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An Analysis of the Impact of Having Uranium Dioxide Mixed in With Plutonium Dioxide

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Abstract: An assessment was performed to show the impact on airborne release fraction, respirable fraction, dose conversion factor and dose consequences of postulated accidents at the Plutonium Finishing Plant involving uranium dioxide rather than plutonium dioxide.

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**AN ANALYSIS OF THE IMPACT OF HAVING
URANIUM DIOXIDE MIXED IN WITH PLUTONIUM DIOXIDE**

**Robert M. Marusich
Fluor Daniel Northwest, Inc.**

October 1998

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ACRONYMS LIST

ARF	airborne release fraction
PFP	Plutonium Finishing Plant
PWR	pressurized water reactor
SAR	Safety Analysis Report

An Analysis of The Impact of Having Uranium Dioxide Mixed in with Plutonium Dioxide

1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

This White Paper addresses the impact on the accident analysis in the Plutonium Finishing Plant (PFP) Final Safety Analysis Report (SAR) of having uranium dioxide alone or mixed in with the plutonium dioxide in the vaults, gloveboxes or process tanks. The effect on criticality is addressed separately.

It is assumed that the material being evaluated is uranium dioxide (UO_2) either alone or mixed in with plutonium metal, fluoride or oxide. It is further assumed that the uranium dioxide came from enriched ^{235}U fuel. Fuel rich in ^{235}U or other non-standard fuel is not considered.

The presence of uranium dioxide will affect the dose consequences for the same quantity of plutonium released and may affect the release fractions and respirable fractions used in the safety analysis report. The presence of uranium dioxide may also affect the toxicological aspects of the release. The toxicological aspects are not covered in this White Paper as they cannot be easily assessed, nor are the toxicological consequences of plutonium releases considered in the safety analysis report. In addition the toxicological consequences vary considerably if the material is UO_2 or UO_3 .

1.2 SUMMARY

Substitution of uranium dioxide powder for plutonium dioxide powder on a gram-for-gram basis will not result in an increase in dose consequences. In fact, the doses could be a factor of 4.4 to 37,000 times less depending on the factors described below. In no case will it be greater.

In all but two cases the release fractions for plutonium dioxide powder is the same as that for uranium dioxide powder. The two cases where it is not is in the waste drum fire analysis where the release for uranium dioxide would be 6 times greater per DOE (1994) and the release due to thermal stress where it can be as much as 20 times greater.

The respirable fractions could be very different depending on the initial responsible fraction of the uranium dioxide powder as compared to that used in the analysis. The respirable fractions should not differ by more than a factor of 10 (i.e., 10 times greater to 1/10 as great) over what was analyzed.

The unit dose factor, "Rem/g," for uranium dioxide releases are a factor of 3700 times less than the unit dose factor used for plutonium oxide releases in the SAR. Even under very conservative assumptions, it is 440 times less than those for plutonium releases.

2.0 IMPACT ON THE RELEASE FRACTIONS

The PFP SAR was reviewed to determine the release fractions used. Of the release fractions used only a few pertain to powder releases. The discussion below addresses each different powder release fractions and the impact of uranium dioxide on it. The term release fraction can be equated with the term "ARF" used in DOE (1994). The respirable fraction will be discussed later.

There are a number of release fractions used in the PFP SAR. The effect on the release fraction of the presence of uranium dioxide will be discussed for each type of release fraction.

2.1 DEFLAGRATION

Section 9.2.1C and 9.2.4B.1.4 provide the release fraction for a postulated deflagration above powders in Glovebox MT-5 and HC-21C. The value for the release fraction came from experiments discussed in DOE (1994), Section 4.4.2.3.1 and Section 4.0. The experiment used uranium dioxide as the powder. Therefore use of this release fraction to determine dispersal of uranium dioxide in the SAR accident would show no change in the quantity dispersed over that for plutonium powders.

2.2 POWDER SPILL

The release fraction for accidents involving powder spills is presented in Section 9.1.3 and 9.2.4A.6.2 of the SAR. The release fraction came from DOE (1994) and was based on experiments in which uranium dioxide was spilled. As a result, use of this release fraction in the SAR for uranium dioxide spills would show no change in released quantity over that for plutonium powders.

