DOE M 474.1-1B

Approved: 6-13-03
Sunset Review: 6-13-05
Expires: 6-13-07

MANUAL FOR CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS

U.S. DEPARTMENT OF ENERGY
Office of Security

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Office of Security

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MANUAL FOR CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS

1. PURPOSE. To prescribe requirements and assign responsibilities for nuclear material control and accountability for the Department of Energy (DOE), including the National Nuclear Security Administration (NNSA). This Manual supplements DOE O 474.1A, *Control and Accountability of Nuclear Materials*, dated 11-20-00.

2. CANCELLATION. DOE M 474.1-1A, *Manual for Control and Accountability of Nuclear Materials*, dated 11-22-00. Cancellation of a directive does not, by itself, modify or otherwise affect any contractual obligation to comply with such a directive. Cancelled directives that are incorporated by reference in a contract remain in effect until the contract is modified to delete the reference to the requirements in the cancelled directives.

3. APPLICABILITY.

   a. General. Except for exclusions listed in paragraph 3d, this Manual applies to nuclear materials at DOE-/NNSA-owned and DOE-/NNSA-leased facilities and DOE-/NNSA-owned nuclear material at other facilities that are exempt from licensing by the Nuclear Regulatory Commission (NRC). Where a responsibility or authority is assigned to an organization that is restructured, the responsibility or authority will be reassigned to the appropriate successor organization as explicitly determined by the appropriate Lead program Secretarial Officer.

   b. DOE Elements. Except for exclusions listed in paragraph 3d, this Manual applies to the DOE organizations listed in Attachment 1.

   c. Site/Facility Management Contractors.

      (1) The Contractor Requirements Document (CRD), Attachment 2, sets forth requirements of this Manual that will apply to site/facility management contracts (contractors responsible for the management and operation of DOE-/NNSA-owned facilities) that include the CRD.

      (2) The CRD must be included in site/facility management contracts that involve nuclear materials and contain DOE Acquisition Regulation (DEAR) clause 952.204-2, titled Security requirements.

      (3) Lead program Secretarial officers must notify contracting officers of affected site/facility management contracts.

      (4) Once notified, contracting officers are responsible for incorporating the CRD for this directive into affected contracts via the laws, regulations, and DOE directives clause of the contracts.

(5) As stated in DEAR clause 970.5204-2, "Laws, Regulations, and DOE Directives," regardless of the performer of the work, site/facility management contractors with the CRD incorporated into their contracts are responsible for compliance with the CRD. Affected site/facility management contractors are responsible for flowing down the requirements of the CRD to subcontractors at any tier to the extent necessary to ensure compliance with the requirements. In doing so, contractors must not unnecessarily or imprudently flow down requirements to subcontracts. That is, contractors will (1) ensure that they and their subcontractors comply with the requirements of this CRD and (2) only incur costs that would be incurred by a prudent person in the conduct of competitive business.

(6) This Manual does not automatically apply to other than site/facility management contracts. Application of any of the requirements of this Manual to other than site/facility management contracts will be communicated as follows.

(a) DOE/NNSA field element managers[1] and heads of Headquarters departmental elements will review procurement requests for new non-site-/non-facility-management contracts that involve nuclear materials and contain DOE Acquisition Regulation (DEAR) clause 952.204-2, titled Security requirements and, if appropriate, ensure that the requirements of the CRD of this directive are included in the contract.

(b) Contracting officers will assist originators of procurement requests who want to incorporate the requirements of the CRD of this directive in new non-site-/non-facility-management contracts, as appropriate.

d. Exclusions. This Manual does not apply to DOE-owned nuclear materials at Department of Defense facilities or foreign facilities. To avoid duplicative or conflicting requirements, DOE facilities, projects, and programs which are under the cognizance of the Office of Civilian Radioactive Waste Management and are subject to NRC regulation must use the rules, standards, and criteria specified by the NRC or NRC-State agreements in lieu of this Manual.

e. Deviations. Deviations from the requirements in this Manual must be processed in accordance with DOE O 470.1, *Safeguards and Security Program*, dated 9-28-95.

[1]Whenever the term field element manager is used in this Manual it includes managers/directors of operations offices, field offices, site offices, service centers, project offices and area offices.

4. DEFINITIONS. Definitions of commonly used terms are provided in the *Safeguards and Security Glossary of Terms,* which is maintained by the Security Policy Staff (online at www.directives.doe.gov/libraries/othersources.html).

5. REFERENCES.

a. Title 42, U.S. Code, Section 2011, et. seq., Atomic Energy Act of 1954, as amended, which establishes a program for Government control of the possession, use, and production of nuclear energy and special nuclear material, whether owned by the Government or others.

b. Title 10, Code of Federal Regulations (CFR), Chapter I, "Nuclear Regulatory Commission," which contains the regulations applicable to NRC and NRC agreement State licensees involved in activities concerning nuclear materials not subject to DOE requirements.

c. Title 10, CFR, part 830, Nuclear Safety Management, which contains nuclear safety and quality assurance requirements.

d. DOE O 151.1A, *Comprehensive Emergency Management System*, dated 11-1-00, which establishes requirements and responsibilities for development, coordination, and direction of emergency planning, preparedness, readiness assurance, response, and recovery operations.

e. DOE M 435.1-1, *Radioactive Waste Management Manual*, dated 7-09-99, describes requirements and specific responsibilities for the management of high-level, transuranic, and low-level wastes and the radioactive component of mixed waste.

f. DOE G 441.1-13, *Sealed Radioactive Source Accountability and Control Guide*, dated 4-15-99, which describes an acceptable methodology for establishing and operating a sealed radioactive source accountability and control program that will comply with 10 CFR 835.

g. DOE O 460.1B, *Packaging and Transportation Safety*, dated 4-4-03, which establishes safety requirements and responsibilities for the proper packaging and transportation of DOE offsite shipments and onsite transfers of hazardous materials and for modal transport.

h. DOE O 461.1, *Packaging and Transfer or Transportation of Materials of National Security Interest*, dated 9-29-00, which establishes requirements and responsibilities for the Transportation Safeguards System packaging and transportation and onsite transfer of nuclear explosives, nuclear components, Naval fuel elements, Categories I and II special nuclear materials, special assemblies, and other materials of national security interest.

i. DOE O 470.1, *Safeguards and Security Program*, dated 9-28-95, which establishes requirements and responsibilities for the DOE Safeguards and Security Program.

j. DOE O 472.1C, *Personnel Security Activities*, dated 3-25-03, which establishes requirements, objectives, procedures, responsibilities, and authorities for the DOE Personnel Security Program.

k. DOE O 474.1A, *Control and Accountability of Nuclear Materials,* dated 11-20-00, which prescribes DOE requirements for nuclear material control and accountability.

l. DOE N 471.3, *Reporting Incidents of Security Concern*, dated 4-13-01, which establishes requirements for enhanced reporting of incidents of security concern.

m. DOE M 474.1-2, *Nuclear Materials Management and Safeguards System Reporting and Data Submission*, dated 2-10-98, which details the data elements and procedures required to document and report nuclear materials transactions, material balances, and inventories to the Nuclear Materials Management and Safeguards System.

n. DOE 1270.2B, *Safeguards Agreement with the International Atomic Energy Agency*, dated 6-23-92, which prescribes policies and responsibilities for compliance with the agreement, including the associated protocol, between the Federal Government and the International Atomic Energy Agency for the application of safeguards in the United States.

o. DOE O205.1, *Department of Energy Cyber Security Management Program*, dated 3-21-03, which establishes requirements, policies, responsibilities, and procedures for developing and sustaining the DOE Unclassified Cyber Security Program.

p. DOE O 473.1, *Physical Protection Program,* dated 12-23-02, which establishes requirements and procedures related to the physical protection of DOE safeguards and security interests.

q. DOE M 473.1-1, *Physical Protection Program Manual,* dated 12-23-02, which establishes requirements and procedures related to the physical protection of DOE safeguards and security interests.

r. DOE M 471.2-2, *Classified Information Systems Security Manual*, dated 8-3-99, which provides requirements and implementation instructions for the graded protection of the confidentiality, integrity, and availability of information processed on all automated information systems used to collect, create, process, transmit, store, and disseminate classified information by or on behalf of DOE.

s. DOE 5400.1, *General Environmental Protection Program*, dated 11-9-88, which establishes the Environmental Protection Program for DOE operations.

t. DOE 5480.20A, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*, dated 11-15-94, which establishes the selection, qualification, and training requirements for contractor personnel involved in the operation, maintenance, and technical support of DOE-owned reactors and nonreactor nuclear facilities.

u. ANSI N15.18, *Nuclear Materials—Mass Calibration Techniques for Control*, American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1988).

v. ANSI N15.19-89, *Nuclear Material Control—Volume Calibration Techniques,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1989).

w. ANSI N15.28-91, *Nuclear Materials Control—Guide for Qualification and Certification of Safeguards and Security Personnel*, American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1991).

x. ANSI N15.36-94, *Nuclear Materials—Nondestructive Assay Measurement Control and Assurance,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1994).

y. ANSI N15.41-84 (R 1994), *Derivation of Measurement Control Programs—General Principles,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1994).

z. ANSI N15.51-90 (R 1996), *Nuclear Materials Management—Measurement Control Program—Nuclear Materials Analytical Chemistry Laboratory,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1996).

aa. ANSI N15.54-90, *Instrumentation—Radiometric Calorimeters Measurement Control Program,* American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036 (1991).

bb. ASTM Standard C993-97, *Standard Guide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (2003).

cc. ASTM Standard C1112-99, *Standard Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material,*

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (1999).

dd. ASTM Standard C1169-97,*Standard Guide for Laboratory Evaluation of Automatic Pedestrian SNM Monitor Performance,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (2003).

ee. ASTM Standard C1189-02, *Standard Guide to Procedures for Calibrating Automatic Pedestrian SNM Monitors,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (2002).

ff. ASTM Standard C1236-99, *Standard Guide for In-Plant Performance Evaluation of Automatic Vehicle SNM Monitors,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (1999).

gg. ASTM Standard C1237-99, *Standard Guide to In-Plant Performance Evaluation of Hand-Held SNM Monitors,* American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103 (1999).

hh. CG-SS-4, *Classification and UCNI Guide for Safeguards and Security Information,* dated September 2000, issued by the Office of Nuclear and National Security Information, which provides original classification determinations for National Security Information concerning nuclear safeguards and security and guidance for derivatively classifying documents and materials containing such National Security Information or Restricted Data and Formerly Restricted Data.

ii. *Design Basis Threat for Department of Energy Programs and Facilities (U)*, DOE Office of Security, which identifies and characterizes potential adversary threats to DOE's programs and facilities that could adversely affect national security, the health and safety of employees, the public, or the environment (1999).

jj. DOE/NRC F 741/741A, *Nuclear Material Transaction Report*, Office of Management and Budget Control Number 1910-1800, dated October 1988, which is used for reporting values to the Nuclear Materials Management and Safeguards System for external transfers of nuclear material.

kk. *Guidance on Meeting DOE Order Requirements for Traceable Nondestructive Assay Measurements*, DOE, Office of Safeguards and Security (May 1994).

ll. *Guide to the Evaluation of Selected Materials Control and Accountability (MC&A) Detection Elements,* DOE, Office of Safeguards and Security (May 1994).

mm. *Measurement Control Guide,* DOE, Office of Safeguards and Security, which provides guidance to assist in the implementation of measurement control requirements (March 1993).

nn. *Performance Assurance Program, Protection Program Supplement,* DOE, Office of Safeguards and Security (November 1996).

oo. *Safeguards and Security Glossary of Terms,* DOE, Office of Safeguards and Security, which provides standardized definitions of terms used in the Safeguards and Security Program (www.directives.doe.gov/libraries/othersources.html).

pp. *Safeguards Seal Reference Guide,* DOE, Office of Safeguards and Security, which provides guidance to nuclear facility personnel in selecting, procuring, and applying the proper seals for safeguarding nuclear material (September 1993).

qq. *Guide for Implementation of DOE 5633.3B*, Office of Safeguards and Security, which provides guidance in the understanding of DOE materials control and accountability requirements (April 1995).

