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External and Internal Nuclear Material Transactions – US Approach

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DOE Drivers and References

- DOE O 474.2 Chg 2: Nuclear Material Control and Accountability
- DOE-STD-1194-2011: DOE Standard, Nuclear Materials Control and Accountability

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Introduction

- Definitions
- DOE requirements for external transactions of nuclear material (NM) as they apply to the shipper.
- DOE requirements for external transaction of NM as they apply to the receiver.
- DOE requirements for shipper/receiver differences.

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Introduction

- DOE requirements for internal transactions of NM.
- DOE requirements for inventory adjustments.

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Introduction: Definitions

- Nuclear Material Management and Safeguards System (NMMSS).
 - **U.S. Government's *Official Database*** to track transactions, movements and inventories of nuclear materials throughout the U.S. as well as imports and exports.

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Introduction: Definitions

- Transaction:
 - Any recorded change affecting an inventory database.
 - Either a physical transfer or a book transfer of NM that is reportable to the nuclear materials management and safeguards system (NMMSS).

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Introduction: Definitions

- External Transfer:
 - Transfer of NM from one reporting identification symbol (RIS) facility to another.
 - Reportable to NMMSS.
- Internal Transfer:
 - Transfer of NM with the same RIS to another.
 - Changes to NM in database.
 - May or may not be reportable to NMMSS.

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Introduction: Transactions

- NMMSS reportable transactions.
 - External shipments/receipts.
 - Normal operating loss(NOL)/ Measured discards.
 - Project number changes.
 - One party transactions.
 - Onsite gain or loss.

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Introduction: Transactions

- NMMSS reportable transactions are recorded using:
 - DOE/Nuclear Regulatory Commission (NRC) Form 741, or
 - An electronic equivalent.

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Introduction: Transactions

- Non-NMMSS reportable transactions
 - Move items between/within site MBAs
 - Mix/split items
 - Apply/remove TID
 - Load/unload containers in an MBA
 - Transactions recorded in site accounting systems

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Introduction: Accountable Nuclear Material

- Three types of nuclear materials.
 - Special Nuclear Material (SNM).
 - Source materials.
 - Other nuclear material.

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Introduction: Graded Safeguards Approach

- A system designed to provide:
 - Varying degrees of protection based on risk and consequences of loss.
 - More protection for materials that can be used in nuclear explosive device.

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Introduction: Nuclear Material Safeguard Categories

DOE-STD-1194-2011

Appendix B: Graded Safeguards Tables

	Attractiveness Level	Pu/U-233 Category (kg)				Contained U-235/Separated Np-237/Separated Am-241 and Am-243 Category (kg)				All E Materials Category IV
		I	II	III	IV ¹	I	II	III	IV ¹	
WEAPONS Assembled weapons and test devices	A	All	N/A	N/A	N/A	All	N/A	N/A	N/A	N/A
PURE PRODUCTS Pits, major components, button ingots, recastable metal, directly convertible materials	B	≥2	≥0.4<2	≥0.2<0.4	<0.2	≥5	≥1<5	≥0.4<1	<0.4	N/A
HIGH-GRADE MATERIALS Carbides, oxides, nitrates, solutions (≥25 g/L) etc.; fuel elements and assemblies; alloys and mixtures; UF ₄ or UF ₆ (≥50% enriched)	C	≥6	≥2<6	≥0.4<2	<0.4	≥20	≥6<20	≥2<6	<2	N/A
LOW-GRADE MATERIALS Solutions (1 to 25 g/L), process residues requiring extensive reprocessing; Pu-238 (except waste); UF ₄ or UF ₆ (≥20% < 50% enriched)	D	N/A	≥16	≥3<16	<3	N/A	≥50	≥8<50	<8	N/A
ALL OTHER MATERIALS Highly irradiated ³ forms, solutions (<1 g/L), compounds; uranium containing <20% U-235 or <10% U-233 ³ (any form, any quantity)	E	N/A	N/A	N/A	Reportable Quantities	N/A	N/A	N/A	Reportable Quantities	Reportable Quantities

¹The lower limit for Category IV is equal to reportable quantities in DOE O 474.2.

²The total quantity of U-233 = (Contained U-233 + Contained U-235). The category is determined by using the Pu/U-233 side of this table.

³In this Technical Standard "highly irradiated" is defined in the definitions.

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External Transfers (Shipper)

- Requirements
 - Written authorization
 - Documentation
 - Transfer checks
 - Measurements
 - Accounting

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External Transfers (Shipper)

- Written Authorization
 - Verify that intended receiver is authorized to receive material
 - Step 1: Reporting identification symbol directory.
 - Step 2: Call point of contact
 - Recognized state license
 - Authorization request form
 - Point of contact

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External Transfers (Shipper)

- External Transfers
 - Documented on DOE/NRC Form 741
 - Transfers between facilities with different RIS.
 - Prepare to distribute Form 741
 - Domestic facility prepares both shipper and NMMSS data
 - Receivers' s data for shipments to foreign entitles within one day.

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External Transfers (Shipper)

- Independently measured values
 - All un-irradiated Category I and II SNM transferred between facilities with different RIS
 - Shipper determines values prior to shipment
 - Measurement method determined and agreed upon by shipper/receiver

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External Transfers (Receiver)

- Transfer Checks
 - Performed immediately after receipt
 - Compare and confirm appropriate documentation of
 - Shipping container item count
 - Tamper indicating device
 - Identification numbers
 - Must be documented
 - Shipper Receiver Agreements (SRA)

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External Transfers (Receiver)

- Receiver measurements
 - Verification and accountability measurements
 - Quantitative determination of material quantities
 - Confirmatory
 - Quantitative determination to verify that attribute or characteristic of material is consistent with expectations.

