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MASTER

NUCLEAR MATERIALS INVENTORY PLAN

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1. ABSTRACT

In any processing, manufacturing, or active storage facility it is impractical to assume that any physical security system can prevent the diversion of Special Nuclear Material (SNM). It is, therefore, the responsibility of any DOE Contractor, Licensee, or other holder of SNM to provide assurance that loss or diversion of a significant quantity of SNM is detectable. This ability to detect must be accomplishable within a reasonable time interval and can be accomplished only by taking physical inventories. The information gained and decisions resulting from these inventories can be no better than the SNM accounting system and the quality of measurements performed for each receipt, removal and inventory.

Inventories interrupt processing or production operations, increase personnel exposures, and can add significantly to the cost of any operation. Therefore, realistic goals for the inventory must be defined and the relationship of the inherent parameters used in its validation be determined.

The purpose of this document is to provide a statement of goals and a plan of action to achieve them.

2. GENERAL

The inventory at Rockwell Hanford Operations (Rockwell) includes plutonium dioxide, plutonium metal, plutonium nitrate, assorted plutonium bearing scrap, uranyl nitrate solution, oxides of uranium and lesser amounts of other accountable nuclear material.

This inventory of nuclear materials is contained within a system of material balance areas (MBA's), which have physical and/or administrative boundaries whereby the amount of material entering or leaving the MBA is a measured quantity. It is at this MBA level that effective physical inventories are taken and evaluated.

Physical inventories will be conducted by validation of all or a statistically significant sample (as defined in Section 3.3) of each MBA. This validation will be accomplished by attribute testing of the sample and by variable testing on a randomly selected subset of this sample.

The value of β (to be defined later) will determine whether a sampling or all items are used for the validation.

Table 2, Appendix A provides a β for each MBA. A listed value of N/A indicates that all items are used for the physical inventory.

Table 2 also provides information on inventory frequency. The four inventory periods are:

- Daily - An administrative determination that no gross irregularities appear to exist. This may include alarm checks, walk-throughs, container counts, empty pedestal checks or combinations thereof.
- Bimonthly - Category I SNM will be inventoried every two months based on a sampling plan or in total. Processing areas will be inventoried during normal shutdown conditions but not less frequently than annually.
- Semiannual - Category II SNM will be inventoried every six months based on a sampling plan or in total.
- Annual - Category III and Category IV nuclear material will be inventoried in total at least once every twelve months.

3. INVENTORY SYSTEM

The taking of the physical inventory is divided into five phases:

- Categorization of the MBA
- Determination of sampling parameters
- Inventory Validation Listing
- Validation
- Reconciliation

3.1 Categorization of the MBA

DOE Order 5630.2, "Control and Accountability of Nuclear Materials, Basic Principles", provides the guidance to determine the category for each MBA. Prior to each inventory period an assessment of quantity and type of material for each MBA will determine its category for inventory frequency requirements. The nature of the MBA in conjunction with its category will determine inventory frequency. Table II, Appendix A is a listing of present category and inventory frequency for each MBA.

3.2 Determination of Sampling Parameters

Sampling parameters are to be applied to MBA's having a large number of individual items or inactive process areas where previously measured holdup in equipment lends itself to discrete identification.

The two parameters that determine the statistically significant sample are:

- Target Quantity (T.Q.) - A quantity of SNM which defines an unacceptable level of performance.
- Risk (β) - Defined as the probability that unacceptable performance will not be detected.

Both T.Q. and β are administratively controlled values. Accessibility and physical protection are determining factors for β which has values ranging from 0.2 to 0.5. Material attractiveness and available quantities are evaluated to determine a T.Q.

Figures 1 and 2, Appendix B are provided as visual aids for the effect of these parameters on sample size.