6. IMPLEMENTATION. This Manual will be implemented within 60 days after the effective date, or as required by contract.

7. CONTACT. Questions concerning this Manual should be directed to the Manager, Materials Control and Accountability Program, at 301-903-6008.

BY ORDER OF THE SECRETARY OF ENERGY:

KYLE E. McSLARROW
Deputy Secretary

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CHAPTER I. PROGRAM ADMINISTRATION

1. GENERAL. This chapter provides minimum requirements for implementing a nuclear material control and accountability (MC&A) program.

   a. Special nuclear material (SNM) must not be received, processed, or stored at a facility until facility approval has been granted in accordance with the requirements of DOE O 470.1, *Safeguards and Security Program,* dated 9-28-95.

   b. Each facility must control and account for nuclear materials (Table I-1) as required by this Manual and DOE O 474.1A, *Control and Accountability of Nuclear Materials,* dated 11-20-00. DOE/NNSA field elements[1] must implement an MC&A program using requirements contained in this Manual as the minimum for nuclear materials. The level of control and accountability for the materials must be graded based on the consequences of their loss.

   c. Each facility must designate a management official responsible for MC&A. This official must be organizationally independent from responsibility for nuclear material utilization programs, including nuclear material production, storage, processing, research, and disposition. This official, along with line management, has responsibility for and the authority to ensure the safeguards of accountable nuclear material. Each facility or site that has a reporting identification symbol (RIS) must designate a nuclear materials representative who will be responsible for nuclear materials reporting and data submission to the Nuclear Materials Management and Safeguards System (NMMSS). The NMMSS is used to accumulate and distribute information concerning nuclear materials transactions and inventories. The objective of the system is to report accurate and complete data as soon as possible after the events described by the data occur. This national database must provide nuclear materials information relating to safeguards, materials management and production, inventory quantities and valuations, and other programs requested or required by DOE or the Nuclear Regulatory Commission (NRC).

   d. Each facility must maintain documentation that defines authorities and responsibilities for MC&A functions (e.g., accounting system, measurements, measurement control, inventories, audit, material access controls, and surveillance). Each facility must have a program to ensure that personnel performing MC&A functions are trained and qualified to perform their duties and responsibilities and are knowledgeable of requirements and procedures related to their functions.

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[1]Wherever the term field element is used throughout this Manual, it includes operations offices, field offices, site offices, service centers, project offices and area offices.

Table I-1. Nuclear Materials.

Material Type	SNM, Source, or Other	Reportable Quantity*	Weight Field Used for Element	Weight Field Used for Isotope	Material Type Code
Depleted Uranium (U)	source	kilogram	total U	U-235	10
Enriched Uranium[1]	SNM	gram	total U	U-235	20
Normal Uranium	source	kilogram	total U	—	81
Uranium-233	SNM	gram	total U	U-233	70
Plutonium-242[2] (Pu)	SNM	gram	total Pu	Pu-242	40
Plutonium-239-241	SNM	gram	total Pu	Pu-239 + Pu-241	50
Plutonium-238[3]	SNM	tenth of a gram	total Pu	Pu-238	83
Americium-241[4] (Am)	other	gram	total Am	Am-241	44
Americium-243[4]	other	gram	total Am	Am-243	45
Berkelium (Bk)	other	microgram	—	Bk-249	47
Californium-252 (Cf)	other	microgram	—	Cf-252	48
Curium (Cm)	other	gram	total Cm	Cm-246	46
Deuterium[5] (D)	other	tenth of a kilogram	D_2O	D_2	86
Enriched Lithium (Li)	other	kilogram	total Li	Li-6	60
Neptunium-237 (Np)	other	gram	total Np	—	82
Thorium (Th)	source	kilogram	total Th	—	88
Tritium[6] (H-3)	other	gram	total H-3	—	87

*Materials are reported to the nearest whole unit, except for Pu-238, deuterium, and tritium.

[1]Uranium in cascades is treated as enriched uranium and should be reported as material type 89.

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

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

[4]Americium is only reportable when separated from plutonium.

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

[6]Units for reporting tritium to the Nuclear Materials Management and Safeguards System are set forth in DOE M 474.1-2, *Nuclear Materials Management and Safeguards System Reporting and Data Submission,* dated 2-10-98. If requested by the receiver, the shipper must report shipment data for tritium to 0.01 gram. Tritium contained in water (H_2O or D_2O) used as a moderator in a nuclear reactor is not an accountable material.

e. Each facility with nuclear materials must develop an MC&A plan that provides the safeguards authorization basis. The MC&A plan specifies how nuclear material inventory holdings will be controlled and accounted for. The MC&A plan must describe the elements of the program that are designed to deter and detect loss, theft, and diversion of nuclear materials and to ensure that nuclear materials are in their authorized locations and being used for their intended purposes. The MC&A plan must document how the MC&A program meets the DOE MC&A Order (DOE O 474.1A) requirements and document agreements between site contractor organizations (and Government organizations for Government-operated facilities) as to how the MC&A program is operated including facility-specific requirements approved by the DOE/NNSA field element manager. Changes in these agreements approved by the DOE/NNSA field element manager do not require reapproval of the MC&A plan, but should be documented as an addendum to the plan. The plan must specify review frequency and change control mechanisms and be approved by the DOE/NNSA field element.

f. Facility emergency plans must address conditions that indicate possible loss of control of SNM. Emergency plans must be consistent with Safeguards and Security directives and must specify MC&A measures to be taken before resuming operations following an emergency. Each facility must establish procedures for emergency conditions and periods when MC&A systems are inoperative. These procedures must ensure that access to or removal of SNM would be detected during these periods. Other requirements for facility emergency plans are specified in DOE O 151.1A, *Comprehensive Emergency Management System,* dated 11-1-00.

g. For all facilities for which roll up (i.e., the accumulation of smaller quantities of SNM) to a Category I quantity is credible, the safeguards and security system must provide graded protection sufficient to ensure that the failure or defeat of a single component will not increase the level of risk for the system above an acceptable level. The vulnerability assessment process must include a determination of the extent to which the failure or defeat of a single component would increase this risk and whether the increase in risk is acceptable. When the increase in risk exceeds an acceptable level, compensatory measures must be taken immediately and upgrades to the system must be initiated. The level and acceptability of the risk must be documented in the facility site safeguards and security plan.

h. An MC&A program must be established for all nuclear materials on inventory under a three-letter RIS. The DOE/NNSA field element manager or the head of the responsible DOE/NNSA Headquarters element may require that applicable nuclear material safeguards measures (outlined in this Manual and in DOE O 474.1A) be maintained and/or implemented for SNM of attractiveness level D or higher that has been removed from inventory as waste and for which a

vulnerability resulting in an unacceptable level of risk has been identified. Materials previously removed from inventory are exempt from the requirements of this Manual and DOE O 474.1A provided they—

(1) were declared waste before November 22, 2000, the issuance date of DOE M 474.1-1A, *Manual for Control and Accountability of Nuclear Materials,* dated 11-22-00;

(2) have been written off the MC&A records; and

(3) are under the control of a waste management organization.

Additionally, safeguards terminations approved before the issuance of this Manual remain in effect and do not need to be reapproved.

i. Termination of safeguards exempts nuclear materials from requirements of this Manual, DOE O 474.1A, and the physical protection requirements for nuclear material. Before safeguards can be terminated radiological sabotage risks associated with the materials must be evaluated and measures must be in place to ensure that radiological protection requirements will be met after safeguards termination. After termination of safeguards, the materials will still need to be accounted for and protected per industrial security, waste management, and radiological sabotage requirements. Requirements for safeguards termination depend on the safeguard attractiveness levels of the material. Attractiveness levels are described in Table I-4 and additional guidance on determining attractiveness levels is provided in the *Guide for Implementation of DOE 5633.3B, Control and Accountability of Nuclear Materials,* dated April 1995.

(1) Safeguards can be terminated on nuclear materials provided the following conditions are met.

(a) The material must be attractiveness level E if it is SNM. (The second column of Table I-2, contains additional and more descriptive information on lower-grade forms of SNM that can be classified as attractiveness level E for purposes of terminating safeguards and/or determining appropriate levels of safeguards protection.)

(b) The material has been determined by the DOE/NNSA field element to be discardable in accordance with DOE/NNSA guidelines.

(c) The material is transferred to the control of a waste management organization where the material is accounted for and protected in accordance with waste management regulations. The material must not be collocated with other accountable nuclear materials.

(2) In some cases, it may be necessary to dispose of nuclear materials of attractiveness level D or higher SNM. For DOE facilities, termination of safeguards for such materials must be approved by the head of the responsible DOE program office after consultation with the Director, Office of Security. For NNSA facilities, termination of safeguards for such materials must be approved by the Chief, Defense Nuclear Security, NNSA, after consultation with the Director, Office of Security.

The Director, Office of Security, will solicit the views of the Deputy Administrator for Defense Nuclear Nonproliferation and the Assistant Secretary for Policy and International Affairs on such matters. When disposal of greater than a Category II quantity of SNM is being considered, the risk of theft of the material must be evaluated based on required industrial security and waste management controls. A copy of the risk assessment must be provided to the responsible approving authority (i.e., the head of the DOE program office or the Chief of Defense Nuclear Security, NNSA) before approval of safeguards termination. Conditions 1i(1)(b) and 1i(1)(c) also apply to these materials.

j. Reduced safeguards can be applied to materials that both meet the criteria of Table I-3 and have been removed from processing material balance areas. Such materials are referred to as retained waste. The reduced safeguards and security requirements for such materials are as follows.

(1) Physical protection of retained waste must be commensurate with the safeguards category of the material defined in Table I-4.

NOTE: Protection measures against other risks, such as radiological sabotage and information security, may still be required based on results of vulnerability or risk assessments.

(2) Nuclear materials accountability information (e.g., material type, quantity, location) must remain on the site's inventory records and within the NMMSS.

(3) Measurement and physical inventory requirements for the material identified in Table I-3 can be deferred to a time when—

(a) the material is removed from site or

(b) the material is reintroduced into a processing material balance area.

Table I-2. Attractiveness Level E Criteria for SNM.

