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Semi-Annual Report on Strategic Special Nuclear Material Inventory Differences

January 1978

U.S. Department of Energy
Assistant Secretary for Defense Programs
Office of Safeguards and Security

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STATEMENT OF THE
DEPARTMENT OF ENERGY (DOE) DIRECTOR OF SAFEGUARDS AND SECURITY

The Department of Energy has specified accounting requirements as part of its integrated safeguards system for the protection of special nuclear materials. This report provides and explains the generally small differences between the amounts of nuclear materials charged to DOE facilities and the amounts that could be physically inventoried.

These Inventory Differences, previously called Material(s) Unaccounted For (MUF), are being publicly released on a semiannual basis. This report covers data from October 1, 1976, through March 31, 1977, and is the first such semi-annual report subsequent to the August 4, 1977, publication (by DOE's predecessor, Energy Research and Development Administration) of all historical Inventory Difference data prior to October 1, 1976. All Inventory Differences reported here have been analyzed, investigated when necessary, and resolved.

These data and explanations, together with the absences of physical indications of any theft attempt, support a finding that during this period no theft or diversion of a significant amount of strategic special nuclear material has occurred.

H. E. Lyon, Director
Safeguards and Security
Department of Energy

UNITED STATES DEPARTMENT OF ENERGY
REPORT ON STRATEGIC SPECIAL NUCLEAR MATERIAL INVENTORY DIFFERENCES
OCTOBER 1, 1976, TO MARCH 31, 1977

This periodic report of Inventory Differences (ID) covers the first six months of fiscal year 1977 (October 1, 1976, through March 31, 1977) for Department of Energy (DOE) and DOE contractor facilities possessing significant quantities of strategic special nuclear material (SSNM)*. The initial ID report, issued as ERDA 77-68 in August 1977, contained data for fiscal year 1976 (July 1, 1975, to September 30, 1976) for Energy Research and Development Administration (ERDA) and ERDA contractor facilities and also contained historical data for ERDA/AEC and ERDA/AEC contractor facilities from 1947 through fiscal year 1975 and for AEC licensees from 1954 through calendar 1967, including cumulative IDs by facility. The Nuclear Regulatory Commission has responsibility for subsequent licensee data and issued their first report simultaneously with the ERDA report of August 1977.

Included in this report are the low enriched uranium IDs for DOE's gaseous diffusion plant cascades. Two of the three cascades produce only very low enriched uranium (natural uranium enriched in the uranium-235 isotope to less than 5 percent). One plant, Portsmouth (Piketon, Ohio), does produce some amount of highly enriched uranium (to greater than 20 percent in the uranium-235 isotope). However, for inventory purposes it is not possible to distinguish between this highly enriched material and the vast bulk of low enriched material; hence the average enrichment of the plant ID is listed. The meaning of these cascade IDs are further placed in perspective by the analysis

*Strategic special nuclear material is plutonium or uranium-233 or uranium-235 in material whose uranium-235 content is 20% or greater (known as highly enriched uranium). A significant quantity is either 2 kilograms of plutonium or uranium-233 or 5 kilograms of uranium-235 in highly enriched uranium or the appropriate weighted combination.

on page 12. Not included in this report are data for the Rocky Flats and Y-12 nuclear weapons production facilities. These are not included in order to protect classified nuclear weapons information.

Inventory Differences are simply the differences in amount of material between what the accounting records show charged to a facility and what a physical inventory shows on hand. These differences are generally due to errors in estimating material in unmeasurable form at the time of an inventory, unmeasurable holdup in equipment, measurement imprecisions, inaccuracies in initial determinations of SSNM produced or used in nuclear reactors, and inventory or bookkeeping errors. However, since it is possible that even a small ID may be caused by theft of nuclear material, both DOE and contractors operating DOE facilities carefully maintain, analyze, and investigate ID data.

IDs are expected in nuclear material processing and are not, in and of themselves, evidence of lost or stolen material. On the other hand, ID analysis provides valuable information on the effectiveness of the safeguard system's physical protection and material control measures as well as a check on the process controls and material management procedures. IDs outside safeguards control limits or involving a missing SSNM discrete item are investigated. If necessary, an operation may be shut down until an ID is resolved.

Analysis of accounting statistics alone, however, cannot show with absolute certainty that theft has not occurred. Therefore, DOE relies on a safeguards system that integrates stringent physical security and material control measures with material measurement and accounting to ensure that material

is not misappropriated. It is this total integrated safeguards system coupled with analysis and, when necessary, investigations of IDs, that DOE and DOE contractors operating DOE facilities use to arrive at a judgment of whether or not theft of significant amounts of SSNM has occurred. Analyses of the data as they were generated, in each case, have resulted in the explanations for the IDs provided in this report. These explanations, together with the absences of physical indications of any theft attempt, support a finding that during this period no theft or diversion of a significant amount of nuclear material has occurred.

