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*Inter-Office Correspondence*

MONSANTO RESEARCH CORPORATION

DATE: 10/29/62 UNIT: 701-1

From LOCATION : Technical Support Department  
Mound Laboratory

CC :

DATE : October 29, 1962

MOUND LABORATORY-MONSANTO

SUBJECT :

Central File No. 62-10-308

REFERENCE :

TO : Mr. D. L. Scott

Released through the  
**MOUND LSDR PROJECT**  
(funded through DOE's OPENNESS INITIATIVE)  
Record Copy held at Mound Facility

I am forwarding to you for your information a copy of the revised version of the Fuels and Development Program at Mound Laboratory which was prepared and submitted on multilith mats to the Division of Reactor Development, Attention Mr. J. M. Simmons.

As you will note this program is divided into two parts. The unclassified part contains the extension of the program on alloys, alloy phase studies, physical properties and ceramics related to plutonium. The classified portion contains a new phase of the plutonium research program in which we have been requested to participate. During a recent visit to the Division of Reactor Development, AEC, Washington, this program was outlined to me. The ultimate aim of this program is to determine the causes of failures of plutonium components in weapon assemblies.

One of Dr. Glenn T. Seaborg's objectives will be attained if basic studies on plutonium metal as related to small amounts of impurities are carried out. This would be our field of participation. Since basic plutonium research is of interest to both DRD and DMA and since this work will be classified, Mound Laboratory has been selected for the task. DRD will conduct the necessary discussions with DMA concerning our participation.

*Lerroy V. Jones*  
Lerroy V. Jones

LVJ:clt

Distribution:

- Copy 1A - D. L. Scott
- Copy 2A - L. J. Wittenberg
- Copy 3A - L. V. Jones

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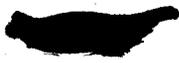
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<b>MOUND DECLASSIFICATION REVIEW</b>	
1. REVIEW DATE: <u>5/21/71</u>	DISTRIBUTION (CHECK NUMBER)
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2ND REVIEW DATE: <u>10/19/71</u>	3. COORDINATE WITH
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Contractor: Mound Laboratory  
Monsanto Research Corporation  
Miamisburg, Ohio

Contract Number: AT-33-1-GEN-53

Present Contract Term: July 1, 1962 through June 30, 1963

Cost of Present Term: \$450,000

Contract Title: Reactor Fuels and Materials  
Development - Plutonium  
Research Programs

Classification: Secret

Principal Investigator: Dr. Lerroy V. Jones

Cognizant AEC Office: Fuels and Materials Development  
Branch - Division of Reactor  
Development

Purpose:

The Reactor Fuels and Materials Program at Mound Laboratory is directed toward the fundamental investigations of plutonium and plutonium-bearing materials. The portion of the program described in this section is specifically concerned with the determination of the metallographic and physical effects of small concentrations of elements, termed impurities, on plutonium and gallium stabilized plutonium metal.

The effects of common impurities, such as: iron, nickel, silicon, carbon, calcium, magnesium, aluminum, copper, manganese, phosphorus, and various combinations of these materials, will be studied at concentrations up to approximately five atomic per cent. Phase transformations of the plutonium system as related to these impurities will be investigated by differential thermal analysis, high temperature calorimetric analysis, metallographic techniques, annealing and quenching studies and dilatometry.

  
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The correlation of the concentration of these impurities with changes in the internal structure of as-cast plutonium, which may result in structural discontinuities, will be evaluated. The measurement of the structural discontinuities by non-destructive techniques will be investigated. Methods, such as internal friction measurements, which indicate the effects of changes in the structure of the plutonium will be developed. Dimensional stability of test pieces will be studied under static and cyclic conditions.

The disposition of these impurities in the plutonium metal matrix will be followed over a range of compositions by use of micro-analytical techniques. The resultant change in the plutonium crystal structure will be determined by x-ray diffraction techniques. The electron microprobe x-ray analyzer in cooperation with instrumental and chemical analysis will be used for the identification of the inclusions and grain boundary precipitates in the plutonium metal system.

Reports Issued:

Progress reports are issued monthly as part of the Mound Laboratory Technical Report (Secret).