Description/Form	Complies with DOE M 474.1-1B, Chapter I, Paragraph 1i	
	Maximum concentration* (wt%) for MC&A and physical protection termination	**Maximum SNM concentration* (wt%) for only physical protection equivalent to Category IV**
SNM solutions and oxides: nitrate, caustic or chloride solutions; contaminated/ impure oxides, metal fines and turnings, glovebox sweepings	0.1	N/A
SNM amenable to dissolution and subsequent separation: pyrochemical salts; chloride melt; hydroxide cake; floor sweepings; alumina; condensates; reduction residues; sand, slag, and crucible; magnesium oxide crucibles	0.1	0.2
SNM in organic matrixes or requiring mechanical separation disassembly and subsequent multiple recovery operations: HEPA filters, organic solutions, oils and sludges, graphite or carbon scrap, surface contaminated plastics, metal components, combustible rubber	0.2	1.0
SNM bound in matrix of solid, sintered, or agglomerated refractory materials: SNM embedded in glass or plastic, high-fired incinerator ash, spent resins, salt sludges, raffinates, and sulfides	0.5	2.0
SNM microencapsulated in refractory compounds or in solid-dilution: vitrified, bituminized, cemented, or polymer-encapsulated materials; SNM alloyed with refractory elements (tungsten, platinum, chromium, stainless steel); ceramic/glass salvage	1.0	(To Be Determined)

*SNM weight percent is based on element weight for plutonium and isotope weight for U-235 and U-233.

(4) With respect to current and potential SNM-bearing inventory or byproduct material selected for International Atomic Energy Agency (IAEA)

safeguards, materials that meet the criteria in Table I-3 can be transferred to the retained waste category.

Reductions in safeguards for retained waste require the approval of the responsible DOE/NNSA field element.

Table I-3. Technical Criteria for Retained Waste.

Description and Form	SNM Concentration Range (Wt %)*
SNM solutions and oxides	>0.1 ≤ 0.5
SNM amenable to dissolution and subsequent separation	>0.2 ≤ 1.0
SNM alloyed with aluminum, thorium, zirconium, spent fuel	≤ 1.0
SNM in organic matrixes; SNM requiring mechanical separation/disassembly and multiple recovery operations	>1.0 ≤ 5.0
SNM bound in matrix of solid, sintered, or agglomerated refractory metals	>2.0 ≤ 7.5
SNM microencapsulated in refractory compounds or in solid-dilution	> 5.0 ≤ 10.0

*SNM weight percent is based on element weight for plutonium and isotope weight for U-235 and U-233.

k. A facility identified for decommissioning, closure, or deactivation is not exempt from compliance with requirements stated in this Manual. The facility's MC&A program must be maintained at a level appropriate to the category and attractiveness level of the nuclear material on inventory until a termination survey determines that no nuclear material remains at the facility.

Such a determination may be made if no material remains or the only remaining material is waste that meets the definition of attractiveness level E and has been written off the MC&A books. Requirements for termination surveys are contained in DOE O 470.1. Before decommissioning, all nuclear material holdup must be measured and credited to the accountability books.

Unless demonstrated to be otherwise, the category of SNM in process holdup must be considered to be the category of the total SNM put into the process during its lifetime. After a facility has transferred all its nuclear material except

waste to another facility, the inventory balance is zero, and the termination survey has been completed, the facility may still need to maintain a RIS account with NMMSS. For such facilities, transfers of nuclear material in waste to and from other RIS accounts will need to be reported to NMMSS using DOE/NRC F 741/741A, *Nuclear Material Transaction Report,* dated October 1998.

l. When procedures, techniques, and standards promulgated by the American Society for Testing and Materials (ASTM) and the American National Standards Institute exist, they must be used to develop the basis for facility MC&A programs unless otherwise directed by DOE directives. Standards issued by IAEA and NRC can also be used when appropriate and when consistent with DOE regulatory goals.

2. GRADED SAFEGUARDS. The concept of graded safeguards is one of providing the greatest relative amount of control and effort to the types and quantities of SNM that can be most effectively used in a nuclear explosive device. The following paragraphs present basic information and requirements for determining nuclear safeguards categories.

a. DOE/NNSA field elements and facilities must establish and follow a graded safeguards program for nuclear materials. Categories of nuclear material for implementation of DOE's graded safeguards program are shown in Table I-4. Additional guidance on determining safeguards attractiveness for SNM is provided in *The Guide to Implementation of DOE 5633.3B, Control and Accountability of Nuclear Materials* (April 1995).

b. The material category of an SNM location (e.g., material balance area, material access area, protected area, facility) must be determined to establish the required protection level. In many cases the material category is determined directly from Table I-4. Directions for determining the material category when multiple material types and attractiveness levels must be considered are provided in the following paragraphs. When a facility can demonstrate that accumulation of small quantities of SNM is not credible, the summation of these quantities need not be used to define the category quantity. Determination of category involves grouping materials by SNM type, attractiveness level, and quantity. Material quantities are element weights for plutonium and isotope weights for U-235 and U-233. Procedures for determining material category are as follows.

(1) One SNM Type, One Attractiveness Level. Sum the material in the attractiveness level and determine the category from Table I-4.

(2) One SNM Type, Multiple Attractiveness Levels (a Category III or greater quantity of B-level material included).

(a) Determine the amounts of SNM for materials in each of attractiveness levels B, C, and D.

(b) Calculate the "effective" quantity for attractiveness levels B and C by multiplying the quantity in attractiveness levels B and C by the appropriate factors in Table I-5.

(c) Sum the effective amounts in attractiveness levels B and C.

(d) Compare the total effective amount as calculated in paragraph 2b(2)(c) above to the amounts in attractiveness level B from Table I-4.

(e) Compare the amount of attractiveness level D to Table I-4.

(f) The material category is the highest level of material category determined using the procedures in paragraphs 2b(2)(a) through 2b(2)(d) or in paragraph 2b(2)(e).

(3) One SNM Type, Multiple Attractiveness Levels (less than a Category III quantity of B-level material included).

(a) Determine the amounts of SNM for all attractiveness levels.

(b) Compare the total amounts in each level to those in Table I-4.

(c) The material category level is the highest level of the material categories determined using the procedures in paragraphs 2b(3)(a) and 2b(3)(b).

(4) Multiple SNM Types.

(a) Determine the category for each SNM type following the above procedures.

(b) The category is that determined for the individual SNM type that requires the highest level of protection.

3. MC&A REQUIREMENTS FOR SOURCE AND OTHER NUCLEAR MATERIALS.

a. Source and other nuclear materials listed in Table I-1 [with the exceptions of tritium, separated neptunium-237 (Np-237), and separated americium, as described in 3b and 3c below] are subject only to the following requirements. The accounting system must document inventories and material transfers at the RIS level.

Table I-4. Graded Safeguards.

	Attractiveness Level	Pu/U-233 Category (kg)				Contained U-235 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	
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	
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	
LOW-GRADE MATERIALS Solutions (1 to 25 g/L), process residues requiring extensive reprocessing, moderately irradiated material, 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	
ALL OTHER MATERIALS Highly irradiated forms, solutions (<1 g/L), uranium containing <20% U-235 or <10% U-233[2] (any form, any quantity)	E									Reportable Quantities

[1]The lower limit for Category IV is equal to reportable quantities in this Manual.

[2]The 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.

(1) Reporting to NMMSS must be in accordance with DOE M 474.1-2, *Nuclear Materials Management and Safeguards System Reporting and Data Submission,* dated 2-10-98.

(2) Physical inventories must be conducted at a frequency and in a manner approved by the DOE/NNSA field element manager and must be documented in the site MC&A plan.

(3) Minimum MC&A requirements for potential substitution materials (materials that could be substituted for strategic material during physical inventories) collocated with SNM of significant strategic value are specified in Chapter II, paragraph 3a(2), of this Manual.

(4) The DOE/NNSA field element manager will determine all other MC&A requirements and document them in the site MC&A plan.

b. Tritium is a nuclear material of strategic importance; therefore, graded safeguards programs for tritium must 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.

Table I-5. Effective Quantities.

Attractiveness Level	Pu/U-233 Factor	U-235 Factor
B	1	1
C	1/3	1/4

c. Separated Np-237 and americium (Am-241 and Am-243) are materials of safeguards interest.

(1) Separated Np-237 and americium are to be protected, controlled, and accounted for as if they were SNM.

(2) Departmental protection program strategies and graded safeguards thresholds for separated Np-237 and americium are to be identical to those for U-235. The category for these isotopes is determined using the U-235 side of Table I-4. (In this context, "separated" refers to the recovered or product material generated from chemical and processing operations on the target/source material.)

4. LOSS DETECTION ELEMENT EVALUATION.

a. Vulnerability Assessment. Each Category I facility must develop detailed vulnerability assessments for identifying and evaluating facility capability to detect the loss of a Category I quantity of SNM. The head of the DOE/NNSA field element MC&A organization must approve the vulnerability assessment before it is submitted as part of the site safeguards and security plan. The vulnerability assessment must address the same points established for preparation of the site safeguards and security plan. Vulnerability assessments must cover the full threat spectrum specified in Office of Security guidance. Potential targets must include all Category I locations and any other areas for which a credible scenario for unauthorized accumulation of a Category I quantity of SNM has been identified. Vulnerability assessments must be reviewed annually and updated when system changes or new information indicates a potentially significant change in the risk of unauthorized removal of Category I quantities of SNM. Results of reviews, including changes in vulnerability assessments, must be documented in the facility vulnerability analysis report.

b. Performance Testing. Each facility must develop a performance testing program to support and verify vulnerability assessments. DOE O 470.1 lists requirements for the design, planning, and documentation of performance tests. MC&A performance testing programs must comply with the requirements of DOE O 470.1.

(1) Performance tests must be designed to demonstrate that the system is functional and to ensure that the system performs as specified and/or required. In addition, facilities must—

(a) identify those components of the MC&A system that provide the greatest effectiveness against theft and diversion;

(b) design, conduct, and document tests that substantiate component effectiveness; and

(c) integrate the results of these component tests into safeguards and security vulnerability assessments.

(2) Performance testing must include not only those elements that can detect a threat in time to prevent it, but also those elements that can effectively account for SNM to ensure that safeguards and security systems are functioning properly. Performance testing program design must focus on testing individual detection elements. Elements identified in a vulnerability assessment that contribute to detection capability must be tested on a frequency based on the level-of-threat risk established by the vulnerability assessment.

(3) The design of performance tests should consider prudent judgment and use of resources. The scope and extent of testing should be based on the graded safeguards concept; the testing program should include more testing for higher-category facilities than for lower-category facilities. Facilities must take corrective actions for findings and vulnerabilities identified during system testing.

(4) Performance testing must include testing to determine whether safeguards and security systems have failed including testing for loss of SNM. (The capability of the accounting system to provide information about the quantity and the identifying characteristics of the potential missing material should also be tested.) Corrective action plans for systems that have failed must be developed and interim compensatory measures put in place.

c. MC&A Performance Requirements. Table I-6 contains minimum performance requirements for the following MC&A system elements:

- access controls,
- material surveillance,
- tamper-indicating devices (TIDs),
- portal monitoring,
- accounting record system,
- inventory confirmation/verification measurements, and
- inventory difference control limits.

(1) The selected system elements must be validated through performance testing.

(a) Testing must be established at a frequency that, at a minimum, is in accordance with DOE O 470.1 and must be documented in the MC&A plan.

Table I-6. Performance Requirements for MC&A Elements.

