.00215	1.0319	0.00215	1.0319	0.00215	1.0319	0.00215	1.0319	0.00215	1.0319	0.00215	1.0319	0.00215
53	66	65	1000	50	500.0	9.00	1.05821	0.00238	1.0582	0.00238	1.0582	0.00238	1.0582	0.00238	1.0582	0.00238	1.0582	0.00238	1.0582	0.00238
54	67	66	500	50	250.0	3.00	0.98479	0.00												

Figure A2-2. MCNP Output For Water Reflected Infinite Cylinders.

[illegible]

A3.0 MCNP Validation

Several high-enriched uranium benchmark cases were run using the MCNP Code. The benchmark cases were six critical experiments chosen from NEA (1995). These six cases span the concentrations of concern. The results are shown in Table A3-1.

Table A3-1. Results of the Validation Runs

Validation Runs					
Case Number	Fissile Concentration kg/L	Actual	calc k_{eff}	std dev	Δk_{eff} Actual - calc.
HEU-SOL-THERM-018-1	0.3	1.0	0.99211	0.00100	-.00789
HEU-SOL-THERM-019-1	0.4	1.0	1.00303	0.00097	+.00303
HEU-SOL-THERM-009-1	0.65	1.0	1.00408	0.00068	+.00408
HEU-MET-THERM-003-4	4.6	0.9826	0.97735	0.00083	-.00525
HEU-SOL-THERM-016-1	0.15	1.0	0.99687	0.00096	-.00313
HEU-SOL-THERM-010-4	0.1	1.0	1.00047	0.00063	+.00047

The data for both the plutonium and uranium benchmarks are summarized in Table A3-2.

Table A3-2. Comparison of Bias between actual k_{eff} and MCNP calculated k_{eff} .

	Metal		Non-Metal	
Fissile	Mean k_{eff}	Range above and below the mean	Mean k_{eff}	Range above and below the mean
Plutonium	0.9956	-0.00081 to -0.0086	1.0125	-0.0020 to 0.0041
Uranium	0.9948	-0.0052	0.9929	-0.0079 to 0.0041

The benchmark for uranium metal matches the results for plutonium metal benchmark runs. The uranium solutions benchmarks have the same range as plutonium solutions, but the mean is lower than plutonium solution benchmark results. The mean value of k_{eff} for uranium solutions is about 0.02 lower than that for plutonium. This means that the calculated critical mass for uranium is too large. The impact of this bias is determined next. It was stated above that materials containing uranium having enrichments less than 50 wt% could be stored and processed using CPS for plutonium. Figure 1 shows that for spheres, the closest approach of the critical mass for 50 wt% enriched uranium to plutonium is at a fissile concentration of 200 g/L. The critical mass of plutonium at a fissile concentration of 200 g/L is 1.3499 kg. The critical mass for 50 wt% enriched uranium is 1.53025 kg. The critical mass for 50 wt% enriched uranium at a k_{eff} of 1.02 is 1.6681 kg. So the estimated critical mass at a k_{eff} of 0.98 is found from

$$1.53025 - (1.6681 - 1.53025) = 1.39 \text{ kg.}$$

Alternatively, using the MCNP code, the critical mass for 50 wt% enriched uranium at a k_{eff} of 0.98 is 1.39 kg. Both of the estimates of a mass of a 50 wt% enriched uranium at a k_{eff} of 0.98 are above the critical mass of plutonium. A similar calculation performed for infinite cylinders shows similar results. Therefore use of 50 wt% enriched uranium covers the bias.

APPENDIX B
STATEMENT OF WORK FOR REV. 1

-----Original Message-----

From: Greenborg, less
Sent: Tuesday, March 06, 2001 12:00 PM
To: Mo, Blaise S
CC: Dobbin, Kenneth D; Wilkinson, Alan D; Erickson, David G; Toffer, Hans; Greenborg, Jess
Subjea: EU>50%

Blaise;

Confirming our phone conversation, the following CSERs will be upgraded now:

98-005 (Canning thermally stabilized powder)
99-007 (Muffle furnace operations)
00-002 (Prep for thermal stabilization)
00-008 (18BS, packaging thermally stabilized materials)
00-010 (Bag less transfer)

The following CSERs will be upgraded if/when needed.

00-001 (HC46F)
00-006 (Storage in drums)

Jess
376-3482

Fluor Hanford

STATEMENT OF WORK

DATE 1/12/01

REV. NUMBER 00

REFERENCE INFORMATION (Project Internal Use Only)

COST ACCOUNT CHARGE NUMBER (CACN): 1 10844

CODE OF ACCOUNT (COA): BA30

ORG/COST 7 1 AG00

TOTAL EST 7 COST:

AUTHORIZED AMOUNT FOR THIS ACTION or RELEASE

PREFERRED VENDOR:

NONCOMPETITIVE JUSTIFICATION ATTACHED: N *(Criticality work is exclusive and assigned and monitored by Central FH Group. Therefore no NCJ is required.*

ISMS CHECKSHEET ATTACHED: Y

CONTRACT NUMBER:

RELEASE NUMBER

MODIFICATION NUMBER:

1.0 WORK SCOPE TITLE or CONTRACT RELEASE TITLE

Provide a Criticality Safety Evaluation Report (CSER) that establishes volume and moderation limits so that fissile materials in the form of metal or oxides with a uranium enrichment greater than 50% can be managed under Pu limits on a gram per gram substitution basis with Pu mass limits. Revise CSERs 98-005, 99-007, 00-001, 00-002, 00-006, and 00-008 to remove the U-235 enrichment restriction.