3.3 Inventory Verification List

Nuclear Materials Control Accounting shall prepare a listing for each MBA to be inventoried. The listing (s), where applicable, shall include:

- Location
- Element weight
- Measurement method
- Gross weight
- Seal number (s)
- Item identification
- Material form
- Container type
- Calculated wattage
- Label element weight

A summary page for the MBA will also be generated including:

- Items for variable testing
- Calculated β
- Known discrepancies

The criteria for selection of items for attribute testing is:

- Each MBA will be divided into cells. Where a cell is defined as a continuous segment of SNM content per item. (e.g. 401 to 600 grams or 601 to 900 grams)
- The number of items to be randomly selected from each cell is calculated by:

$$N_i = \left[\left(N_i - \frac{D_i - 1}{2} \right) (1 - \beta_i^{1/D_i}) \right] + 1 \quad (*)$$

Where: $D_i = (T.Q.) (N_i) / (T)$

N_i = Number of items in cell

T = grams SNM in MBA for element inventoried

$\beta_i = (\beta)^A$

A = SNM (grams) in cell / SNM (grams) in MBA

n_i = The number of items to be sampled from Cell i.
(Expressed as a truncated integer.)

The specific items to be validated will be selected by a random number selection method.

(*) This equation is a suitable approximation to the hypergeometric distribution.

Selection of items for variable testing is accomplished by modifying the previous equation to:

$$n_i = N_i (1 - \beta_i \gamma/D_i) + 0.5$$

The elements of the equation are defined the same and γ represents the precision of the measurement method.

This method of selection optimizes the detection of possible diversion by either gross substitution or partial removal.

The specific items to be tested will be identified by a random number selection method and will be a subset of the attribute sample.

3.4 Validation

The validation procedure is divided into two phases: attribute and variable testing.

- 3.4.1. Attribute testing is used for making decisions regarding the acceptability of inventory, based on certain characteristics of the item. The item is classified as acceptable or defective (not acceptable), depending on whether or not the particular characteristic of the item (e.g. location, identification, weight, radiation, etc.) are considered to be satisfactory. Testing on an attribute basis is designed to detect:

- honest mistakes, in the situation where no time diversion has occurred.
- missing or changed items, where the records or container have been altered to mask diversion.

All known discrepancies between label information and the inventory record are noted on the inventory listing and do not constitute a defect.

The procedure for attribute testing is:

- Locate item
- Inspect container and TID (if applied) for integrity
- Verify label information

Refer to Section 3.6 for resolution of defects

- 3.4.2 Variable testing is used to develop quantitative information regarding the validity of stated quantities. The measurement of a specific property such as:

- Heat output
- Neutron emission
- Specific gamma activity
- Weight
- Chemical reactivity
- Etc.

To provide the capability for using nondestructive or chemical assay methods to detect diversion.

Table 1, Appendix B contains limits for various measurements and is to be used as a general guide to evaluate the reasonableness of stated quantities.

The data received from measurements will be reviewed on an item by item basis to detect gross discrepancies and collectively to detect "skimming".

Refer to Section 3.6 for resolution of defects.

3.5 Reconciliation

Reconciliation is the comparison of the actual physical inventory findings to the current book values for that MBA, and the adjustment (if necessary) of book values.

Where a statistical sampling plan is used, reconciliation is a comparison of the physical inventory findings to the current book values for that sample.

If no major discrepancies are found, reconciliation is to be completed within five working days from receipt of measured values.

3.6. Resolution of Defects

- 3.6.1 If a container appears to have been opened or substituted as evidenced either by container or TID condition, the inventory will be discontinued. Immediate notification of appropriate authorities is required and a complete MBA inventory and investigation is conducted.
- 3.6.2 If a statistical difference between measured and book value for an item or group of items is noted, immediate notification of appropriate authorities is required and an investigation conducted.
- 3.6.3 Minor discrepancies in label information will be noted on the inventory listing and resolved upon completion of the inventory.
- 3.6.4 Discrepancies not covered above, such as an item not in its assigned storage location, will be investigated immediately after the inventory. Appropriate notifications and actions will follow the findings of the preliminary investigation.
- 3.6.5 The MBA will remain closed to all transfer of material except those associated directly with the investigation.