2.3 PRESSURIZATION OF CONTAINERS DUE TO RADIOLYTIC HEATING

SAR Section 9.2.4A.6.3.1.1, 9.2.4A.6.3.6.D and 9.1.4 present the results of radiolytic heating and pressurization of containers. Section 3 of this report will show that while the alpha particle energy is the same for uranium as for plutonium (as evidenced by similar values for "Rem/Ci"), the number of curies is less. The number of curies comes from information in Tables 1, 2 and 3. For the worst case (97.5% enriched), there are 1.5×10^{-4} Ci in 1 gram. The SAR shows Ci/g values for plutonium hundreds of times larger. As a result, the decay heating (which is equivalent to Curies times energy per disintegration) is less. Since the decay heating is less, the pressurization is less. Therefore storage of an equivalent amount of uranium dioxide is bounded.

2.4 HYDROGEN GENERATION RATE

SAR Section 9.2.4A.6.3.2.A.n discusses hydrogen generation in the 236-Z solvent extraction process. The hydrogen generation rate is proportional to heat rate. Section 2.3 discusses heat rate.

2.5 SUSPENSION FROM DUCT SURFACES

SAR Section 9.2.4A.6.3.1.W discusses resuspension of plutonium from the surfaces of ducts due to seismic vibrations. The model used was based on beryllium powder. As such, it is useful for uranium dioxide for the same reasons that it was used for plutonium dioxide or fluoride; it was the experiment that produced the greatest release fraction regardless of material or activity.

2.6 CRUSHING FILTER BOXES AND FILTERS

SAR Section 9.2.4A.6.3.1.W and 9.2.4A.6.3.1.X presents an analysis of the release due to crushing filter boxes or filters. The release fraction came from a 1979 assessment of a hypothetical seismic event at another nuclear facility. The value was based on engineering judgement and, as such, is as applicable for UO_2 as it is for plutonium powders.

2.7 MECHANICAL RELEASE

SAR Section 9.2.2D.2.1.2 described an accident where the drum was breached by a forklift. The release fraction was 5×10^{-5} . The value came from an experiment in which uranium dioxide was vented from a container under a small amount of pressure (0.06 MPa or 0.5 psig). This experiment was performed using UO_2 powders and therefore covers accidents in which UO_2 is the material being dispersed.

2.8 EXPLOSION OVER CONTAMINATED MATERIAL

SAR Section 9.2.2D.2.1.3 discussed the release due to explosion. The release fraction is chosen as 10^{-5} . The value came from DOE (1994) Section 5.2.2.3 concerning pressurized air flow over powder. The value was based on experiments performed on uranium dioxide powder (DOE 1994, Section 4.4.2.2.2) and computer simulations of detonations over powder. As a result, use of this release fraction for uranium powders will show no increase in quantity dispersed over that from plutonium powders.

2.9 FIRES

2.9.1 Thermal Stress on Powder Beds

SAR Sections 9.2.2A.9.2.2C and 9.2.4B.2.4 provide the release fractions for a fire occurring over or near powder beds. Section 9.2.2C and 9.2.4B.2.4 use a release fraction of 6×10^{-5} . This value comes from DOE (1994), Section 4.4.1.1 where experiments in which plutonium oxide powders were thermally stressed. DOE (1994) points out that the value used for oxide powders is quite similar to that for non-reactive powders whether they are thermally stressed or not. As a result, the release of thermally stressed uranium dioxide powders would be no greater.

The release fraction described in Section 9.2.2A is different. The release fraction is based on a release rate measured for reactive plutonium powders times the duration of the fire. The combination produces a value for release fraction of 1.4×10^{-4} . The value is appropriate for plutonium fluoride powders. However, if the plutonium fluoride powders were replaced by uranium dioxide powders, the release fraction would be 6×10^{-5} . One should be able to argue that the value of 6×10^{-5} came from data involving a one hour fire and that for a 0.25 hour fire the release fraction is 1.5×10^{-5} . One might also use the statement in DOE (1994) that the resuspension of thermally stressed non-reactive powders should be the same as that for non-thermally stressed powders. DOE (1994), Section 4.4.4.1 shows a release rate of 4×10^{-5} /hr for resuspension of calcium molybdate powder from soil. Using this value for a duration of 0.25 hr yields 10^{-5} . Table A.3 of DOE (1994), Test 25a shows a respirable release rate over 24 hours of 4.4×10^{-4} /hr for UO_2 powder on stainless steel given 9.8 m/s winds. The DOE (1994) values of 6×10^{-5} and 10^{-5} surround the value of 1.4×10^{-4} used. To be fair, it must be noted that the value of 10^{-5} has the respirable fraction included. The value of release fraction times respirable fraction is shown below.