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Contract Title: Reactor Fuels and Materials  
Development - Plutonium  
Research Program

Classification: Unclassified

Principal Investigator: Dr. Lerroy V. Jones

Cognizant AEC Office: Fuels and Materials Development  
Branch - Division of Reactor  
Development

Purpose:

The Reactor Fuels and Materials Program at Mound Laboratory is directed toward fundamental investigations of plutonium-bearing materials. Potential fuel materials for fast breeder reactors are emphasized. The utilization of plutonium as a power reactor fuel is desired because of its neutron efficiency in fast breeder reactor concepts.

Plutonium alloy phase equilibria studies are directed toward the development of complete phase diagrams of plutonium alloy systems. The phase relationships in the plutonium-copper, plutonium-cerium, plutonium-gold and plutonium-yttrium binary systems and the plutonium-cerium-copper ternary system have been studied. These systems are defined by differential thermal analysis measurements and metallographic examinations with analytical support by micro-hardness test procedures, x-ray diffraction techniques and electron microprobe x-ray analyses. Visual observations of the phase changes in plutonium metal and its alloys are studied up to 1000°C by use of the vacuum hot-stage microscope.

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The high temperature operation of fast reactors has focused attention on molten plutonium alloys as fuel materials and on other liquid metals as coolants. Apparatus have been developed for the measurements of density, viscosity, specific heat and thermal conductivity of molten metals. Plutonium, plutonium alloys and the rare earth metals are being studied by these methods up to 1000°C. Techniques are being developed to measure the surface tension and the interfacial tension between plutonium alloys and immiscible liquid metals.

The thermal properties: specific heats, latent heats of phase transformations and thermal conductivities, of plutonium metal and alloys are being determined up to 700°C in a high temperature calorimeter.

The formulation and characterization of plutonium-bearing ceramic materials at high temperatures are being studied. The micro-spheroidization of plutonium oxide particulates has been accomplished by the use of the induction coupled plasma torch. The stability of mixed plutonium oxide solid solutions with other high melting oxides are being determined near their melting points. Additional studies have included the incorporation of plutonium oxide into silicate glasses, the measurement of the chemical, physical and nuclear properties of the plutonium-bearing glasses, and the fabrication of these glasses into various forms.

## Reports Issued:

1. "The Density of Liquid Plutonium" by C. Z. Serpan, Jr. and L. J. Wittenberg, Transactions of the Metallurgical Society of AIME, 221, 1017-20 (1961)
2. "Observations of the Physical Peculiarities of Plutonium" by C. Z. Serpan, Jr. and L. J. Wittenberg, Transactions of the ASM, 55, 261-64 (1962)
3. "The Viscosity and Density of Molten Plutonium Metal and a Plutonium-Cerium-Cobalt Eutectic Alloy" by L. V. Jones, D. Ofte, W. G. Rohr and L. J. Wittenberg, Transactions of the ASM, 55, 819-25 (1962)
4. "Development of Plutonium-Bearing Glass for a Reactor Fuel" by P. A. Tucker, L. V. Jones and L. J. Wittenberg, Second Conference on Nuclear Reactor Chemistry, Gatlinburg, Tennessee, October 1961, TID-7622

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5. "A High Temperature Calorimeter for Thermal Property Measurements of Plutonium Metal" by T. K. Engel and K. C. Jordan, Third Conference on Nuclear Reactor Chemistry, Gatlinburg, Tennessee, October, 1962
6. "High Density Plutonium Dioxide Microspheres for a Reactor Fuel" by L. V. Jones, D. Ofte, P. A. Tucker and L. J. Wittenberg, Third Conference on Nuclear Reactor Chemistry, Gatlinburg, Tennessee, October, 1962
7. "Plutonium Reactor Fuels and Materials Research Program at Mound Laboratory" by L. V. Jones and L. J. Wittenberg, American Nuclear Society Regional Meeting, Richland, Washington, September, 1962
8. "Viscosity of Bismuth, Lead, and Zinc to 1000°C" by D. Ofte and L. J. Wittenberg, Transactions of the Metallurgical Society of the AIME (in press)
9. "Purity of Cerium Metal by Differential Thermal Analysis and Metallographic Examinations" by J. E. Selle and D. E. Etter. Presented before the Metallurgical Society of the AIME, New York City, October 1962
10. Progress reports are issued monthly as part of Mound Laboratory Progress Report, MLM, and distributed under TID-4500 through OTIE

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