4. RESPONSIBILITIES

4.1 Nuclear Materials Accounting

- Provides inventory listings
- Assists custodians in reconciliation

4.2 Principal Custodians

- Provides detailed inventory procedures
- Conducts the physical inventory
- Performs reconciliation
- Resolves differences in attribute data
- Reports significant discrepancies to the Manager, Nuclear Materials Control
- Coordinates all aspects of the program with plant management and implements recommendations for corrective action.
- Provides access to, and control within, the MBA
- Plans, schedules and maintains records of inventory activities

4.3 Production Operations

- Provide operational support for the inventory activities, including weight checks, nondestruction assay, sampling and labeling

4.4 Analytical Laboratories

- Maintain auditable records generated during equipment calibration and nuclear material measurements
- Provide analytical support services

4.5 Nuclear Material Measurements

- Assists custodian in reconciliation

4.6 Nuclear Material Administration

- Audits compliance with inventory procedures

5. USE OF FORMS

5.1 Inventory Activities Report

The "Inventory Activities Report" form identifies the items verified and provides a record of all verification efforts afforded each item. Lack of substantiation or other questionable status is noted in the space provided at the bottom of the form. The completed form is signed by the custodian and includes the names of all personnel involved.

5.2 Inventory Discrepancy Summary

This form is used to provide a detailed record of the observed discrepancy and the action taken to resolve questionable status. The completed form is signed by the custodian and includes the names of all personnel involved in the investigation.

5.3 Inventory Hold Tag

The "Inventory Hold Tag" is used to prevent issuance of, or tampering with, the item being held. Each item must be tagged and removed from production channels.

Inventory and Operations personnel shall implement the necessary activities to effect early resolution of the problem. The lower portion of the tag shall contain the detailed disposition instructions and shall be signed by the custodian and approved by Nuclear Materials Control management.

An example of each of the above forms is provided in Appendix C.

6. SUMMARY

The inventory, as planned and conducted, provides, with an acceptable degree of uncertainty, that loss or diversion of nuclear material has not occurred. It follows the graded safeguard concept of providing a degree of protection for materials based on their attractiveness to diversion and does so in a timely manner.

APPENDIX A

<u>MBA No.</u>	<u>Title</u>	<u>Category</u>	<u>Manager</u>	<u>Principal Custodian</u>
101	Facility Services - Z Plant	IB	J. W. Patterson	H. V. Colton
102	Plutonium Reclamation - Z Plant	IB	J. W. Patterson	R. R. Lehrschall
103	Plutonium Conversion - Z Plant	IB	J. W. Patterson	T. J. Keefe
104	Product Handling and Operations	IA	J. W. Patterson	M. D. Swett
105	Product Handling and Operations - Item Control	IA	J. W. Patterson	F. F. Walters
106	PWR Core II - Bldg 221-T	Exempt	J. W. Patterson	M. K. Bayless
107	D&D - Bldg 233-S	IB	J. W. Patterson	J. B. Shannon
201	Uranyl Nitrate Storage - Purex P Tanks	III	B. F. Campbell	J. D. McIntosh
202	Purex Separations Process - 202A	IB	B. F. Campbell	C. A. Petersen
203	Purex Oxide Conversion - 202A	N/A	B. F. Campbell	None (Future MBA)
204	UO ₃ Plant - Uranium Conversion	III	B. F. Campbell	G. E. Millward
205	Feed Storage & Dissolution	Exempt	B. F. Campbell	C. A. Petersen
206	Tank Farms Operations - 2COE & 200W	IV	B. F. Weaver	R. C. Adams
301	Process Control Laboratory - Z Plant	IA	C. P. Sutter	B. R. FitzPatrick
302	Process Control Laboratory - Purex	III	C. P. Sutter	R. A. Buchanan
303	Radio Chemical Standards Laboratory - 222-S	III	C. P. Sutter	D. J. McCain
304	Radio Chemical Standards Laboratory - Z Plant	IA	C. P. Sutter	D. J. McCain
305	Process Control Laboratory - 222-S	III	C. P. Sutter	R. Maffeo