Access Controls. Performance tests must be designed and conducted to fully evaluate the effectiveness of access controls for Category I and II quantities of SNM. At least 95 percent of the tests conducted must demonstrate detection of unauthorized access to Category I and II quantities of SNM.

Material Surveillance. Performance tests must be designed and conducted to fully evaluate the effectiveness of material surveillance activities for Category I and II quantities of SNM. At least 95 percent of the tests conducted must demonstrate detection of unauthorized actions related to the control of Category I and II quantities of SNM.

TIDs. The tamper-indicating device (TID) record system must accurately reflect the location and identity of TIDs for at least 99 percent of the TIDs inspected. The TID program must ensure that TIDs are properly in place for at least 95 percent of the TIDs inspected.

Portal Monitoring. In addition to performance testing necessary to verify that vulnerability assessment or DOE/NNSA field element detection requirements are being met, testing of portal monitors (SNM and metal) must include all applicable tests described in ASTM guides. When standards set in applicable ASTM guides are not met, compensatory actions must be taken.

Accounting Record System. The accounting record system must accurately reflect item identity and location for at least 99 percent of items selected.

Inventory Confirmation/Verification Measurements. For Category I and II items, acceptance/rejection criteria for verification measurements and, where possible, for confirmatory measurements, must be based on the standard deviation for the measurement method under operating conditions. Control limits for such criteria must be set at no wider than three times the standard deviation for the method. The DOE/NNSA field element should review and approve the control limits. When limits based on three standard deviations are unreasonably large, the DOE/NNSA field element manager may require tighter limits.

Inventory Difference Control Limits. For Category I and II material balance areas, limits-of-error must not exceed 2 percent of the active inventory during the inventory period or a Category II quantity of material. For Category III and IV material balance areas, limits-of-error of inventory differences shall not exceed a specified percentage of the active inventory during the inventory period to a maximum of a specified quantity; the specified percentage and maximum quantity must be approved by the DOE/NNSA field element manager.

(b) If these system elements fail to meet performance requirements, a corrective action plan must be developed and, where necessary, compensatory measures must be taken.

(c) Access control and material surveillance testing must be facility-specific; the scope and the extent of the testing must be documented by facility management and approved by the DOE/NNSA field element manager.

(d) The accounting systems performance requirement must be verified against all items selected for physical inventory and/or transfer.

(e) Performance must be verified at least annually except for facilities whose physical inventories are conducted less than once a year. For such facilities, performance must be verified at the same frequency as inventories are conducted.

(2) When errors in accounting records are found, they must be corrected; when more than 1 percent of the items selected are in error, corrective actions must be taken for the accounting system as a whole.

(3) To comply with the TID performance requirement, TIDs must be inspected for all items selected for physical inventory and/or transfer.

(4) Performance must be verified at least annually except for facilities whose physical inventories are conducted less than once a year. For such facilities, performance must be verified at the same frequency as inventories are conducted.

(5) Testing to ensure TIDs are properly in place must include checking to see that the TID has been properly applied and the integrity of the TID has not been violated. (Testing for this requirement is not intended to require destruction of properly applied TIDs whose integrity has not been violated.) Additional guidance for testing metal detectors is given in *Performance Assurance Program, Protection Program Supplement* (Office of Safeguards and Security, 1996).

(6) In performance requirements for inventory differences, the term “active inventory” means the sum of additions to inventory, beginning inventory, ending inventory, inventory adjustments, and removals from inventory after all “common terms” have been excluded. (In this context, “common terms” are material values that appear in the active inventory calculation more than once and come from the same measurement.)

(7) The DOE/NNSA field element manager may establish additional or more stringent performance requirements for system elements at his/her facilities. Other paragraphs in this Manual contain requirements that can be readily performance tested. Testing of system elements associated with these requirements should be a regular part of the performance testing program.

5. REPORTING INCIDENTS OF SECURITY CONCERN. Each facility must identify MC&A loss detection elements for each material balance area and must establish a graded program for monitoring these elements and associated data to determine the status of nuclear material inventories and to identify security incidents. Security incidents must be reported in accordance with DOE N 471.3, *Reporting Incidents of Security Concern,* dated 4-13-01.

In addition, the DOE/NNSA field element must independently evaluate the significance of the incident. For NNSA facilities, additional reporting should be performed as required by the Office of Defense Nuclear Security. Information related to monitoring and assessment activities must be documented and retained.

6. ADMINISTRATIVE CONTROLS. Each facility with nuclear materials must establish a program to periodically review and assess the integrity and quality of its MC&A program and practices. The assessment program must address both normal operations and emergency conditions. The frequency and content of these assessments must be on a graded basis, consistent with requirements of DOE O 470.1, and approved by the DOE/NNSA field element manager. The results of all assessments must be reported to facility management, and assessment reports that could potentially reveal sensitive information should be reviewed for classification. Each noted deficiency must be addressed and corrected. The assessment must be performed by personnel who are knowledgeable of MC&A.

Reviews must be conducted before startup of new facilities or operations and when changes occur in facilities, operations, or MC&A features that might alter the performance of the MC&A system. At a minimum, the assessment program must address the following issues.

a. Identification of abnormal situations.

b. Loss mechanisms, loss detection capabilities, and localization of inventory differences.

c. Selection, maintenance, calibration, and testing functions to ensure proper equipment and system performance.

d. MC&A system checks and balances, including separation of responsibilities and duties, used to identify irregularities and detect tampering with materials or MC&A system components.

e. Change controls, including authorization requirements, to detect unauthorized or inappropriate modification of system components, procedures, or data. The change control system must address requirements for review; authorization; documentation; notification; and controls on equipment selection, procurement, and maintenance.

f. Procedures or checks to ensure the reliability and accuracy of MC&A data and information.

g. Performance testing conducted by the facility. This portion of the assessment should address the design of performance tests and the results obtained by the testing program since the last assessment.

h. Procedures for emergency conditions and for periods when MC&A system components are inoperative.

i. Material containment, material access, and material surveillance procedures.

j. Physical inventory program and reconciliation practices.

k. Accounting system procedures, capabilities, and sensitivities.

l. Identification of personnel with MC&A responsibilities who should be included in the facility personnel security assurance program, consistent with DOE O 472.1C, *Personnel Security Activities,* dated 3-25-03.

m. Measurement control program.

n. TID programs.

In addition to the assessments described above, an organization independent of MC&A must conduct internal audits of the facility's MC&A function to assess compliance with internal plans and procedures. The DOE/NNSA field element manager must approve the frequency of these audits.

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CHAPTER II. MATERIALS ACCOUNTABILITY

1. GENERAL. This chapter describes requirements for nuclear materials accountability. These requirements must be applied in a manner consistent with the graded safeguards concept. The chapter is divided into five functional areas: accounting systems, physical inventories, measurement and measurement control, nuclear material transfers, and material control indicators.

2. ACCOUNTING SYSTEMS. Each facility must have a system for tracking nuclear material inventories; documenting nuclear material transactions; issuing periodic reports; and assisting with the detection of unauthorized system access, data falsification, and material gains or losses. The accounting system must provide a complete audit trail for all nuclear material from receipt through disposition. Each facility must use the generally accepted accounting principles promulgated by the Financial Accounting Standards Board in the design and operation of the nuclear material accounting system unless otherwise specified in DOE directives.

   The facility nuclear materials accounting system must include checks and balances and be structured to ensure timely detection (normally within 24 hours, but in no case later than in the subsequent inventory reconciliation) of errors or discrepancies in records associated with a Category I or II quantity of SNM, including, where possible, detecting falsified data and identifying the responsible persons. The system must also be capable of detecting omissions and other data discrepancies and ensuring completeness of accounting records.

   a. Accounting Systems Database and Procedures. Each facility must maintain procedures that describe the structure and operation of the nuclear materials accounting system. The procedures must accurately reflect current nuclear material accounting practices. Specific requirements for accounting procedures include the following:

      (1) descriptions of the inventory database (including procedures for updating and reconciling inventory data with the results of physical inventories) and the required data elements for each applicable material type;

      (2) identification of accounting reports and their frequency, distribution, and timeliness consistent with accounting requirements;

      (3) identification of organizational responsibilities for management and operation of the accounting system; and

      (4) recording, reporting, and submitting data to the NMMSS, by material type and reporting unit, as specified in DOE M 474.1-2.

b. Account Structure.

(1) A facility must consist of one or more material balance areas established to identify the location and quantity of nuclear materials in the facility. Each facility must maintain readily retrievable accountability data by material balance area that reflects quantities of nuclear materials on inventory, quantities of nuclear materials received and shipped, and other adjustments to inventory.

(2) The material balance area account structure must sort data by material types, processes, and functions; provide the capability to localize inventory differences; and provide a system of checks and balances for verifying the accuracy of the accountability data and records.

(3) A material balance area boundary must not cross a materials access area boundary. Each material balance area must consist of a single geographical area and be an integral operation.

(4) Facility management must designate an individual in each material balance area to ensure that MC&A requirements are implemented in that material balance area.

(5) The material balance area custodian is responsible for controlling nuclear material located in the material balance area, preparing and signing internal material transfer documents, and conducting and reconciling material balance area physical inventories.

(6) A material balance area custodian must not be responsible for multiple material balance areas when transfers of nuclear material occur between those material balance areas (i.e., a single custodian must not serve as both shipper and receiver for material transfers).

c. Records and Reports.

(1) Each facility must maintain records, submit data, and issue reports as required by this Manual and facility procedures. The reports must accurately describe all nuclear material transactions and inventories. Inventory adjustments must be identified by material balance area and must be reported as required in this Manual.

(2) Nuclear materials records must be updated by authorized personnel only. The records system must provide an audit trail for all transactions affecting the nuclear materials database.

(3) The material balance area records system must be capable of being updated daily or on demand for all nuclear materials transactions. (This requirement is for updating records based on reports or information; it does not pertain to how quickly a facility must be able to complete measurements.) The records system must also be capable of generating book inventory listings of all SNM within 3 hours. For all other nuclear material, the records system must be able to generate book inventories within 24 hours. The accuracy of the accounting record system must be validated according to testing methodology, testing frequency, and record maintenance requirements contained in DOE O 460.1B, *Packaging and Transportation Safety*, dated 4-4-03, and applicable DOE guidance. Performance requirements for accounting record system accuracy are contained in Chapter I, paragraph 4.

3. PHYSICAL INVENTORIES. Each facility must implement a physical inventory program for SNM that complies with the following requirements. Inventory requirements for separated Np-237 and americium are the same as for SNM.

a. Periodic Physical Inventories.

(1) Conduct of Physical Inventories. Inventories must be based on measured values, including measurements or technically justifiable estimates of holdup. Process monitoring techniques may be used for material that is undergoing processing and recovery operations and is inaccessible for measurements. Facilities must have documented plans and procedures that define responsibilities for performing inventories and specify criteria for conducting, verifying, and reconciling inventories. Facilities may use statistical sampling, based on graded safeguards, to verify the presence of items during inventories. Parameters for statistical sampling plans must be defined by the facility and approved by the DOE/NNSA field element. Facilities must specify in their sampling plans the population, confidence level, minimum detectable defect, definition of a defect, and action to be taken if a defect is encountered.

The following are minimum sampling parameters for safeguards categories.

Category	Confidence Level	Minimum Detectable Defect
I	95 percent	3 percent
II	95 percent	5 percent
III & IV	95 percent	10 percent

The inventory population must be stratified according to item category as shown above. Separate samples must be derived for each inventory stratum.