INVENTORY DIFFERENCE DATA

OCTOBER 1, 1976, TO MARCH 31, 1977

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
PLUTONIUM*

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Albuquerque</u>		
Los Alamos Scientific Lab. Los Alamos, New Mexico	(0.2)	Cumulative small differences between measured values of plutonium taken at different inventory periods.
Mason & Hanger - Silas Mason Amarillo, Texas	None	Plutonium contained in weapons parts. All weapon parts accounted for.
Monsanto Research Corp. Mound Facility, Miamisburg, Ohio	<0.1	Cumulative small differences in measurements of Pu contained in low level residues.
Sandia Laboratories, Albuquerque, New Mexico	<(0.1)	Picked up accountability for one PuBe source previously listed as a negligible quantity.
<u>Chicago</u>		
Argonne National Lab., Idaho National Engineering Lab., Idaho Falls, Idaho	<0.1	Cumulative inventory differences due to rounding.
Argonne National Laboratory Argonne, Illinois	<0.1	Cumulative inventory differences due to rounding.
Battelle Memorial Institute Columbus, Ohio	4.4	To correct for accounting error in 1975 when an off-site shipment of plutonium was erroneously credited as highly enriched uranium (an appropriate inventory increase in Battelle's highly enriched uranium account appears in the following section) and to adjust for a correction to receipts for 1973.
Brookhaven National Laboratory Upton, New York	<0.1	Cumulative inventory differences due to rounding.

<0.1 means inventory difference amount is less than 50 grams

() means an inventory increase

*This and subsequent Plutonium tables exclude Pu-238 which is reported separately.

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
PLUTONIUM*

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Idaho</u>		
Allied Chemical Corporation National Reactor Testing Station, Idaho Falls, Idaho	(0.2)	Cumulative small amounts of nondeclared plutonium produced in and recovered from irradiated high enriched uranium fuel elements.
<u>Nevada</u>		
Nevada Test Site, Mercury, Nevada	None	Plutonium contained in test devices. All test devices accounted for.
<u>Oak Ridge</u>		
Oak Ridge National Laboratory Oak Ridge, Tennessee	<0.1	Cumulative difference of small measurement inaccuracies.
<u>Pittsburgh Naval Reactors</u>		
Duquesne Light Co., Shippingport, Pennsylvania	None	Contained in irradiated fuel elements. All elements accounted for.
Westinghouse Electric Corp. Bettis Atomic Power Lab., Naval Reactors Facility, Idaho Falls, Idaho	None	Contained in irradiated fuel elements. All elements accounted for.
<u>Richland</u>		
Atlantic Richfield Hanford Co. Richland, Washington	3.0	Cumulative difference due to cleanup of equipment in process areas. This ID has been offset in a subsequent reporting period after measurement of material in equipment using advanced measuring techniques.

<0.1 means inventory difference amount is less than 50 grams

() means an inventory increase

*This and subsequent Plutonium tables exclude Pu-238 which is reported separately.

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DCE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
PLUTONIUM*

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Richland (cont'd.)</u>		
Hanford Engineering Development Laboratory, Richland, Washington	(0.3)	Cumulative small differences between measured values of plutonium taken at different inventory periods.
Pacific Northwest Lab., Battelle Richland, Washington	(4.3)	Cumulative difference due to cleanup of equip- ment in laboratory area.
United Nuclear Industries, Inc. Richland, Washington	(0.2)	Cumulative small differences between measured values of plutonium taken at different inven- tory periods.
<u>San Francisco</u>		
Lawrence Livermore Laboratory Livermore, California	0.1	Cumulative difference resulting from measure- ment uncertainty, recategorization of waste to normal operating loss, and a shipper- receiver difference.
Atomics International Canoga Park, California	<0.1	Cumulative inventory differences due to rounding.
<u>Savannah River</u>		
E. I. duPont de Nemours Aiken, South Carolina	14.9	Cumulative difference between imprecise theoretical reactor calculations of plutonium produced in plutonium production reactors versu the measurement of the amount actually recovered.

<0.1 means inventory difference amount is less than 50 grams

() means an inventory increase

*This and subsequent Plutonium tables exclude Pu-238 which is reported separately.