<u>MBA No.</u>	<u>Title</u>	<u>Category</u>	<u>Manager</u>	<u>Principal Custodian</u>
401	Process Development Laboratory - Z Plant	IA	R. C. Roal	D. G. Bouse
402	Process Development Laboratory - 222-S	III	R. C. Roal	D. A. Dodd
403	Design Engineering - 271T & 224T	III	R. G. Oliver	M. T. Slind
404	Environmental Analysis & Monitoring - 202S, 221U	III	D. L. Uhl	W. F. Nicaise
501	2736-Z, Room 1 (ICA)	IA	D. E. Six	C. C. Jones
502	2736-Z, Room 2 (ICA)	IA	D. E. Six	C. C. Jones
503	2736-Z, Room 3 (ICA)	IA	D. E. Six	C. C. Jones
504	2736-Z, Room 4 (ICA)	IA	D. E. Six	C. C. Jones
505	224-T, First Floor (ICA)	IB	D. E. Six	C. C. Jones
506	224-T, Second Floor (ICA)	IB	D. E. Six	C. C. Jones
507	224-T, Third Floor (ICA)	IB	D. E. Six	C. C. Jones
508	224-T, Third Floor Cubicle (ICA)	IB	D. E. Six	C. C. Jones

APPENDIX A, TABLE 2 - Classified

See RHO-SS-PL-6

APPENDIX B

TABLE 1

<u>Description</u>	<u>Test Equipment/Method</u>	<u>± Limits</u>
Storage Weight	Mettler Electronic Balance	5 grams*
Pu Concentration	Chemical Assay	0.5 percent
Pu Concentration	Radioassay	15 percent
Density	Density Meter	0.2 percent
Pu Metal/Oxide	Calorimeter (NDA Isotopics)	5 percent
Pu Metal/Oxide	Neutron Well Counter (NWCC)	5 percent
Pu Nitrate	Ge (Li) Counter	20 percent
Scrap Metal	Calorimeter (NDA Isotopics)	10 percent
Scrap Oxide	Calorimeter (NDA Isotopics)	10 percent
Incinerator Ash	Segmented Gamma Scan	10 percent
Incinerator Ash	NaI Counter	15 percent
Slag and Crucible	Segmented Gamma Scan	10 percent
Slag and Crucible	NaI Counter	15 percent
Pu in Polystyrene	Neutron Well Counter (NWCC)	10 percent
Pu in Graphite	Segmented Gamma Scan	10 percent
Pu in Waste Cartons	NaI Counter	25 percent
Miscellaneous Offsite Scrap	Calorimeter (NDA Isotopics)	10 percent
Miscellaneous Offsite Scrap	Segmented Gamma Scan	20 percent

*Includes the weight of accumulated by-products (e.g., corrosion, moisture).
The inherent weight capability of the balance should be on the order
of ±0.1 gram.

Figure 1

Figure 2

APPENDIX C

INVENTORY ACTIVITIES REPORT

Activities Report No. _____

Date _____

<u>Item No.</u>	<u>Gross Weight</u> <u>Recorded</u>	<u>(grams)</u> <u>Verified</u>	<u>NDA (g Pu)</u> <u>Recorded</u>	<u>Verified</u>
-----------------	--	-----------------------------------	--------------------------------------	-----------------

Remarks and Sample Data _____

Signed _____
Principal Custodian

Signed _____
Inventory Personnel

INVENTORY DISCREPANCY SUMMARY

INDS No

ITEM NUMBER _____

DATE _____

LOCATION _____

SPOT LOCATION _____

VERIFICATION REQUIRED

BULK WEIGHT CHECK

NDA

CHEMICAL ASSAY

MEASUREMENT DATA

	BOOK VALUES	MEASURED VALUES	DIFFERENCE
GROSS WEIGHT			
NET WEIGHT			
GRAMS Pu			
ISOTOPIC			

MEASUREMENT METHOD

(SGSAS)

CALORIMETER

Z-L-APU-01C

BARREL COUNTING SYSTEM

NaI COUNTER

METTLER BALANCE

NWCC

COMMENTS:

(Lab Sample No., etc.)

SIGNED _____
OperationsSIGNED _____
Inventory Personnel

INVENTORY HOLD TAG

CAUTION: Do not move or handle without specific approval of
undersigned Inventory Personnel.

DISPOSITION INSTRUCTIONS:

Date _____

Signed _____
Inventory Personnel

Approved _____
Nuclear Materials Control