(2) Physical Inventory Frequencies. Each facility must perform physical inventories of Category I and II material balance areas that involve activities other than processing at a frequency determined by the DOE/NNSA field element manager, but at least semiannually. Management must ensure that physical inventories are performed bimonthly in Category I and II material balance areas where processing occurs. In processing areas where process controls provide equivalent levels of theft and diversion detection, physical inventories may be performed upon completion of the material campaign.

In such cases, the DOE/NNSA field element manager must approve a processing plan before starting the campaign. The process plan must identify compositions and quantities of material to be processed, projected processing timetable, process control measures used, and procedures necessary for material controls during process interruptions. Other factors to be considered for frequency determination include personnel radiation exposure, the operational mode of the facility, and credible protracted diversion scenarios.

At least annually, each facility must perform simultaneous physical inventories of all Category I and II material balance areas for which the established inventory frequency is annual or more frequent. Material balance areas with extended inventory frequencies of greater than 1 year are excluded from this requirement.

For each facility, physical inventories for SNM must be performed for Category III and IV material balance areas at a frequency to be determined by the DOE/NNSA field element manager, but at least biennially.

Category IV source and other nuclear material in Category I and II material balance areas must be inventoried on a schedule defined by the DOE/NNSA field element manager, but at least biennially, except when the source and/or other nuclear material is a credible substitution material. When substitution materials are collocated with SNM, facilities must inventory substitution materials with the same frequency as the SNM and use inventory measurement methods that can distinguish between SNM, source, and other nuclear material. Except for materials required to be protected as SNM and potential substitution materials collocated with SNM, source and other materials outside Category I and II material balance areas will be inventoried at a frequency approved by the DOE/NNSA field element manager and documented in the MC&A plan.

In addition to the requirements listed above, inventory checks for Category IA items not in storage must be performed weekly for physical count verification and monthly for serial number verification. Inventory checks for stored Category IA items must consist of a physical count whenever the storage area is accessed and a serial number verification on a monthly basis.

(3) Extensions to Inventory Frequency Requirements. Extensions to inventory frequencies must be approved by the DOE/NNSA field element in accordance with the alternative inventory control provisions in Table II-1. Facilities must determine inventory values in time to complete inventory computation and reconciliation and determine inventory differences within the DOE reporting requirements specified in this Manual and approved inventory frequencies. For Category I and II storage areas, Table II-1 may be used to determine the frequency of physical inventories based on the successful implementation of alternative inventory control measures. Inventory periods specified for each alternative measure are additive so long as the measures function independently.

Total inventory extension is equal to the summation of inventory periods for all alternative measures used, with a maximum allowable period of 5 years. Table II-1 is designed so that longest inventory extensions are given for measures that provide material attribute information. Items added to these storage areas must have appropriately measured values. If inventory extensions are granted for Category I or II storage areas other than in accordance with the provisions of Table II-1, a deviation must be submitted in accordance with requirements of DOE O 470.1.

The DOE/NNSA field element manager may extend inventory periods beyond 2 years, with a maximum inventory period of 5 years, for Category III and IV storage areas that have alternative inventory control measures.

(4) Physical Inventory Reconciliation Program. Each facility must implement a physical inventory reconciliation program in which the book inventory for each material balance area is compared with and, if necessary, adjusted to the physical inventory. The reconciliation must be completed within 15 calendar days following receipt of all inventory information, measurement data, and sample analyses. Any inventory differences must be identified and reported as required.

b. Special Inventories. At each facility, management must establish and implement procedures for conducting special inventories at the request of authorized facility personnel or the cognizant DOE/NNSA field element or as a result of routine disassembly of critical assemblies, changes in custodial responsibilities, missing items, inventory differences exceeding established control limits, and abnormal occurrences.

Table II-1. Inventory Periods Based on Alternative Measures for Category I and II Storage Locations.

Alternative Inventory Control Measures*	Inventory Periods
Formidable barriers	1 year
Hazardous environment	1 year
Bulk containment	1 year
Vault enhancement above baseline requirements	9 months
Continuous monitoring of physical or mechanical parameters	1 year
General (area-wide) confirmatory measurements	1 year
Continuous item observation (e.g., video/image, laser surveillance)	2 years
Continuous item monitoring (e.g., monitoring of serial number, TIDs, movement)	2 years
Mass (load cell)	2 years
Confirmatory measurements on individual items (e.g., thermal, gamma, or neutron emission)	3 years
Quantitative measurements on individual items	May qualify as a continuous inventory**

*When multiple measures are used for storage materials balance areas, the inventory periods are additive as long as the alternative measures function independently.

**If the measurements are both item- and material-specific and there is a level of confidence that the measurements are correct, the monitoring may qualify as a continuous physical inventory. To be considered a continuous physical inventory, automated measurements must be made on all items on a second-to-second basis.

c. IAEA Inventories. Physical inventories performed during IAEA inspections may, with the concurrence of the DOE/NNSA field element manager, serve in place of a scheduled physical inventory.

d. Inventory Verification/Confirmation Measurements.

(1) Each facility must establish and implement a system for performing measurements as part of a physical inventory. Verification measurements must be made on SNM items that are not tamper indicating. Confirmation

measurements must be made on tamper-indicating SNM items. Such measurements may use a statistically based sampling plan applied in a manner consistent with the graded safeguards concept. Facilities must develop sampling plans, which the DOE/NNSA field element manager must approve. (NOTE: These plans must be based on the defined population and must not be a subset of the sample selected for physical inventory. Separate sampling plans must be implemented for verification and confirmation measurements to ensure that a sufficient number of non-tamper-indicating items are measured.) Sampling plans must specify the population, confidence level, minimum detectable defect, definition of a defect, and action to be taken if a defect is encountered. Minimum sampling parameters for safeguards categories are as follows.

Category	Confidence Level	Minimum Detectable Defect
I	95 percent	3 percent
II	95 percent	5 percent
III & IV	95 percent	10 percent

The inventory population must be stratified according to item category as shown above. Separate samples must be derived for each stratum.

Sampling plans for performing verification and confirmation measurements may supplement physical inventories that are conducted to verify the presence of 100 percent of inventory items. The DOE/NNSA field element manager may establish a material quantity threshold for requiring inventory verification and confirmation measurements. For materials not amenable to verification measurement, confirmatory measurements of two material attributes must be substituted for verification measurements. Materials not amenable to verification measurement must be identified and documented in the MC&A plan.

(2) Each facility must establish documented acceptance or rejection criteria for inventory confirmation and verification measurements based on valid technical and statistical principles. For Category I and II items, acceptance and rejection criteria must be consistent with performance requirements for confirmation and verification measurements shown in Table I-6. Each facility must prepare and implement a response plan for evaluating and resolving all verification and confirmation measurements that fail to meet acceptance criteria. Items that fail to meet the confirmation or verification measurement acceptance criteria must not be processed before the discrepancy is resolved.

4. MEASUREMENT AND MEASUREMENT CONTROL. Measurement and measurement control programs must be implemented at all facilities with nuclear material. Measurement programs used to determine Category I or II inventories of SNM or used to determine a Category I or II SNM throughput over a 6-month period must meet the requirements set forth in paragraphs 4(a) through 4(e) below, consistent with facility-specific measurement program objectives. Measurement programs used to determine Category III or IV inventories of SNM must address the topics set forth in paragraphs 4(a) through 4(e) below, but the specific measurement and measurement control requirements are to be determined by the DOE/NNSA field element and to be approved by the DOE/NNSA field element manager. Nuclear materials not amenable to verification measurement by the site must be identified in the facility's MC&A plan. Inventory values for these materials must be based on measured values made at other sites or technically justified estimates. Justification and supporting documentation for these inventory values must be included as part of the MC&A plan. Additional guidance on measurement control is provided in the *Measurement Control Guide* published by the Office of Safeguards and Security.

   a. Organization. Measurement and measurement control programs must be independent from operations.

   b. Selection and Qualification of Measurement Methods. Each facility must select, qualify, and validate measurement methods capable of providing the required levels of precision and accuracy. Facility management is responsible for selecting and qualifying a measurement method. Target values for precision and accuracy of nuclear material measurements endorsed by recognized national and international nuclear organizations must be considered performance goals for facility measurement systems. Alternative measurement performance goals must be defensible and documented. Precision and accuracy requirements must be approved by the DOE/NNSA field element and documented in the MC&A plan. Each facility must have procedures to ensure that only qualified measurement methods are used for accountability purposes.

   c. Training and Qualification of Measurement Personnel. Individuals responsible for performing nuclear material measurements must have sufficient knowledge to perform the measurements in an acceptable manner.

      (1) Training. Each facility must have a documented plan for training measurement personnel. The plan must be reviewed annually and updated as necessary to reflect changes in measurement technology and must specify training qualification and requalification requirements for each measurement method.

      (2) Qualification. Each facility must have a documented qualification program to ensure that measurement personnel demonstrate acceptable levels of proficiency before performing measurements and that

measurement personnel are requalified according to requirements in the training plan. Measurement personnel must demonstrate proficiency in destructive analysis of nuclear material at a minimum of once per day for each method they will use that day.

d. Measurement Systems. Nuclear material measurement systems must provide accurate nuclear material values for inventories and transactions.

(1) Sampling. Sampling programs must be implemented to ensure that portions of bulk material taken for measurement are representative of the bulk material. Each facility must have a documented sampling plan for each measurement point used for accountability purposes. The plans must be based on valid technical and statistical principles and must take into account material type, measurement requirements, and any special process or operational considerations.

(a) The basis for the sampling plan must be documented and validated through studies of the materials or items being sampled.

(b) The sampling plan must specify, at a minimum, the sampling procedure, number and size of required samples, mixing time and procedure (when applicable), provisions for retaining archive samples, and estimates of variance associated with the sampling method.

(c) Sampling procedures must be documented and reviewed annually or whenever changes are made, including changes to the type or composition of the material being sampled.

(2) Measurement Methods. Each facility must develop, document, and maintain data on measurement methods for all nuclear material on inventory except those materials not amenable to measurement. These methods must be written to provide clear direction to the analyst or operator and must be validated initially and revalidated whenever changes are made.

(a) In determining inventory values and consistent with the graded safeguards concept, measurement methods must be selected in a manner that minimizes the contribution of measurement error to the uncertainty of the inventory difference.

(b) Verification measurements, when used to adjust accountability records, must have accuracy and precision comparable to or better than the original measurement method.

(c) The method used for confirmatory measurements must be capable of determining the presence or absence of a specific attribute of the material consistent with valid acceptance and rejection criteria.

(d) All measurement methods must be calibrated using standard or certified reference materials or secondary standards traceable to the national measurement base and must be revalidated as necessary.

(e) Measurement equipment and instruments must meet precision and accuracy requirements under in-plant conditions.

(f) Documentation of measurement data must be maintained to provide an audit trail from source data to accounting records.

e. Measurement Control Programs. Each facility must develop and implement control programs for all measurement systems used for accountability purposes. Control programs must ensure the effectiveness of measurement systems and the quality of measured values used for accountability purposes. Control programs must also produce precision and accuracy values for use in determining inventory difference control limits and shipper/receiver limits of error. A measurement control program, as referred to herein, must include, at a minimum, the following elements.