SAR Section 9.2.2A	$(5.6 \times 10^{-4})(0.25)(0.04) = 5.6 \times 10^{-6}$
DOE (1994), Section 4.4.4.1	$(4 \times 10^{-5})(0.25) = 10^{-5}$
DOE (1994), Section 4.4.1.1	$(6 \times 10^{-5})(0.01) = 6 \times 10^{-5}$
DOE (1994), Table A.3	$(4.4 \times 10^{-4})(0.25) = 10^{-4}$

It is concluded that the presence of uranium dioxide powders in place of plutonium fluoride powders would result in a respirable release 10 to 20 times greater for the accident in Section 9.2.2A of the SAR.

2.9.2 Thermal Stress of Contaminated Material

SAR Section 9.2.2D.2.1.1 provides the release fraction for burning contaminated waste material. The value used came from DOE (1994), Section 5.2.1.1. The values in Section 5.2.1.1 was based on experiments involving burning contaminated material contaminated with uranium dioxide powder. As a result, the release quantity for waste contaminated with uranium dioxide rather than plutonium would be the same.

The same section uses a value for release fraction times respirable fraction of 10^{-5} for the release off non-combustible waste. DOE (1994) uses 6×10^{-5} for the release off non-combustible waste as a bounding value. Use of the bounding value would mean that the SAR respirable releases should be 6 times greater. Use of the specific arguments in the cited reference for the release fraction would likely show that the value used is also acceptable for uranium dioxide powders as a value for aerodynamic entrainment in enclosed locations is given as 4×10^{-6} /hr. As a result, the releases due to thermal stress of non-combustible material being thermally stressed could be a factor of 6 greater.

2.9.4 Powder in Ducts

Section 9.2.2A.3.3 provides a discussion of the release of plutonium fluoride from deposits in ducts. The section states that the release is based on experiments made with UO_2 powder. Therefore the release fraction for UO_2 under similar conditions will be identical.

2.9.5 Powders in Filters that Collapse

Section 9.2.2A.3.3 provides a discussion of the release of plutonium fluoride from collapsed filters. The SAR states that the release fraction is based on an engineering estimate not experiment. On that basis, the release fraction would be the same for plutonium powder as well as uranium powder.

2.10 CONCLUSION

The release fractions that would be used for accidents involving uranium dioxide would be the same for all accidents except those in SAR Sections 9.2.2A (thermal stress of plutonium fluoride powder beds) and 9.2.2D.2 (thermal stress of non-combustible contaminated material). In these two cases the release fraction would be 10 and 6 times greater respectively.

3.0 DOSE CONSEQUENCES

The dose consequences are proportional to the value "rem/g."

$$\text{Rem/g} = \sum_i (C_i/g)_i (\text{Rem/Ci})_i$$

where i = denotes a sum over all uranium and/or plutonium isotopes.

The values for this summation for plutonium is found in Tables 9.3.5-1 through 9.3.5-6 of the SAR.

The values for the summation for uranium are provided in Tables 1 and 2 for 3.2 wt% enriched uranium fuel following irradiation.

Table 1
Uranium Mass Distribution for Post Irradiated PWR Fuel² (per Croff, 1980)

Isotope	Ci	Ci/g ¹	Gram	Normalized Grams
²³³ U	2.8E-5	9.6×10^{-3}	2.9E-3	0
²³⁴ U	1.19	6.3×10^{-3}	1.9E+2	2.0×10^{-4}
²³⁵ U	0.017	2.2×10^{-6}	7.7E+3	8.1E-3
²³⁶ U	0.26	6.4×10^{-5}	4.0E+3	4.2E-3
²³⁸ U	0.32	3.4×10^{-7}	9.4×10^{-5}	0.988

¹ Ci/g = 3.578×10^5 / [half life, yr * at.mass]
² Values chosen are 10 yr decay time per Table A.11 Croff (1980). ²³⁴U curies are only 10% greater at 30 yr. (See Table 2 for significance of ²³⁴U).

Table 2
Uranium Dose Distribution for Post Irradiated PWR Fuel

Isotope	Ci	Ci/g	Rem/Ci ¹	Rem/g	Rem ²
²³³ U	2.8E-5	9.6×10^{-3}	1.35×10^8	1.3×10^6	0
²³⁴ U	1.19	6.3×10^{-3}	1.33×10^8	8.4×10^5	1.7×10^2
²³⁵ U	0.017	2.2×10^{-6}	1.23×10^8	2.7×10^2	2.2
²³⁶ U	0.26	6.4×10^{-5}	1.25×10^8	8.1×10^3	34.0
²³⁸ U	0.32	3.4×10^{-7}	1.18×10^8	4.1×10^1	40.0
				TOTAL	250