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External Transfers (Receiver)

- Verification and accountability measurements
 - Quantitative determination
 - Required unless both RISs are same site/same contractor
 - May not be required for all materials

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External Transfers (Receiver)

- Confirmatory measurements
 - NDA and/or gross weight
 - Item count
 - For 'safeguards closure' of transaction
 - Other categories of material

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External Transfers (Receiver)

- Shipper/Receiver Measurement Requirements

Material Category and Attractiveness Level	Material Confirmation	Accountability Measurements
IA	3 working days	Shipper's value
IB	5 working days	30 calendar days
IC, II	10 working days	30 calendar days
III	10 working days	120 calendar days or on input to process
IV	20 working days	On a statistical basis within 180 days or on input to process

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External Transfers (Receiver)

- DOE/NRC Form 741
 - Preparation and distribution
 - Within 10 days of receipt of material
- Foreign exports or imports
 - Shippers data for receipts from foreign entities within 10 days

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Shipper/Receiver Difference (SRD)

- Difference Between
 - Measured quantity of NM stated by shipper as having been shipped
 - Measured quantity stated by receiver as having been received

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Shipper/Receiver Difference Assessment

- Each facility must have written procedures for
 - Evaluating shipper/receiver differences
 - Investigating/reporting significant shipper/receiver differences

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Significant Shipper/Receiver Difference

- SRD is considered significant when:
 - Discrepancy in number of items
 - Magnitude of difference exceeds:
 - Limits obtained by statistical combination of valid limits or limit of error (LE), or
 - Square root of two (1.4) times the valid LE when either shipper/receiver LE invalid

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Significant Shipper/Receiver Difference

- If both shipper and receiver LE are invalid
 - LEs must be re-determined and
 - SRD re-evaluated

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Significant Shipper/Receiver Difference

Example 1

- Assume that both the shipper and receiver LE are valid and independently assessed

- SRD** 105g

- Shipper LE 100g

- Receiver LE 110g

$$\sqrt{100^2 + 110^2} = \sqrt{10,000 + 12,100} = \sqrt{22,100} = 149\text{g}$$

Since the SRD of 105 grams < combined LE of 149 grams, there is no significant SRD.

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Significant Shipper/Receiver Difference

Example 2

- Assume that both the shipper and receiver LE are valid and independently assessed

— SRD	145g
— Shipper LE	100g
— Receiver LE	110g

If the receivers LE is valid and the shipper's is not, then

$$1.4 \times 100 = 140g$$

If the shippers LE is valid and the receiver's is not, then

$$1.4 \times 110 = 154g$$

In the first case, an SRD of 145g would be significant because it is $> 140g$.

In the second case, an SRD of 145g would not be significant, because it is $< 154g$.

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Shipper/Receiver Difference Investigation

- Receiver notifies the field element operation office, and shipper
- Shipper/Receiver
 - Investigate their measurements
 - Investigate their LE (must complete within 30 days)
 - Document investigation

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Shipper/Receiver Difference Resolution

- Occurs when both operations offices obtain assurance that
 - Measurements and LEs are valid
 - Investigation indicates that theft or diversion did no occur
 - Shipper/Receiver agrees to accept other's values and correct shipping document

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Unresolved Shipper/Receiver Difference

- If SRD is not resolved
 - SRD must be resolved by Office of Safeguards and Security
 - Receiving facility must not process NM continued in shipment involving unresolved significant SRD.
 - Unless shipper/receiver agreement allowing this has been approved by both managers of shipper's and receiver's operations offices

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Shipper/Receiver Agreement

- Agreement between RIS sites that documents
 - Measurement requirements
 - Acceptance criteria for closing transactions
 - May include other criteria for shipment

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Internal Transactions

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Internal Transactions

- Internal transfers:
 - Are between MBAs in a RIS site
- Adjustments to inventory
 - Change to NM quantities
 - Change in material form
 - Generate inventory differences

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Internal Transfers

- DOE requires each facility to provide:
 - System of measurements
 - Records for material flow between MBA
- Facility may require transfers at lower level
- Documented on NM transfer forms
 - Site specific and may have electronic equivalent

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Internal Transfers

- Prepared and distributed within established time frames
- Signed by authorized custodians or alternates
- Transfer checks
 - Performed as soon as possible but no later than one workday after receipt

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Internal Transfers

- Confirmation/Verification measurements
 - $\text{SNM} \geq 50$ grams
 - Excluding $< 20\%$ U-235
 - Excluding $< 10\%$ U-233
 - Requires DOE Cognizant Security Authority approval

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Inventory Adjustments

- One-party transactions
- Changes to inventory values
 - Reported as inventory adjustment, or
 - Reported as ID
- Audit trail between source document and inventory

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Inventory Adjustments

- Reporting inventory changes
 - Form 741: Transaction report
 - Report additions and removals
 - Report ID
 - Reported using change codes
 - Form 742: Material balance report

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Inventory Adjustments

- Changes to inventory-removals
 - Decay
 - Normal operating losses
 - Fission/Transmutation
 - Down blending/Degradation
 - Accidental losses
 - Approved write-offs

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Inventory Adjustments

- Examples of changes to inventory reported as inventory difference (ID)
 - Re-measurement
 - Holdup differences
 - Measurement adjustments
 - Rounding
 - Adjustment to reporting errors
 - Shipper/Receiver adjustments

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Inventory Adjustments

- Evaluation required:
 - SNM ID
 - Non-SNM may be required by DOE line management
 - All inventory adjustments entered in the accounting system
 - Documented program for evaluations

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In Summary:

Nuclear Material Transfers

- All Material Control and Accounting Subsystems are involved
 - MC&A program management
 - Material Control
 - Measurements
 - Accounting
 - Physical Inventory

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