(1) Scales and Balances Program. All scales and balances used for accountability purposes must be maintained in good working condition, recalibrated according to an established schedule, and checked for accuracy and linearity on each day that the scale or balance is used for accountability purposes.

(2) Analytical Quality Control. Data from routine measurements must be analyzed statistically to determine and ensure accuracy and precision of the measurements.

(3) Sampling Variability. The uncertainty associated with each sampling method, or combination of sampling and measurement methods, must be determined and maintained on a current basis.

(4) Physical Measurement Control. The precision and accuracy of volume, temperature, pressure, and density measurements must be determined and ensured.

(5) Instrument Calibration. Instruments must be calibrated using appropriate standards, when available. At a minimum, measurement values must be

compared with more accurate measurement system values on a prescribed basis; the frequency is defined by demonstrated instrument performance.

(6) Reference Materials (Standards). All calibration and working standards used in a measurement control program must be traceable to the national measurement base through the use of standard reference materials or certified reference materials and must have smaller uncertainties associated with their reference values than the uncertainties of the measurement method in which they are used. Working standards used in a measurement control program must be representative of the type and composition of the material being measured when the material matrix affects the measured values. (For additional information see *Guidance on Meeting DOE Order Requirements for Traceable Nondestructive Assay Measurements,* dated May 1994.)

(7) Sample Exchange Programs. Each facility's measurement control program must include participation in appropriate interlaboratory control programs to provide independent verification of internal analytical quality control.

(8) Statistical Controls. For each measurement method used for accountability purposes, control limits must be calculated and monitored and documented procedures must exist to correct out-of-limits conditions. Control limits must be established at the two-Sigma level (warning limits) and three-Sigma level (alarm limits). Control data exceeding the two-Sigma limits must be investigated, and when warranted, timely corrective action must be taken. If a single data point exceeds the three-Sigma level, the measurement system in question must not be used for an accountability measurement until the measurement system has been demonstrated to be within statistical control. For measurement methods relying substantially on operator technique, control limits must include uncertainties for each analyst/method combination. Statistical control limits must be monitored to ensure that they are consistent with target values approved by the DOE/NNSA field element manager.

(9) Measurement Method Qualification. Each facility must have a documented method qualification program to ensure its measurement method demonstrates acceptable performance before being used for accountability measurements. For destructive analysis and nondestructive assay of nuclear material, performance must be demonstrated at least once per day for each method being used. For nondestructive analysis measurement systems for which meeting this requirement is impractical or unnecessary, the control measurement frequency must be at least one of every five measurements unless otherwise approved by the DOE/NNSA field element manager.

(10) Measurement Control Procedures. Each facility must develop documented measurement control procedures for all measurement methods used for accountability. Each facility must have a program to ensure that measurement control procedures are followed.

(11) Statistical Programs. Each facility must have a documented program for the statistical evaluation of measurement data for determining control limits and precision and accuracy levels for each measurement system used for accountability. The program must ensure the quality of measurement and measurement control data and provide estimates of uncertainty on inventory and inventory control statements.

The statistical program, at a minimum, must contain the following elements:

(a) valid statistical techniques to determine the total random error and the measurement biases generated for each measurement system or sampling/measurement system and to determine control limits, rejection limits, and outlier criteria;

(b) a valid statistical technique to develop sampling plans for inventory and measurement of nuclear material;

(c) analysis of measurement control data and reporting to the responsible organization at specified times and frequencies; and

(d) documentation of all major assumptions made in each data evaluation process.

5. NUCLEAR MATERIAL TRANSFERS. Each facility must have a program to control and account for both internal and external facility transfers of nuclear materials. This program must include documented procedures that specify requirements for authorization, documentation, tracking, verification, and response to abnormal situations that may occur during transfer of nuclear materials. (See DOE M 474.1-2 for directions on preparing and submitting DOE/NRC F 741/741A and DOE forms required for documenting external transfers for materials accounting purposes.)

a. External Transfers.

(1) The shipper must obtain written verification and maintain documentation that the intended receiver is authorized to accept the material before the material is transferred.

(2) Transfers of nuclear material between facilities having different RISs must be documented on DOE/NRC F 741/741A. These forms must be prepared

and distributed to the principals of the transaction and the cognizant DOE/NNSA field element, preferably on the day of the transfer but within 24 hours or on the first workday after the transfer if it occurs on a nonworkday. (DOE/NNSA field element managers may direct DOE contractors to discontinue routine distribution of DOE/NRC F 741/741A to their offices.)

(3) Immediately after receipt, shipments must be subjected to a transfer check. Transfer checks must consist of confirmation of shipping container or item count, validation of TID integrity and identification (if applied), and comparison with shipping documentation to ensure the shipment was received intact. For external transfers, all SNM containers must be tamper indicating. For purposes of transfer checks, receipt occurs when the transfer vehicle is unloaded or the transfer vehicle's integrity is breached (TIDs removed or broken) at the receiving facility. Each facility must have documented procedures that specify actions to be taken in the event discrepancies are detected. Records of transfer checks are subject to audit and must be retained at least until the next annual DOE safeguards survey. (For accountability purposes, material in transit at the end of a reporting period must be included in the receiver's reported inventory even though physical receipt of the material has not yet occurred.)

(4) For all unirradiated Category I and II quantities of SNM transferred between facilities having different RISs, the receiver must perform a verification or accountability measurement except when the RISs are both located on the same site and have the same site contractor. Accountability measurements differ from verification measurements in that accountability measurements are entered into the receiver's accountability records, whereas for verification measurements the shipper's values are entered into the receiver's accountability records.

The receiver may choose to establish a new accountability value or accept and book the shipper's accountability value considering the potential impact on the inventory difference. Transfer of nuclear material produced to program specification and intrinsically tamper-indicating may be verified by performing a confirmatory measurement rather than a verification/accountability measurement unless the DOE/NNSA field element manager requires verification/accountability measurements.

Use of confirmatory measurements in lieu of verification/accountability measurements for such items requires a shipper/receiver agreement approved by both the shipper's and receiver's DOE/NNSA field element managers. For Category III and IV transfers, DOE/NNSA field element managers may require that measurements be made consistent with the strategic, nonproliferation, and/or monetary value of the material, or as

required for environmental, safety, and operational controls. Material received must not be put into the process until the required verification/accountability measurements have been completed, unless a deviation is approved or the criteria defined in paragraph 5a(4)(f) apply. When verification/accountability measurements are required and materials are to be put in the process before the verification/accountability measurements have been made, an agreement should be reached between the shipper and receiver as to how significant shipper/receiver differences will be handled.

(a) The shipper must independently determine the measured values before shipment unless the integrity of the item and of the existing measured values have been ensured. The shipper's measured values must be documented on DOE/NRC F 741 and DOE/NRC F 741A, if applicable.

(b) The receiver's confirmation and verification/accountability measurements (when required) for Category I and II quantities of SNM transfers must be accomplished in accordance with the requirements in Table II-2. The receiver's verification/accountability measurements for transfers involving other categories of nuclear material, when required by the DOE/NNSA field element manager [see paragraph 5a(4)], must be performed in accordance with the requirements in Table II-2. The DOE/NNSA field element manager may require that precision and accuracy goals be met for measurement of shipments and receipts. If the receiver's verification/accountability measurements cannot be accomplished consistent with requirements in Table II-2, the confirmatory measurements outlined in paragraph 5a(4)(e) apply.

(c) For shipment of unirradiated SNM containing greater than 250 grams of a single SNM type and for each discrete item exceeding 250 grams, limits of error at the 95 percent confidence level must be assigned to shipper and receiver accountability/verification measurements for both the element and isotope values. Limits of error need not be reflected on the DOE/NRC F 741 for external transfers for which accountability measurements cannot be performed. For other shipments, the shipper and receiver may estimate the limits of error. Limits of error are also required for all measurements of external transfers of tritium that exceed 2 grams except as noted above.

(d) Documented acceptance/rejection criteria must be established and used to evaluate confirmatory measurement data. A response plan

Table II-2. Shipper/Receiver Measurement Requirements.

Material Category and Attractiveness Level	Material[1] Confirmation	Verification/Accountability[2] 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 statistical bases within 180 days or on input to process

[1]Confirmatory measurement by nondestructive analysis, gross weight check, and item count (if not done as part of transfer checks). Confirmatory measurements are not required for all materials. When confirmatory measurements are required, they must be performed within the time frames of this table.

[2]Quantitative determination of material quantities (within designated measurement uncertainty limits). Accountability measurement values are entered into receiver's accountability records. For verification measurements, the shipper's values are entered into the receiver's accountability records. Verification/ accountability measurements are not required for all materials. When verification/accountability measurements are required, they must be performed within the time frames of this table.

for investigation and resolution of confirmatory measurements that fail acceptance criteria must be developed and implemented, and all outliers must be investigated and resolved.

(e) If delays in completing the receiver's verification/accountability measurement will result in a protracted delay in closure of the transaction, a confirmatory measurement may be used to effect a "safeguards closure" of the transaction. The transaction is documented by an "A-S" entry on DOE/NRC F 741 and DOE/NRC F 741A, if required (see DOE M 474.1-2). A safeguards closure may be used when the integrity of the shipment is ensured and only verification/accountability measurement differences are possible between shipper and receiver. If the receiver's verification/ accountability measurement performed after a safeguards closure indicates a shipper/receiver difference,

the difference may be resolved by mutual agreement of the shipper's and receiver's DOE/NNSA field element managers and an adjustment (correcting entry) to the DOE/NRC F 741 and/or DOE/NRC F 741A, if required.

The safeguards closure may be applied only when all of the following conditions have been met.

1 No discrepancies are found in the verification of the piece count, identification number, and integrity of the TIDs and gross weight of the items or containers received, and no evidence indicating theft or diversion of the material is found.

2 The shipper's and receiver's confirmation measurements measure the same nuclear material attribute, the results of the methods can be compared on a technically valid basis, and the results of the measurements are within the established limits of agreement.

3 A shipper/receiver agreement establishing the criteria for closing transactions based on confirmatory measurements, approved by both the shipper's and receiver's DOE/NNSA field element managers, is in effect for the transaction.

(f) Limited processing is acceptable for materials not amenable to nondestructive assay in order to perform a receipt measurement, as approved by both the shipper's and receiver's DOE/NNSA field element managers. Limited processing can include homogenization and dissolution.

(5) SNM in foreign reactor fuel returns must either be measured or the risk of diversion of material from the fuel must be documented and the responsible Under Secretary or his/her designee must approve the acceptance of the fuel without measurement.

b. Internal Transfers.

(1) Each facility must provide a graded system of measurements and records to reflect the flow of material between material balance areas within that facility and between it and other facilities on the same site.

(2) The facility control system must be designed to monitor transfer activities and to deter and detect unauthorized removal of material during transfers. It should flag abnormal situations (e.g., inappropriate transfers of

quantities or materials or unauthorized personnel receiving or shipping materials).

(3) Transfers must be documented on nuclear material transfer forms or electronic equivalents that contain required information, prepared and distributed within established time frames, and signed by authorized custodians or their alternates.

(4) Materials must be subjected to a transfer check within 1 workday after receipt. These checks must include verification of shipping container or item count, TID integrity (if applied), and identification number. These transfer checks must be compared with appropriate documentation. Irradiated SNM requires only a transfer check.

