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TITLE

SPECIFICATION FOR PLUTONIUM DIOXIDE

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SPECIFICATION FOR PLUTONIUM DIOXIDE

H. R. Wisely

1.0 Scope

1.1 This specification replaces Specification HW-76566 Rev. 1, in defining the physical and chemical requirements of the PuO_2 powder used for PRTR fuel elements.

1.2 The scope of this specification excludes discussion of/or provision for preventing criticality incidents, health and safety requirements, and hazards avoidance. Observance of this specification does not relieve the user of the obligation to fulfill the requirements of AEC Nuclear Safety Guide - TID-7016, American Standard Radiation Protection for Nuclear Plants, and all other Federal, State, and local regulations on possessing, shipping, processing, or using radioactive or source and special materials.

2.0 Lot Size

2.1 A lot is defined as a quantity of material that is uniform in isotopic, chemical, and physical characteristics. The lot size shall be agreed upon between buyer and seller.

2.2 A lot may be divided for packaging as identifiable sublots or batches to be agreed upon between buyer and seller.

3.0 Sampling and Quality Control Procedures

3.1 A representative sample shall be taken from each lot of PuO_2 powder for the purpose of determining chemical and physical properties.

3.2 The sample shall be sufficient to perform the specified quality control tests at the seller's laboratory.

3.3 Complete analytical data shall be provided for each lot.

3.4 The buyer reserves the privilege to sample at random from any sublot or batch for the purpose of ascertaining the quality of the lot, and provisionally accept or reject the entire lot on the basis of tests performed on such a sample.

3.5 Lots found to be unacceptable shall not be resubmitted unless all defects have been corrected by the seller.

4.0 Physical Properties

4.1 All of the powder in each lot shall pass through a 325 mesh U.S. Standard Sieve, or equivalent. Sieving practice shall be in accordance with ASTM-B214-56.

4.2 Milled powder that agglomerates due to excessively fine particle size and/or adsorbed moisture is unacceptable.

4.3 Specifications regarding surface area of the powder shall be agreed upon between buyer and seller.

5.0 Isotopic Composition

5.1 The plutonium isotopic composition of the PuO_2 powder lot shall fall within the limits specified by the buyer. Unless otherwise agreed, the lot may be composed of a homogeneous blend of PuO_2 batches that, individually, do not meet the isotopic requirements.

5.2 The plutonium isotopic composition of the PuO_2 powder, as determined by mass spectrographic analysis, shall be provided for each lot.

5.2.1 When all of the powder in the lot is derived from a single plutonium metal button, or from a single solution batch, the isotopic content of the Pu in the button or the solution batch will be accepted as representative of the PuO_2 powder.

5.2.2 When the PuO_2 powder lot is formed from a homogeneous blend of oxide derived from more than one button or solution batch, the isotopic content of the blended oxide shall be determined from a representative sample of the oxide lot.

6.0 Chemical Properties

6.1 All chemical testing shall be performed on portions of the representative sample taken from the PuO_2 lot, and shall be done by methods that have been mutually agreed upon.

6.2 Acceptable PuO_2 must meet the following specifications:

6.2.1 The plutonium content shall be at least 87.5 weight percent of the PuO_2.

6.2.2 The oxygen-to-plutonium ratio shall be 2.00 ± 0.05.

6.2.3 The chlorine content shall not exceed 10 ppm.

6.2.4 The fluorine content shall not exceed 10 ppm.

6.2.5 The carbon content shall not exceed 100 ppm.

6.2.6 The boron content shall not exceed 2 ppm.

6.2.7 The total impurity content, calculated as the "equivalent boron content" (EBC), shall not exceed 4 ppm on a weight basis relative to plutonium. The method of calculation and a list of impurities to be included are given in Appendix A.

7.0 Packing and Marking

7.1 The plutonium dioxide shall be packaged in a tightly closed metal can which is sealed within a vapor tight bag. The exterior of this bag shall be free of smearable contamination. This package shall be enclosed within a dust tight, rigid container suitable for storage.

7.2 No single package of PuO_2 shall contain more than 2.6 kg of oxide.

7.3 The rigid exterior carton shall be clearly marked as follows:

PuO_2 Lot Number

Net Oxide Weight (gms)

Pu Content (gms)
%Pu-240

Allotment Number

8.0 Inspection

8.1 Material which, upon subsequent inspection and testing at the buyer's laboratory, fails to meet this specification is subject to rejection and return to the seller at the seller's expense.

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APPENDIX A

CALCULATION OF THE EQUIVALENT BORON CONTENT (EBC)

The EBC shall be calculated by the following formula:

$$EBC = \frac{(\text{Atomic wt. of boron})(\sigma_a \text{ impurity})}{(\text{Atomic wt. of impurity})(\sigma_a \text{ boron})} \times (\text{ppm impurity})$$

The EBC values for the elements listed below were calculated from σ_a data given in the Argonne National Laboratory Publication ANL-5800, "Reactor Physics Constants" Second Edition, July 1963.

Element	EBC/ppm	Element	EBC/ppm
Aluminum	0.000127	Molybdenum	0.000403
Barium	0.000125	Nickel	0.001122
Beryllium	0.000016	Phosphorus	0.000092
Bismuth	0.000002	Potassium	0.000758
Boron	1.000000	Silicon	0.000082
Cadmium	0.312085	Silver	0.008362
Calcium	0.000157	Sodium	0.000327
Carbon	0.000005	Tin	0.000075
Chlorine	0.013652	Titanium	0.001734
Chromium	0.000854	Tungsten	0.001495
Cobalt	0.009232	Vanadium	0.001405
Copper	0.000868	Zinc	0.000241
Fluorine	0.000001	Zirconium	0.000029
Hafnium	0.008423	Rare Earths	
Iron	0.000672	Dysprosium	0.083702
Indium	0.023800	Europium	0.405152
Lead	0.000012	Gadolinium	4.188365
Lithium	0.146485	Samarium	0.533281
Magnesium	0.000041		
Manganese	0.003441		

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