¹ Rem/Ci = (Sv/Bq) (3.7×10^{12}) for Class Y from EPA (1998)
² (Rem/g) (normalized grams from Table 1)

Much of the uranium oxide material in the plant is highly enriched. The unit dose factor must therefore be recalculated based on the isotopic distribution in highly enriched fuel. The radionuclide ²³⁴U accounts for the majority of the inhalation dose potential in PWR fuel. In enriched fuel, the concentration of ²³⁴U would be higher than in PWR fuel. The ratio of ²³⁴U to ²³⁵U is thus used to estimate the dose potential of highly enriched fuel. The post irradiation mass ratio of ²³⁴U to ²³⁵U in PWR fuel is 1:41. The pre-irradiation mass ratio for 31 and 97.51 enriched fuel comes from data received from the Portsmouth Gaseous Diffusion plant. Table 3 provides the data.

Table 3
Radionuclide Ratio for Pre Irradiated Fuel -
Portsmouth Gaseous Diffusion Plant

weight, g		
Isotope	3% enriched	97.5% enriched
^{234}U	2.6×10^{-4}	8.3×10^{-3}
^{235}U	0.03	0.975
^{238}U	0.97	0.017
$^{234}\text{U} : ^{235}\text{U}$	1:115	1:117

The post irradiation ratio is similar to the pre-irradiation ratio at low enrichments (1:41 to 1:115). It is therefore assumed that at high enrichments the ratio of ^{234}U to ^{235}U in post-irradiated fuel is also 1:41. This provides a more conservative dose estimate than assuming a ^{234}U to ^{235}U ratio of 1:115. Table 4 provides the dose factor based on this ratio.

Table 4 - Dose Factor for a ^{234}U to ^{235}U Mass Ratio of 1:41

Isotope	Mass	Rem/g	Rem
^{234}U	0.024 g	8.4×10^5	2.0×10^4
^{235}U	0.975 g	2.7×10^2	2.6×10^2
		Total	2.0×10^4

The value of "rem/g" for the mass-weighted average of all plutonium containers in PFP is taken from Table 9.3.5-5 of the SAR and is 7.4×10^7 ; a factor of 3700 larger. Even with a $^{234}\text{U} : ^{235}\text{U}$ ratio that is 10 times greater (i.e., 1:4), the unit dose factor for UO_2 is 440 times less than for PuO_2 in the plant. The above technique neglects dose contribution from ^{236}U and ^{238}U . This introduces little error because these isotopes are present in much smaller mass fractions in enriched fuel vs PWR fuel.

4.0 RESPIRABLE FRACTION

The respirable fraction is a function of many variables. Figure 9.2.2A-6 of the SAR shows the particle size distribution for 2 batches of plutonium fluoride powder. The batch from PFP showed 4% in the respirable range where the other batch showed none in the respirable range. The size distribution is a function of the process used to make the powders, the process temperature, and the post processing operations. For example, in DOE 1994, many experiments were performed with ball-milled powder having 100% of the particles within the respirable size. As a result, there is no set size distribution. In addition, the respirable fraction can be accident specific. The SAR shows that the largest respirable fraction is 40% for the oxide created by burning solid plutonium metal and the smallest is 4% for plutonium fluoride powders. The difference is a factor of 10.

It is therefore possible that uranium dioxide powder taken out of the vault could have widely varying respirable fraction over the plutonium dioxide powder it is mixed with (or analyzed against). However, as shown in Section 3, the dose consequences will be significantly less even if the respirable fraction is an order of magnitude greater.

5.0 REFERENCES

- Craft, A. G., Alexander, C. W., 1980, "Decay Characteristics of Once - Through LWR and LMFBF Spent Fuels, High-Level Wastes, and Fuel - Assembly Structural Material Wastes," ORNL/TM-7431, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- EPA, 1988, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Ingestion and Submersion," EPA-520, Federal Guidance Report No. 11, Environmental Protection Agency, Washington D.C.
- DOE, 1994, "Airborne Release Fractions/Rates and Respirable Fractions for Non-Reactor Facilities," DOE-HDBK-3010, Department of Energy, Washington D.C.
- WHC, 1995, "Plutonium Finishing Plant Final Safety Analysis Report," WHC-SD-CP-SAR-021, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

CHECKLIST FOR PEER REVIEW

Document Reviewed: HNF-3496, "An Analysis of the Impact of Having Uranium Dioxide Mixed in With Plutonium Dioxide"

Scope of Review: Entire Document

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 appropriate NRC Regulatory Guide or other standards
☐	☐	☒	* Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved.

Brett Hall Brett Hall
Reviewer (Printed Name and Signature)

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