



Material Control & Accountability for DOE Tritium Facilities

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Motivation for Material Control

- Manhattan Project develops materials for use in nuclear weapons
- Post-war/Cold War proliferation concerns
- Regulations passed to prevent loss or theft of materials that could be used in a nuclear weapon



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A Brief History of MC&A

- The Atomic Energy Act of 1946 defined three types of nuclear materials:
 - Fissionable (Pu and enriched U)
 - Source (materials “essential to the production of fissionable materials”, particularly U and Th)
 - Byproduct (materials “yielded in or made radioactive by... the processes of producing or utilizing fissionable material”)

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A Brief History of MC&A

- The Atomic Energy Act of 1954 made a few changes (from 22 pages to 180):
 - “Fissionable” → “Special Nuclear Material”
 - Source and byproduct stay the same
 - Allowed Congress to add other materials to SNM and Source categories if needed
- AEC Manuals and Appendices (7400 series) specified the requirements for safeguards and security programs

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A Brief History of MC&A

- 1967: NPT negotiations determine tritium is not SNM and will not be under international control
- 1970: First computerized NM accounting system (Nuclear Materials Information System) includes deuterium and tritium
- 1974: Use of tritium in US nuclear weapons is declassified
- 1974: AEC split into ERDA and NRC
- 1977: ERDA becomes DOE

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A Brief History of MC&A

- 1980: DOE issues 5630 series of Orders
 - Types of NM are Special, Source, and Other
 - Introduces “Graded Safeguards”: different materials and forms are protected differently
 - Defined by Categories (I-IV) and two Attractiveness Levels (A, B) for Cat. I material
 - Safeguards are based on the quantity of material and how easily it could be made into a nuclear weapon or explosive device

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A Brief History of MC&A

- 1988: DOE issues 5633 series of Orders
 - Expand Attractiveness Levels to five (A-E) and applies them to all materials
 - Tritium is an “Other” material, but is subject to additional requirements
 - Reportable Quantity (RQ) of tritium is 0.01 gram, in reality 50 Ci due to rounding rules

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Special Provisions for Tritium (DOE O 5633.3A, 2/12/93)

- a. Except for tritium and depleted uranium, source and other nuclear materials shall be treated as attractiveness level E materials. Therefore, the requirements for an MBA containing only source and other nuclear materials shall be that of Category IV. When source and other nuclear materials are present in MBAs containing SNM, only the SNM is used to determine the category of the MBA. However, source and other materials are subject to Category IV requirements.
- b. Tritium is a nuclear material of strategic importance; therefore, graded safeguards programs for tritium shall be established and followed equivalent to the following categorizations:
 - (1) Category III. Weapons or test components containing reportable quantities of tritium. Deuterium-tritium mixtures, or metal tritides that can be easily decomposed to tritium gas, containing greater than 50 grams of tritium (isotope) with a tritium isotopic fraction of 20 percent or greater.
 - (2) Category IV. All other reportable quantities, isotopic fractions, types, and forms of tritium.

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More Changes to Tritium MC&A

- DOE Manual 474.1-1, 8/11/99, no changes
- DOE Manual 474.1-1A, 8/11/99, no changes
- DOE Manual 474.1-1B, 6/13/03: Reportable Quantity for tritium changed to 1 gram, reporting unit still 0.01 gram
- DOE Manual 470.4-6, 8/26/05, no changes

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Tritium Reportable Quantity Change

- Facilities with less than a reportable quantity of tritium are exempt from MC&A requirements
 - 9619 Ci or 4809 Ci due to rounding rules?
- Transactions involving a *total* of ≥ 0.5 g of tritium must be reported to DOE
- Items with ≥ 0.5 g of tritium must still record tritium content to 0.01 g
- Items with ≤ 0.5 g of tritium no longer reportable

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Confusing DOE Guidance

- “Facilities with a **reportable quantity** of material that exceed a **reporting unit** or more of material are to report transactions and inventories to NMMSS.” – DOE O 474.2, Chg 2: 11/19/12
- “Facilities with more than **a gram of tritium** are still required to report transactions of 1/100 of a gram or more.” – DOE HSS FAQ

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Confusing DOE Guidance

- “If a transaction of discrete items, each of which is less than a **reportable quantity**, sum to a **reportable quantity**, the transaction should be recorded to most accurately reflect the actual quantity involved.” – NMMSS User Guide 2.0, 4/1/13
- “A transfer of multiple discrete items, which individually are less than .5 of the **reporting unit** and are the same material type, need to be summed to a total of that material type. If that sum is equal to or greater than .5 of the **reporting unit**, the quantity is rounded to the nearest whole **reporting unit**” – DOE HSS FAQ

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Confusion about Terminology

- Reportable Quantity – “the minimum amount of material subject to the [MC&A] requirements”
- Reporting Unit – “the mass unit that site/facility accounting systems must use for reporting inventories and transactions” (kg, g, μg)
- Accountable Quantity – NOT DEFINED!!!
- For tritium, these terms are not equivalent
- At LANL, Accountable = Reportable Quantity

