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CASSINI PU-238 PROGRAM SPECIFICATIONS FOR PLUTONIUM DIOXIDE POWDER FOR GENERAL PURPOSE HEAT SOURCE FUEL (U)

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CASSINI Pu-238 PROGRAM

Specifications For Plutonium Dioxide Powder General Purpose Heat Source Fueled Clad Fabrication (U)

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Cassini Pu-238 Program
Specifications For Plutonium Dioxide Powder
For General Purpose Heat Source Fuel

1.0 GENERAL

1.1 Scope

This fuel specification defines the chemical and physical requirements for plutonium-238 isotope in the plutonium dioxide powder form. Westinghouse Savannah River Company (WSRC) shall provide plutonium-238 isotope, in the oxidized chemical form, by the plutonium oxalate 3+ precipitation method to Los Alamos National Laboratory (LANL). A temperature above 740 °C ± 60°C for 3 ± 0.5 hours will be used to calcine the oxalate precipitate.

1.2 Definition

1.2.1 Fuel Powder Lot

That quantity of plutonium-238 isotope contained within each EP-61 shipping container, comprised of material taken from one or more fuel powder precipitations, shall be identified as a "Fuel Powder Lot" for purposes of chemical analysis. The fuel powder lot acceptance by LANL shall be based upon replicate measurements upon a single representative sample from each container.

2.0 APPLICABLE DOCUMENTS

2.1 Information and Reference Documents

The following documents provide the basis and the methods for determining the isotopic and chemical characteristics of the plutonium dioxide powder for product evaluation, safety testing, and flight quality fueled clad fabrication for the Cassini Program:

Procedure Number	Operation Title
WSRC L3.5, 2M41.1	Uranium or Plutonium Isotopic Abundance Analysis, Mass Spectrometry Method
ANC-DE-1-SC-25, R2	Spectrochemical Analysis
ANC-DE-1-MS-3, R4	Uranium & Plutonium Isotopic Composition Analyses
ANC-DE-1-RC-7, R3	Actinide Analysis
ANC-DE-1-PA-27, R4	Total Plutonium
TBD	Plutonia Powder Acceptance
TBD	MRB Board Members and Charter

2.2 Precedence of Documents

In the event of conflict between this specification and any other documents, this specification shall prevail.

3.0 REQUIREMENTS

Westinghouse Savannah River Company and Los Alamos National Laboratory shall conform to the following requirements.

3.1 Specification Changes

Changes in this specification shall be reviewed and approved in accordance with the "Change Control Board - Membership and Responsibilities", as appropriate as defined in the "Interface Working Agreement for Encapsulated Plutonium-238 Fuel Form Production", (Latest Revision)

3.2 Non-Conforming Material

Plutonium dioxide powder which does not comply with requirements in this specification shall be evaluated to determine proper disposition and corrective action in accordance with the "Material Review Board - Membership and Responsibilities", as defined in the "Interface Working Agreement for Encapsulated Plutonium-238 Fuel Form Production", (Latest Revision).

3.3 Quality Assurance

All work performed by LANL shall comply and be in accord with HS-QA-PD-8, "LANL Quality Assurance Program Plan", Revision 1, July 12, 1991, HS- Qa-PD-9, "Supplemental Procedure", Revision 0, October 25, 1991 and DOE Order 5700.6C dated August 21,1991. WSRC shall comply and be in accordance with DOE Order 5700.6C dated August 21,1991 or applicable DOE field office guidance.

4.0 POWDER QUALIFICATIONS

4.1 Plutonium-238 Dioxide Powder

The plutonium dioxide utilized for the Cassini program shall come from the Pu-238 inventory located at the various DOE contractor plants and laboratories. This material shall be a chemically recovered product of unblended or isotopically blended PuO_2. It shall be calcined and derived from plutonium 3^+ oxalate precipitated in the WSRC HB-Line Facility using the reverse strike method. It shall meet the limits set forth in this specification.

4.2 Plutonium Composition Requirements

4.2.1 Plutonium-238 Isotopic Content

4.2.1.1 The Non Flight Unit Test Program shall use a combination of low and high isotopic material of both blended and unblended plutonium dioxide powder:

The unblended plutonium dioxide powder will be utilized to support the Recharacterization Program. 83.0 to 85.5 percent of the total mass of the contained plutonium isotopes (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) shall be of the plutonium-238 isotope at the WSRC date of analysis.

The blended plutonium powder will be utilized in the Qualification, and Safety Testing Programs. 78.0 to 82.0 percent of the total mass of the contained plutonium isotopes (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) shall be of the plutonium-238 isotope at the WSRC date of analysis.

4.2.1.2 The Flight Unit Program shall consist of plutonium dioxide powder blended to a uniform isotopic content. 83.0 ± 1 percent of the total mass of the contained plutonium isotopes (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) shall be of the plutonium-238 isotope at the WSRC date of analysis.

4.2.1.3 The mass fraction (expressed as a percent) of each plutonium isotope, relative to the total plutonium content, shall be measured and confirmed by LANL as cited in the the product description supplied from WSRC. The measurement shall be determined by mass spectrometry.