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
U-235 IN 20% AND GREATER ENRICHED URANIUM

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Albuquerque</u>		
Los Alamos Scientific Lab. Los Alamos, New Mexico	2.6	Cumulative differences between calculations of U-235 content in scrap and recycle materials (accumulated over a 17-year period) compared with measurements of U-235 actually recovered.
Mason & Hanger - Silas Mason Amarillo, Texas	None	Contained in weapons parts. All weapon parts accounted for.
Monsanto Research Corp. Mound Facility, Miamisburg, Ohio	< 0.1	Cumulative inventory differences due to rounding.
Sandia Laboratories, Albuquerque, New Mexico	< 0.1	Cumulative inventory differences due to rounding.
<u>Chicago</u>		
Ames Laboratory Ames, Iowa	< 0.1	Correction for 1968 posting to inventory difference of what should have been reported as an accidental loss.
Argonne National Laboratory, Idaho National Engineering Laboratory, Idaho Falls, Idaho	(3.4)	Cumulative difference based on recovery of irradiated EBR II fuel which had been carried on an estimated basis.
Argonne National Laboratory Argonne, Illinois	< 0.1	Cumulative inventory differences due to rounding.
Battelle Memorial Institute Columbus, Ohio	(3.2)	To correct for accounting error in 1975 when an off-site shipment of plutonium was erroneously posted as highly enriched uranium.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
U-235 IN 20% AND GREATER ENRICHED URANIUM

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Chicago (cont'd.)</u>		
Brookhaven National Laboratory Upton, New York	(1.5)	Correction for 1972 posting of fission data erroneously entered as inventory difference.
<u>Idaho</u>		
Allied Chemical Corp., Idaho National Engineering Laboratory Idaho Falls, Idaho	2.8	Adjustment to inventory records between plant shutdowns and cleanout to correct for cumulative small measurement differences between measured plant inputs, measured plant removals, and physical inventory values obtained immediately following periodic cleanout of plant equipment.
EG&G, Idaho, Inc.* TRA, LPTF Idaho Falls, Idaho	<0.1	Cumulative inventory differences due to rounding.
EG&G, Idaho, Inc.* ARA, LOFT, PBF, TAN Idaho Falls, Idaho	<0.1	Cumulative inventory differences due to rounding.
<u>Nevada</u>		
Nevada Test Site, Mercury, Nevada	None	Inventory consists principally of test devices and nuclear rocket fuel. All material accounted for.

<0.1 means inventory difference amount is less than 50 grams

() means an inventory increase

*On Oct. 1, 1976, EG&G, Idaho, Inc. became an Idaho operating contractor, replacing Aerojet Nuclear Co.

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
U-235 IN 20% AND GREATER ENRICHED URANIUM

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Oak Ridge</u>		
Goodyear Atomic Corp. Piketon, Ohio (except cascades)	8.1	5.7 kg is due to a shipper receiver difference A future inventory correction will offset this amount. The remainder is due to cumulative small differences between measured values of U-235 taken at different inventory periods.
Oak Ridge National Laboratory Oak Ridge, Tennessee	<0.1	Cumulative difference from many small measure- ment differences.
<u>Pittsburgh Naval Reactors</u>		
Duquesne Light Co., Shippingport, Pennsylvania	None	Contained in irradiated fuel elements. All elements accounted for.
Westinghouse Bettis Laboratory West Mifflin, Pennsylvania	<0.1	Cumulative inventory differences due to rounding.
Westinghouse Naval Reactor Facility Idaho National Engineering Lab. Idaho Falls, Idaho	None	Contained in irradiated fuel elements. All elements accounted for.
<u>Richland</u>		
Hanford Engineering Development Laboratory, Richland, Washington	0.3	Attributable to blending of uranium isotopes to produce specific U-235 enrichments of less than 20%. This small cumulative inventory decrease of U-235 is compensated by a comparabl inventory increase of U-235 in the less than 20% enriched inventory.
Pacific Northwest Lab., Battelle Richland, Washington	<0.1	Represents U-235 resulting from remeasurement of material on inventory.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
U-235 IN 20% AND GREATER ENRICHED URANIUM

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>San Francisco</u>		
Atomics International Canoga Park, California	<0.1	Cumulative differences from small uncertainties in measurements of various forms of materials during physical inventories.
Lawrence Livermore Laboratory Livermore, California	<0.1	Difference is the result of a small shipper-receiver difference and a small unmeasured discard to waste.
Lawrence Livermore Laboratory Mercury, Nevada	None	Contained in reactor fuel elements. All fuel elements accounted for.
<u>Savannah River</u>		
E. I. duPont de Nemours Aiken, South Carolina	(39.4)	This is the cumulative difference between: 1) the amount obtained from theoretical calculations of uranium burned up in reactor operations and the measured amount later recovered; and 2) the initial measurements of uranium in scrap and the measurements of uranium later recovered.
<u>Schenectady Naval Reactors</u>		
General Electric Co., Kesselring Site West Milton, New York	<0.1	Cumulative difference of many small measurement differences.
General Electric Co., Knolls Lab. Schenectady, New York	<0.1	Cumulative difference of many small measurement differences.
General Electric Co., Windsor Site Windsor, Connecticut	None	Inventory consists of prototype reactor fuel. All material accounted for.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977. INVENTORY DIFFERENCES
FOR THE URANIUM GASEOUS DIFFUSION PLANTS
ENRICHED URANIUM OF LESS THAN 5% U-235