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Suggestions for DOE-HDBK-1129

- Define the terms Reportable Quantity, Reporting Unit, and “accountable quantity” for tritium
- Explain the different requirements for facilities based on the total inventory
- State the accepted practices for dealing with discrete items or containers that contain less than 0.5 g but greater than 50 Ci of tritium
 - Tracking/Inventory control
 - Shipping

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DOE Order 474.2, 6/27/2011

- Eliminated “Source” materials as a type
- All references to tritium being a “material of strategic importance” deleted
 - No graded safeguards for tritium
 - As an “other” material, tritium is ATL E, Category IV

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Special Nuclear Materials

Special nuclear materials (SNM) in this table must be controlled and accounted for in a graded manner consistent with the Graded Security Protection policy and Graded Safeguards Table.

Table A. Special Nuclear Materials **

Material Type	Reportable Quantity*	Weight Field Used for Element	Weight Field Used for Isotope	Material Type Code
Enriched Uranium	gram	total U	U-235	20
Uranium-233	gram	total U	U-233	70
Plutonium-242 ¹ (Pu)	gram	total Pu	Pu-242	40
Plutonium-239-241	gram	total Pu	Pu-239 + Pu-241	50
Plutonium-238 ²	tenth of a gram	total Pu	Pu-238	83
Uranium in Cascades	gram	total U	U-235	89

*Reportable quantity is the minimum amount of material subject to the requirements of this Order. Facilities with less than a reportable quantity of a material are exempt from the requirements of the Order for that material. Facilities with a reportable quantity of material that exceed a reporting unit or more of material are to report transactions and inventories to NMMSS. A reporting unit is the mass unit that site/facility accounting systems must use for reporting inventories and transactions.

¹Report as Pu-242 if the contained Pu-242 is 20 percent or greater of total plutonium by weight; otherwise, report as Pu-239-241.

²Report as Pu-238 if the contained Pu-238 is 10 percent or greater of total plutonium by weight; otherwise, report as Pu-239-241.

** Although classified as other accountable nuclear material, separated Am-241, separated Am-243, and separated Np-237 must be controlled and accounted for as SNM

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Other Nuclear Materials

Other Accountable Nuclear Materials in this list must be controlled and accounted for financial and materials management purposes and being protected in a graded manner consistent with their strategic and monetary importance.

Table B. Other Accountable Nuclear Materials

Material Type	Reportable Quantity*	Weight Field Used for Element	Weight Field Used for Isotope	Material Type Code
Depleted Uranium (U)	Kilogram	total U	U-235	10
Normal Uranium	Kilogram	total U	-	81
Americium-241 ⁴ (Am)	Gram	total Am	Am-241	44
Americium-243 ⁴	Gram	total Am	Am-243	45
Berkelium ³ (Bk)	Microgram	-	Bk-249	47
Californium-252 (Cf)	Microgram	-	Cf-252	48
Curium (Cm)	Gram	total Cm	Cm-246	46
Deuterium ¹ (D)	tenth of a kilogram	D ₂ O	D ₂	86
Enriched Lithium (Li)	Kilogram	total Li	Li-6	60
Neptunium-237 ⁴ (Np)	Gram	total Np	-	82
Thorium (Th)	Kilogram	total Th	-	88
Tritium ² (H-3)	Gram	total H-3	-	87

*Reportable quantity is the minimum amount of material reportable to the Nuclear Materials Management and Safeguard System (NMMSS).

¹For deuterium in the form of heavy water, both the element and isotope weight fields will be used; otherwise, report isotope weight only.

²Tritium contained in water (H₂O or D₂O) used as a moderator in a nuclear reactor is not an accountable material.

³Berkelium must be accounted for at the site level. It is not required that it be reported to NMMSS.

⁴Americium and Np-237 contained in plutonium as part of the natural in-growth process are not required to be accounted for or reported until separated from the plutonium. If separated, these materials must be controlled and accounted for as SNM.

Impact on Tritium Facilities

- Implementation issues for tritium facilities:
 - Pre-existing items have other ATLs assigned
 - Downgrade Cat III MBAs to Cat IV
- Suggest adding language to DOE-HDBK-1129 that explicitly states that since tritium is “Other” material, it is ATL E and Category IV
- Does Termination of Safeguards (TOS) apply to individual items or the total for a shipment?
RQ or RU?

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LANL Tritium MC&A Practices

- “Accountable tritium” means:
 - Individual items containing ≥ 0.5 g of tritium
 - Containers with a total of ≥ 0.5 g of tritium
- Accountable tritium items are tracked via LANMAS and are subject to Physical Inventories
- Less-than-accountable items tracked on LANMAS can be deleted at any time and are not subject to TOS requirements

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Suggestions for future DOE Orders

- Explicitly state that Graded Safeguards only apply to Special Nuclear Materials – O 474.2 states that “The Graded Safeguards Table on the previous page must be used when determining the categorization and attractiveness level of **accountable nuclear material**.”
- Clarify whether TOS applies to individual items or the total amount to be disposed in a particular shipment.

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