(5) If the isotope content of SNM (excluding uranium enriched below 20 percent U-235 or below 10 percent U-233) transferred between material balance areas is 50 grams (fissile) or more, the material must be transferred on a measured value. Confirmation/verification measurement requirements for internal transfers must be approved by the DOE/NNSA field element, including when measurements are not required.

(6) Each facility must establish and use document acceptance/rejection criteria to evaluate measurement data for internal material transfers. In addition, procedures must specify notification and response requirements if nuclear material removal or another abnormal situation is detected. These requirements must be consistent with those contained in DOE N 471.3.

6. MATERIAL CONTROL INDICATORS. Each facility must implement a program to assess the material control indicators described below and to ensure detection of losses and unauthorized removals of nuclear materials. Facilities also must have documented plans that specify responsibilities and procedures for evaluating material control indicators.

a. Shipper/Receiver Difference Assessment. Each facility must have written procedures for evaluating shipper/receiver differences and for investigating and reporting significant shipper/receiver differences.

(1) A shipper/receiver difference is defined to be significant when it meets the following criteria.

(a) It involves a discrepancy in the number of items, regardless of the quantity of nuclear material.

(b) It is statistically significant. (Determination of whether shipper/receiver difference is statistically significant is only required for those shipments for which verification/accountability measurements are made by both the shipper and receiver.) A shipper/receiver difference is defined to be statistically significant when the magnitude of the difference exceeds either of the following:

1 the limit obtained by a statistical combination of the valid limits of error for the shipper's and receiver's measured values

or

2 the square root of 2 (approximately 1.4) times a single valid limit of error when either the shipper's or receiver's limit of error is not valid. (When both shipper's and receiver's limits of error are determined not to be valid, the limits of error must be recalculated and the statistical significance of the shipper/receiver difference must be reevaluated.)

(2) Shipper/receiver difference data must be subjected to trend analysis to detect measurement bias or material loss. Analyses must be designed to detect statistically significant cumulative shipper/receiver differences and to trigger investigations when these differences are detected.

(3) The receiver must notify its DOE/NNSA field element and the shipper of any shipper/receiver difference determined to be significant. Both shipper and receiver must investigate their measurements and limits of error. Such investigations must be completed as required by DOE. All investigations must be documented.

(4) Significant shipper/receiver differences involving a discrepancy in number of items must be reported in accordance with DOE N 471.3.

(5) When shipper/receiver differences are determined to be statistically significant, but the quantities and strategic or monetary values are insufficient to warrant an investigation and subsequent correction to transfer documents, and when the receiver is DOE or one of its contractors or subcontractors, the difference need not be investigated and each party must record its own quantitative value. In the context of this paragraph, differences of less than 50 grams fissile or less than 5 grams of tritium are considered to be insufficient to require an investigation unless there are special circumstances. Authority to invoke the stipulations of this paragraph rests mutually with the shipper's and receiver's DOE/NNSA field element managers.

(6) Statistically significant shipper/receiver differences may be resolved through any of the following methods.

(a) If both the shipper's and receiver's DOE/NNSA field elements obtain adequate assurance that the measurements and limits of error are valid, and the investigation indicates that theft or diversion has not occurred, each facility must record its own quantitative values.

or

(b) If either the shipper or receiver agrees to accept the other's value, the shipper or receiver must prepare a corrected copy of the shipping document using the other's data.

or

(c) If the investigation does not result in a satisfactory resolution, the shipper and receiver must resolve the difference through arbitration.

(7) The receiving facility must not process SNM contained in a shipment involving an unresolved significant shipper/receiver difference unless a shipper/receiver agreement allowing this has been approved by both the shipper's and receiver's DOE/NNSA field element managers.

b. Inventory Difference Evaluation.

(1) Each facility must have a documented program for evaluating all SNM inventory differences, including those involving missing items. Programs for evaluation of inventory differences for other nuclear materials may be established at the option of the DOE/NNSA field element. Each facility must have procedures for establishing control limits and requiring investigation when those limits are exceeded. All inventory differences that exceed control limits must be reported in accordance with the requirements of DOE N 471.3, this Manual, and DOE O 474.1A. Assessments of inventory differences must include statistical tests (e.g., tests of trends and biases) and must be applied, as appropriate, to both total inventory difference and actual inventory difference on both an individual and a cumulative basis for each processing material balance area.

(2) Procedures for establishing control limits for inventory differences of SNM must be based on variance propagation using current data. The data should reflect operating conditions for the material balance period of the

inventory. Other methodologies may be used but they must be approved by the DOE/NNSA field element manager and must be justified based on factors such as limited data, low transfer rates, and/or material category. For Category IV material balance areas, control limits may be based on professional judgement with the approval of the DOE/NNSA field element. Significant differences between historical limits and limits based on variance propagation must be investigated for the purpose of validating, revising, and refining the variance propagation model.

(3) Each facility must have documented procedures for responding to and reporting missing items and inventory differences in excess of control limits. The reporting and investigation of inventory differences must be consistent with the requirements specified in Chapter I, paragraph 5.

c. Evaluation of Other Inventory Adjustments.

(1) Each facility must establish a documented program for evaluating all inventory adjustments entered in the accounting records. The program must have written procedures, including equations for applying radioactive decay and fission transmutation adjustments. A program for holdup adjustments must be justified on the basis of measurements or other factors. Facilities must outline procedures for the statistical review of inventory adjustments using techniques such as tests of trends, biases, and correlation.

(2) Facilities must implement procedures to ensure that all inventory adjustments are supported by measured values or other technically justifiable bases. The program must include procedures for measuring and monitoring environmental waste such as stack effluent and liquid waste streams as required by environmental protection program directives and regulations.

(3) Facilities must establish procedures for reporting reviews of inventory adjustments, including abnormal situations, to the DOE/NNSA field element.

CHAPTER III. MATERIALS CONTROL

1. GENERAL. This chapter describes the requirements for nuclear material control, consisting of four functional areas: access controls, material surveillance, material containment, and detection/assessment. Facilities must formally document the graded nuclear materials control program in the MC&A plan. Requirements for the control of SNM are stated in both DOE M 473.1-1, *Physical Protection Program Manual,* dated 12-23-02, and this Manual. Some requirements are in one directive, but not both. Facilities must comply with all DOE requirements, regardless of the document in which they appear. When facilities are precluded from performing physical inventories as required by this Manual, material control and protection features must be enhanced to ensure inventory integrity.

2. ACCESS CONTROLS. Each facility must have a graded program for controlling personnel access to nuclear materials; nuclear materials accountability, inventory, and measurement data; data-generating equipment; and other items/equipment of which misuse could compromise the safeguards system. Facilities that have multiple Category III and IV locations containing attractiveness level B and C material outside a protected area must ensure that these areas do not contain a total inventory of Category II or greater quantity of SNM unless a vulnerability assessment demonstrates that an unauthorized accumulation of a Category I quantity of material from these facilities is not credible. Facilities must incorporate personnel security assurance programs as a component in the prevention of SNM theft or diversion. Personnel security assurance programs also must be considered in assessments of vulnerabilities related to theft of Category I quantities of SNM. Facilities must test access control systems and procedures according to requirements in DOE O 470.1 and applicable DOE guidance.

   a. Materials Access. Each facility must have a documented program to ensure that only properly authorized personnel have access to nuclear materials. This program must address procedures and mechanisms to detect and respond to access by unauthorized personnel. To minimize the potential for unauthorized access to nuclear material, the amount of material in use must be limited to that necessary for operational requirements, and excess material must be stored in repositories or kept in enclosures designed to ensure that access will be limited to authorized individuals. (See Table II-1 in this Manual; DOE O 473.1, *Physical Protection Program,* dated 12-23-02; and DOE O 472.1C, Attachment 13, for additional access control and storage requirements for SNM. See DOE M 473.1-1 for access authorization requirements for SNM categories.)

   b. Data Access. Each facility must have a graded program to ensure that only authorized persons have the ability to enter, change, or access MC&A data and information.

c. Equipment Access. Each facility must have a graded program to control access to data-generating and other equipment used in material control activities. Such equipment includes measurement equipment, data-recording devices, and TIDs.

d. Other Considerations. Access control programs similar to those described in paragraphs 2b and 2c above must protect against data and equipment falsification or manipulation and must detect unauthorized activities during emergency or other unusual conditions.

e. Unclassified Computer Systems. Where MC&A data and data-generating equipment involve unclassified computer systems, these systems must meet the requirements of DOE O 205.1, *Department of Energy Cyber Security Management Program,* dated 3-21-03.

3. MATERIAL SURVEILLANCE. Each facility must establish a graded nuclear materials surveillance program capable of detecting unauthorized activities or anomalous conditions and reporting material status. The surveillance program must address both normal and emergency conditions and must provide for periodic testing. Facilities must plan and document testing for material surveillance systems and procedures in accordance with DOE O 470.1.

a. Material Surveillance Mechanisms. Material surveillance methodologies must consist of either automated means (e.g., monitoring devices, sensors, or other instrumentation), visual surveillance/direct observation (e.g., two-person rule, monitoring by external personnel), or other alternative safeguards measures that provide the necessary detection. In the case of direct observation, the observer must have the means to recognize, correctly assess, and report activities that are unauthorized or inconsistent with established safeguards requirements. Inventory records, process logs (where available), or other information may also be used to detect anomalies and trigger investigations.

b. Material Surveillance Programs. Surveillance procedures must describe the methodologies and operational/control points on which the program is based and must provide for investigation, notification, and reporting of anomalies.

(1) Category I and II. Material surveillance programs for Category I and II quantities of SNM must ensure that materials are in authorized locations and that they detect unauthorized material flows and transfers. Category I locations must be evaluated to determine the ability of the system to assess material losses from material access area and protected area boundaries. Category II locations must be evaluated to determine the ability of the system to assess material losses from the protected area boundary.

Material surveillance programs for all areas containing Category I or II quantities of SNM must include the following.

(a) Only appropriately authorized and knowledgeable personnel (i.e., individuals who are capable of detecting incorrect or unauthorized actions) must be assigned responsibility for surveillance of SNM.

(b) Controls must be sufficient to ensure that one lone individual cannot gain access to a secure storage area.

(c) All persons in secure storage areas must be under constant surveillance (e.g., two-person rule or equivalent surveillance) at any time the storage area is not locked and protected by an active alarm system.

(d) Surveillance must be sufficient to ensure that unauthorized or unaccompanied authorized personnel cannot enter the storage area undetected when the door is unlocked or open.

(e) When two persons are assigned responsibility for maintaining direct control of items outside an alarmed storage area within a materials access area or protected area, either the two authorized persons must be physically located where they have an unobstructed view of the items and can positively detect unauthorized or incorrect procedures or there must be a system of hardware, procedures, and administrative controls sufficient to ensure no unauthorized accumulation of a Category I quantity without timely detection.

(f) SNM in use or process must be under material surveillance, under alarm protection, or (with the approval of the DOE/NNSA field element manager) protected by alternative means that can be demonstrated to provide equivalent protection.

(2) Category III. The material surveillance program for Category III quantities must ensure that when materials are not in locked storage, they are attended, are in authorized locations, and are not accessed by unauthorized persons.