2.0 INTRODUCTION

This Contract Release provides direction for Fluor Federal Services (FFS) to provide Criticality Safety services related to preparing and revising CSERs. The work performed under this Contract Release is in support of Fiscal Year (FY) 2001 activities.

3.0 WORK SCOPE/ DESCRIPTION OF REQUIRED SERVICES

CSER 99-003 involved a parameter study that conservatively and generally concluded that mass limits applied to the handling of plutonium Pu could be used for U-235 if the **U235** enrichment did not exceed 50% or if the U235 concentration was above 1000 g/l. The 50% enrichment restriction has since been promulgated in subsequent CSERs at PFP. It is relevant to note that the study only observed that U235 was more reactive than Pu as a moderated solution with a fissile concentration between 150 g/l and 850 g/l.

There is a small population of Pu and EU alloy materials that are to be opened, brushed, possibly stabilized, and then packaged in BTCs and stored by July 2001. These materials are stored in vaults and will be handled in Gloveboxes **HC-21A, HC-21C, HC-18M, HC-18BS, HC-21I, and HC-20MB**. U235 is only slightly more reactive than plutonium under a limited, specific range of moderated conditions. Therefore, the volume and moderation of fissile material can be limited such that CSER 99-003 shows it is conservative to use plutonium calculations and a one gram to one gram conversion for U-235. The scope for this work is:

1. Determine the container volume and moderation limits where the CSER 99-003 evaluation shows plutonium calculations are conservative for a uranium system of any enrichment. Hence, plutonium is

more reactive than **U235** and consequently, **U235** may be substituted for Pu metal on a gram for gram basis ~~in~~ mass limits. Assume the most conservative container dimensions so that ~~geometry~~ is not a control.

2. Revise CSERs ~~98-005~~, 99-007, 00-001, 00-002, 00-006, and 00-008 to remove the **U-235** enrichment restriction.
3. Prepare a CSER based upon the CSER **99-003** evaluation that documents the volume and moderation limits established in item 1. Include a list of the contingencies that do not compromise the assumptions of CSER 99-003 (ie. The list of contingencies of the CSERs of item 2.).
4. Do not perform any additional computer calculations. Use results of CSER **99-003** or other CSERs as a basis for this work.

If it should be deemed necessary to perform an additional calculation, that work must ~~first~~ be agreed upon by the technical representative with concurrence of the cost account manager if such work exceeds the initial ~~cost~~ estimates and schedule.

In the conduct of performing this analysis FFS CSS review is sufficient, ~~i.e.~~, no additional outside CSS review ~~is~~ required. It is also expected that FFS CSS obtain reviews and signatures for the revised CSER and submit it to document control.

No work is authorized beyond 100 hours until the PFP Technical Representative and Cost Account Manager ~~have~~ approved a cost ~~estimate~~ and schedule.

4.0 DELIVERABLES / SCHEDULE OR OBJECTIVE ACCEPTANCE CRITERIA

The deliverables are to be detailed in proposal with completion dates for each deliverable based on priority previously established by BTR.

4.1 REPORTS

A FFS monthly status report ~~is~~ required for this release

4.2 DOCUMENT CONTROL REQUIREMENTS

All documents generated under the Contract Release ~~will be reviewed/approved~~ and released as directed by the FH Project Technical Representative.

4.3 HOLD POINTS and/or SOURCE RECEIVING INSPECTION POINTS

N/A

4.4 MEETINGS

Kickoff Meetings

A kickoff meeting is required.

Progress Meetings

Contractor's personnel shall attend progress meetings as directed by the FH Project Technical Representative.

Weekly Review Meetings

Cost and schedule status shall be reponed at a weekly review meeting as directed by the FH Project Technical Representative.

5.0 MINIMUM QUALIFICATION AND COMPETENCE REQUIREMENTS WHICH CONTRACTOR MUST MEET

REQUIRED TRAINING FOR CONTRACTOR (TO INCLUDE QUALIFICATION OR CERTIFICATION REQUIREMENTS IF NECESSARY)

6.0 Performance Period

Desired Start Date: 1 Date: 04/15/01

7.0 Type of Service:

☐ Staff
The assigned staff shall comply with Project Hanford Management Contract, FH and PFP specific procedures. When initiating any direct or indirect, Staff Augmentation employees shall be accountable to stop and consult with the Point of Contact (POC) providing day to day direction or this contract's Buyers Technical Representative (BTR). It is the Augmentation employee's responsibility to know the PFP Casualty Response procedures, Emergency Response Guide, and the PFP Billing Emergency Plan for PFP Allidents (cuts, burns, bruises, etc.) shall be reported immediately to the POC BTR or the cognizant PFP Management.