4.3 Plutonium-236

Plutonium-236 isotope shall not exceed 1 microgram/gram of the total plutonium content at the date of fuel precipitation and at the date of confirmatory measurement performed by LANL.

4.4 Actinide Impurities

The sum of the actinide impurities neptunium-237, americium-241, uranium, and thorium shall not exceed 1% of the total plutonium content when back decayed to the date of fuel precipitation. On the same basis no individual actinide impurity shall exceed 0.5%.

4.5 Nonactinide Cationic Impurities

The limits established for the nonactinide cationic impurities listed below are those established for material acceptance. Impurity levels are to be determined by the method cited in this specification (Section 5.5). Impurity levels exceeding these limits are to be reviewed by the established program MRB's to determine material disposition.

Table 1
Impurity Limits

Element	Micrograms/Gram of PuO_2
Al	100
B	5
Be	5
Ca	150
Cd	25
Cr	175
Cu	25
Fe	400
Mg	25
Mn	25
Mo	50
Na	100
Ni	100
P	20
Pb	100
Si	150
Sn	25
Zn	50

5.0 Powder Analysis

5.1 Calorimetric Acceptance

Each powder lot shall be measured for total thermal emission rate upon receipt by LANL. The measurement shall be to a confidence limit of ± 1.0%.

5.2 Isotopic Acceptance

All powder lots will be measured upon receipt, by a gamma ray spectrometer, as a preliminary acceptance assessment of the Pu-238, Pu-239, Pu-241 content. The measurements shall be to a confidence limit of ± 2.0% for Pu-238 and to ± 15.0% for the Pu-239 and Pu-241 isotope.

5.3 Isotopic Composition

Isotopic composition shall be determined by mass spectrometry at both WSRC and at LANL. The WSRC measured values shall be used in the powder description for receipt of shipments.

5.4 Mass Loss on Ignition

WSRC shall determine a weight loss on ignition for each powder lot. Ignition loss shall indicate less than 0.3% of total sample mass decrease after ignition heating at 700°C ± 7°C in air for 2.25 hours ± 15 minutes.

5.5 Spectrographic Analysis

LANL shall perform a spectrographic analysis of each fuel powder lot received from WSRC to determine the impurity level in the plutonium dioxide powder. All analysis are to be replicated and results compared with the impurity limits established in Table 1.

5.6 Notification of Analysis

5.6.1 Westinghouse Savannah River Company shall provide an isotopic analysis of the plutonium dioxide powder. All shipments will comply with DOE order 5633.3 requirements.

5.6.2 Los Alamos National Laboratory shall provide Westinghouse Savannah River Company with results of analyses for each powder lot received within five (5) working days of completion of analysis. Results of these analyses shall be conveyed to WSRC by facsimile, followed by transmission of hard copies of these data.

6.0 Records

6.1 Record Retention

All production and analytical data shall be retained by WSRC and LANL to confirm that program specifications are being met. Original records for manufactured plutonium dioxide powder and heat sources shall be maintained for a minimum of 30 years beyond the approval date for this specification date. These records shall be retained for retrieval and inspection by DOE or by designated organizations in accordance with DOE requirements and specifications.

7.0 References

7.1 PuFF FEED MATERIAL ACCEPTANCE, DPSOL 235-F-PuFF-3251 Revision 8, Separations Department, June 21, 1983.

7.2 $^{238}PuO_2$ FEED POWDER, DPSTS-235-F-PuFF-5.03, November 6, 1978.

7.3 General Heat Source (GPHS) Specifications, DPSP-79-1076, D. K. Bickford, January 20,1980

7.4 ^{238}Pu Fuel Form Processes Bimonthly Report, November/December 1977. E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, SC.

7.5 ^{238}Pu Fuel Form Processes Monthly Report, June 1976. E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, SC.

7.6 ^{238}Pu Fuel Form Processes Monthly Report, October 1975. E. I. du Pont de Nemours and Co., Savannah River Laboratory, Aiken, SC.

7.7 GPHS FUEL SPECIFICATIONS - NONACTINIDE IMPURITIES, Memorandum, J. D. SCARBROUGH-M. L. LATIMER to R. S. SWINGLE, March 24,1980.

7.8 INTERFACE WORKING AGREEMENT for ENCAPSULATED PLUTONIUM-238 FUEL FORM PRODUCTION REVISION 2, OCTOBER 1991(Draft).

7.9 Conversation Concerning Actinide and Nonactinide Impurities in $^{238}PuO_2$, J. W. Barber with D. K. Bickford, January 9, 1992.

7.10 PLUTONIUM-238 DIOXIDE POWDER MATERIAL SPECIFICATION, Roy W. Zocher, February 1, 1992(Draft).

7.11 Comments from Material Specification Meeting, February 6,1992.

7.0 References(continued)

7.12 Recommendations for Flowsheet for the Pu-238 Fuel for the Boost Surviellance and Tracking System, DPST-86-371, D. H. Taylor and D. F. Bickford, April 11, 1986.

7.13 Ir/PuO2 COMPATIBILITY: TRANSFER OF IMPURITIES FROM PLUTONIUM DIOXIDE TO IRIDIUM METAL DURING HIGH TEMPERATURE AGING, W. H. Christie, D. Pavonne, D. H. Taylor, January, 1984.

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