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Oak Ridge</u>		
Goodyear Atomic Corp. Piketon, Ohio (Average Enrichment = 1.8%)	120.3	All three gaseous diffusion plants inventory differences are attributed to uranium hide-out in solids deposited in the plant equipment and miles of piping in these very large plants and in the measurement uncertainties involved in the simultaneous taking of pressure and temperature measurements and calculating space factors for thousands of instruments at each facility.
Union Carbide, Nuclear Division Oak Ridge, Tennessee (Average Enrichment = 0.38%)	154.0	
Union Carbide, Nuclear Division Paducah, Kentucky (Average Enrichment = 0.68%)	321.2	

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
URANIUM-233

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Albuquerque</u>		
Los Alamos Scientific Laboratory Los Alamos, New Mexico	None	U-233 contained in critical assemblies and compounds. All assemblies and compounds accounted for.
Monsanto Research Corp., Mound Facility, Miamisburg, Ohio	<0.1	Cumulative small differences between initial measurements of stored U-233 and subsequent remeasurements after separation of that U-233 which has radioactively decayed to other elements.
<u>Chicago</u>		
Argonne National Laboratory Argonne, Illinois	<0.1	Cumulative inventory differences due to rounding.
<u>Idaho</u>		
Allied Chemical Corp., Idaho National Engineering Lab., Idaho Falls, Idaho	None	Inventory consists principally of irradiated fuel elements. All elements accounted for.
<u>Oak Ridge</u>		
Oak Ridge National Laboratory Oak Ridge, Tennessee	3.3	Final inventory balance following plant cleanup concluding a 5½ year campaign.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
URANIUM-233

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Pittsburgh Naval Reactors</u>		
Duquesne Light Co., Shippingport, Pennsylvania	None	Contained in irradiated fuel elements. All elements accounted for.
Westinghouse, Bettis Laboratory West Mifflin, Pennsylvania	(1.2)	Cumulative inventory differences resulting from measurement of material after cleanup of the process line and removal of holdup; periodic remeasurements at inventories; and the recovery of scrap previously carried on estimated bases.
<u>Richland</u>		
Pacific Northwest Lab., Battelle Richland, Washington	None	Inventory consists of small amounts of U-233 contained in laboratory samples and standards. All material accounted for.
Atlantic Richfield Hanford Co. Richland, Washington	(0.2)	Represents measured trace amounts of U-233 remaining in large volumes of thorium after separation of U-233 product from irradiated thorium fuel elements.
<u>San Francisco</u>		
Lawrence Livermore Laboratory, Livermore, California	< 0.1	Difference is the result of reweighing of an oxide batch.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
URANIUM-233

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Savannah River</u>		
E. I. duPont de Nemours Aiken, South Carolina	None	Major part of inventory consists of irradiated fuel held in storage basin. All material accounted for.
<u>Schenectady Naval Reactors</u>		
General Electric Co. Knolls Atomic Power Lab. Schenectady, New York	<0.1	Cumulative difference of many small measurement differences.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase

FIRST HALF OF FISCAL YEAR 1977 INVENTORY DIFFERENCES
DOE AND DOE CONTRACTOR SPECIAL NUCLEAR MATERIALS
PLUTONIUM-238

<u>Field Office and Contractor</u>	<u>Inventory Difference in kilograms</u>	<u>Analysis Findings</u>
<u>Albuquerque</u>		
Los Alamos Scientific Laboratory Los Alamos, New Mexico	(0.1)	Cumulative small differences resulting from rounding, material cleanout, and correction for incorrectly prorated material decay.
Monsanto Research Corp., Mound Facility, Miamisburg, Ohio	(0.1)	Cumulative differences due to cleanup of equipment in process areas.
<u>Oak Ridge</u>		
Oak Ridge National Laboratory Oak Ridge, Tennessee	None	Material contained in discrete items which are all accounted for.
<u>Richland</u>		
Atlantic Richfield Co. Richland, Washington	None	Inventory consists principally of oxide scrap. All material accounted for.
<u>Savannah River</u>		
E. I. duFont de Nemcurs Aiken, South Carolina	(2.5)	This is cumulative differences from: 1) imprecise theoretical reactor calculations of Pu-238 produced versus the measured amount recovered; and 2) many small measurement inaccuracies.

<0.1 means inventory difference amount is less than 50 grams
() means an inventory increase