Vendor Key Personnel:

☒ Managed Task (works at the direction of the Vendor)
The vendor shall comply with following FH or PFP Project specific procedures.

☐ Other

8.0 General Project Specific Requirements, Codes, and Standards

Information of a sensitive nature which is obtained, accessed, referenced, handled, reproduced or stored as a result or consequence of work produced under this contract statement of work, shall be protected in accordance with FSP-PFP-5-8, Section 4.18. No such information shall be retained by the sub-contractor following completion of work under this contract statement of work.

Information regarding the quantity, identity, characteristics and locations of special nuclear materials, (e.g., plutonium, uranium, nuclear fuel, etc.) at PFP is of particular concern. Personnel performing work under this contract statement of work who will or may use or produce such information shall discuss the information intended for use with a FH Authorized Derivative Classifier before work commences.

- 1) Employees proposed to perform work in support of this contract release will be required to participate in a brief ONSITE interview with the FH Buyer Technical Representative and a PFP Authorized Derivative Classifier before work commences.
- 2) The purpose of the ONSITE interview is two fold: Identify and discuss sensitive information potentially available to be needed or produced during the performance of work under this contract statement of work.

- 3) Orient the employees to the requirements and key PFP points of contract for protection of sensitive information and prescribe the conditions under which such information will be used, handled, stored, reproduced, or delivered.

PFP is a security protected area and therefore requires an "L" (2) or "Q" (3) DOE security clearance for unescorted access to the PFP protected area. Employees **who** do not possess an approved DOE clearance shall be escorted at all times after passing through the PFP Operations Control Facility (OCF).

The PFP **project requires** specific training beyond the PHMC and **DOE** required training for access in the PFP protected area. All training beyond HGET and Building/Facility Orientation must have prior approval from the Contract Administrator. All no-show costs **are** the responsibility of the vendor.

9.0 FH NMS Project Points of Contact:

Buyers Technical Representative **B.S. Mo.**
Cost Account Manager D.R. Speer _____

10.0 QUALITY **AND** SAFETY REQUIREMENTS

10.1 Configuration Control

10.2 ISMS Requirement

10.2.1 **SP-5A** (Full Implementation)

10.2.2 **SP-5B** X (Partial Implementation)

10.3 Quality Assurance (check the ones that apply)

The contractor is subject to the provision of 10-CFR-830.120 and IO-CFR-820.

X **NQA-I, 1994 Edition, Basic Requirements:** (list requirements) 1-7 and 15-18
 NQA-I, 1994 Edition, Supplemental Requirements: (list requirements) _____
 Other: (list other requirements) _____

10.4 Safety Classification & Quality Level (check only one)

X **A)** Quality Level I – SC
 B) Quality Level I – SS
 C) Quality Level I – GS
 D) Quality Level 2 – SS
 E) Quality Level 2 – GS
 F) Quality Level 3 – GS
 G) Quality Level 0 – GS

10.5 Approval Designator (check all that apply)

 E) Environmental
X **S)** Safety
X **Q)** Quality

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**APPENDIX C
PEER REVIEW CHECKLIST**

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FLUOR DANIEL NORTHWEST

TECHNICAL . PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: **HNF-4436, Rev. 1**
 Title: **CSER 99-003, Rev. 1 Criticality Mass of Uranium as Compared to Plutonium- Implications for PFP Processing Uranium**
 Author: **J. Greenborg, D. G. Erickson**
 Date: **April 26, 2001**
 Scope of Review: *Revised limits for U-235 enrichment > 50%*

Yes	No*	NA	
☐	☐	☒	** Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	Problem completely defined.
☐	☐	☒	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☐	☐	☒	Computer codes and data files documented.
☐	☐	☒	Data used in calculations explicitly stated in document
☐	☐	☒	Data checked for consistency with original source information as applicable.
☐	☐	☒	Mathematical derivations checked including dimensional consistency of results.
☐	☐	☒	Models appropriate and used within range of validity or use outside range of established validity justified.
☐	☐	☒	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☐	☐	☒	Software input correct and consistent with document reviewed.
☐	☐	☒	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced.
☐	☐	☐	Limits/criteria/guidelines checked against references.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.
☒	☐	☐	Format consistent with applicable guides or other standards.
☐	☐	☒	** Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved (i.e., the reviewer affirms the technical accuracy of the document).

R. F. Richard *R. F. Richard*
 Reviewer: (Printed and Signed)

4/26/01
 Date

* All "NO" responses must be explained below or on an additional page.

** Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

NUCLEAR ENGINEERING

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