(3) Category IV. The material surveillance program for Category IV quantities must be site-specific and approved by the DOE/NNSA field element manager.

4. MATERIAL CONTAINMENT. Each facility must have a documented program to provide controls for nuclear materials operations relative to materials access areas, protected areas, material balance areas, other authorized storage repositories, and processing areas.

a. Material Access Area and Protected Area. The facility must have controls to ensure that Category I quantities of SNM are used, processed, or stored only within a material access area contained in a protected area and that Category II quantities of SNM are used, processed, or stored only within a protected area. The containment program must—

(1) identify authorized activities and locations for nuclear materials;

(2) identify mechanisms used to detect unauthorized activities;

(3) identify material types, forms, and amounts authorized to be removed from the materials access area or protected area;

(4) identify containment controls for normal and emergency conditions; and

(5) require a periodic audit of the containment program to ensure compliance and system effectiveness.

b. Material Balance Area. Each facility must have controls to ensure that nuclear materials are used, processed, or stored within a material balance area and are controlled in accordance with the graded safeguards concept. These controls must ensure that materials are removed only through authorized pathways or portals and are subject to transfer and verification procedures identified in Chapter II, paragraph 5, of this Manual. Controls for material balance areas must—

(1) be formally documented;

(2) identify geographical boundaries and functions of the material balance areas;

(3) identify material types, forms, and quantities permitted in each material balance area;

(4) describe administrative controls for each material balance area;

(5) define custodial responsibilities for nuclear materials contained within a material balance area;

(6) identify personnel authorized to receive or ship nuclear material;

(7) identify material flow into and out of the material balance area;

(8) ensure material transfer procedures are followed; and

(9) ensure that material quantities transferred across material balance area boundaries are based on measured values consistent with Chapter II, paragraph 5b(5).

c. Storage Repositories. Requirements for controls on storage repositories are in DOE M 473.1-1.

d. Processing Areas. The facility must have controls for nuclear materials being used or stored in processing areas. The controls for in-process areas must—

(1) describe activities and locations for storing material,

(2) identify components used to detect unauthorized activities or conditions,

(3) include procedures for moving material into or out of the processing area,

(4) describe control procedures for normal and emergency conditions and for maintenance activities,

(5) describe response actions to be taken in abnormal situations, and

(6) provide for audit of the processing controls on a periodic basis to ensure system effectiveness.

5. DETECTION/ASSESSMENT. Each facility must have the capability to detect and assess the unauthorized removal of nuclear materials, consistent with the graded safeguards concept. The system must be interfaced with the facility's physical protection and other organizational systems, as appropriate, and must be able to detect removal of SNM from its authorized location (theft/diversion/errors) and notify the protective force and other organizations to respond when such events are detected.

a. TIDs. Each facility must have a documented program, administered by the MC&A organization, to control TIDs and ensure that TIDs are used to the extent possible to detect violations of container integrity. Testing of TID integrity, location, and application and the TID record system must be conducted according to requirements contained in DOE O 470.1 and other applicable DOE directives and guidance. The TID control program must specify, as a minimum, the following elements:

(1) acquisition/procurement/destruction;

(2) types of TIDs used;

(3) unique TID identification;

(4) storage;

(5) issuance;

(6) personnel authorized to apply, remove, and dispose of TIDs;

(7) containers on which TIDs are to be applied;

(8) procedures for application of TIDs;

(9) frequency and method of TIDs verification;

(10) response procedures for TIDs violations;

(11) assurance that TIDs cannot be reused after violation;

(12) frequency and method of internal program audits;

(13) procedures for reporting TID violations; and

(14) DOE/NNSA field element-approved listing of all containers considered to be intrinsically tamper indicating.

b. Portal Monitoring. Minimum portal monitoring requirements are in DOE M 473.1-1. In addition to those requirements, the detection level of the monitors must be based upon detection of the typical SNM product in the area and the credible number of removals associated with theft of a Category I quantity of material. All detectors and related calibration standards must be maintained and controlled to ensure that portal monitors are capable of meeting detection requirements. Periodic performance testing of portal monitors must be conducted in accordance with Chapter I, paragraph 4b, of this Manual. Planning and documentation of performance testing must meet the requirements of DOE O 470.1, Chapter II. Performance requirements for portal monitors (both SNM and metal) are contained in Chapter I, paragraph 4b. Controls must be established to prevent unauthorized access to portal monitor instrumentation and cabling. A written response plan must be prepared and implemented to provide evaluation and resolution of all alarm conditions, including requirements for notification in accordance with DOE N 471.3 and the requirements in Chapter I, paragraph 5, of this Manual, in the event of unresolved alarms or malevolent actions. Controls must be established to ensure detection capabilities during emergency conditions.

c. Waste Monitors.

(1) All liquid, solid, and gaseous waste streams leaving a materials access area must be monitored to detect the theft or diversion of SNM. Facility

waste-monitoring equipment must be maintained and controlled to ensure that the equipment is capable of detecting specified amounts of SNM. Instrumentation used to monitor waste and equipment removed from a materials access area must be able to detect, in combination with other detection elements, the removal of a Category I quantity of SNM through a credible theft or diversion scenario.

(2) Each facility must establish and implement a response plan for evaluating and resolving situations involving any discharge exceeding facility-specific limits. The plan, which must be approved by the DOE/NNSA field element manager, must include procedures for reporting in accordance with DOE N 471.3 and the requirements contained in Chapter I, paragraph 5, of this Manual if the situation is not satisfactorily resolved or if there is an indication of malevolent action.

d. Daily Administrative Checks. A facility-specific daily administrative checks program must be implemented for each Category I material balance area (or multiple material balance areas where roll up to a Category I quantity of SNM is credible). The DOE/NNSA field element manager must determine and approve the scope and extent of the checks on the basis of recognized vulnerabilities. The administrative checks program must specify the detection objectives, performance procedures, documentation requirements, and response actions.

e. Other Detection/Assessment Mechanisms. Each facility must establish systems capable of detecting and/or assessing SNM removals consistent with the loss detection elements evaluation requirements of this Manual. These monitoring and control systems must provide sufficient information to correctly assess the alarm, localize the removal, and estimate the quantity and form of the diverted or stolen material.

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DEPARTMENT OF ENERGY ORGANIZATIONS TO WHICH
DOE M 474.1-1B, *Manual for Control and Accountability of Nuclear Materials,*
IS APPLICABLE

Office of the Secretary
Office of the Chief Information Officer
Office of Civilian Radioactive Waste Management
Office of Counterintelligence
Office of Energy Efficiency and Renewable Energy
Office of Environment, Safety and Health
Office of Environmental Management
Office of Fossil Energy
Office of Independent Oversight and Performance Assurance
Office of the Inspector General
Office of Intelligence
National Nuclear Security Administration
Office of Nuclear Energy, Science and Technology
Office of Science
Office of Security

DEPARTMENT OF ENERGY ORGANIZATIONS TO WHICH
DOE M 474.1-1B, *Manual for Control and Accountability of Nuclear Materials,*
IS NOT APPLICABLE

Office of Congressional and Intergovernmental Affairs
Departmental Representative to the Defense Nuclear Facilities Safety Board
Office of Energy Assurance
Office of Economic Impact and Diversity
Energy Information Administration
Office of General Counsel
Office of Hearings and Appeals
Office of Management, Budget and Evaluation and Chief Financial Officer

Office of Policy and International Affairs
Office of Public Affairs
Office of Worker and Community Transition
Secretary of Energy Advisory Board
Bonneville Power Administration
Southeastern Power Administration
Southwestern Power Administration
Western Area Power Administration

CONTRACTOR REQUIREMENTS DOCUMENT

DOE M 474.1-1B, *Manual for Control and Accountability of Nuclear Materials*

This Contractor Requirements Document (CRD) establishes the requirements for Department of Energy (DOE) contractors, including National Nuclear Security Administration (NNSA) contractors, responsible for the management and operation of Department-owned facilities and/or for protecting safeguards and security interests and whose contracts include the CRD. Contractors must comply with the requirements listed in the CRD to the extent set forth in their contracts.

Regardless of the performer of the work, contractors with the CRD incorporated into their contracts are responsible for compliance with the requirements of the CRD. Affected contractors are also responsible for flowing down the requirements of this CRD to subcontracts at any tier to the extent necessary to ensure the contractors' compliance with the requirements. In doing so, contractors must not unnecessarily or imprudently flow down requirements to subcontracts. That is, contractors will (1) ensure that they and their subcontractors comply with the requirements of this CRD and (2) only incur costs that would be incurred by a prudent person in the conduct of competitive business.

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CONTENTS

CONTENTS (continued)

CHAPTER I. PROGRAM ADMINISTRATION

1. GENERAL. This chapter provides minimum requirements for implementing a nuclear material control and accountability (MC&A) program.

   a. Special nuclear material (SNM) must not be received, processed, or stored at a facility until facility approval has been granted. [See DOE O 470.1, *Safeguards and Security Program,* dated 9-28-95.]

   b. The site/facility contractor must control and account for nuclear materials listed in Table I-1. The level of control and accountability for the materials must be graded based on the consequences of their loss.

   c. The site/facility contractor must designate a management official responsible for MC&A. This official must be organizationally independent from responsibility for nuclear material utilization programs, including nuclear material production, storage, processing, research, and disposition. This official, along with contractor line management, has responsibility for and the authority to ensure the safeguards of accountable nuclear material.

      The management contractor for a facility which has a reporting identification symbol (RIS) assigned to it must designate a nuclear materials representative who will be responsible for nuclear materials reporting and data submission to the Nuclear Materials Management and Safeguards System (NMMSS).

      The NMMSS is used to accumulate and distribute information concerning nuclear materials transactions and inventories. The objective of the system is to report accurate and complete data as soon as possible after the events described by the data occur. This national database must provide nuclear materials information relating to safeguards, materials management and production, inventory quantities and valuations, and other programs requested or required by DOE or the Nuclear Regulatory Commission (NRC).

   d. The site/facility contractor must maintain documentation that defines authorities and responsibilities for MC&A functions (e.g., accounting system, measurements, measurement control, inventories, audit, material access controls, and surveillance). The contractor must have a program to ensure that personnel performing MC&A functions are trained and qualified to perform their duties and responsibilities and are knowledgeable of requirements and procedures related to their functions.

   e. A contractor at a site/facility with nuclear materials must develop an MC&A plan that provides the safeguards authorization basis for the site/facility. The MC&A plan specifies how nuclear material inventory holdings will be controlled and

accounted for. The MC&A plan must describe the elements of the program that are designed to deter and detect loss, theft, and diversion of nuclear materials and those elements designed to ensure that nuclear materials are in their authorized locations and being used for their intended purposes. The contractor must obtain DOE/NNSA field element[1] approval of the MC&A plan and its components, including related facility-specific requirements, any changes to those requirements, and the review frequency and change control mechanisms.

The MC&A plan must document how the MC&A program meets contract requirements and document agreements between site contractor organizations (and Government organizations for Government-operated facilities) as to how the MC&A program is operated including facility-specific requirements approved by the DOE/NNSA field element manager.[2] Changes in these agreements approved by the DOE/NNSA field element manager do not require reapproval of the MC&A plan, but should be documented as an addendum to the plan. The plan must specify review frequency and change control mechanisms and be approved by the DOE/NNSA field element.

f. Contractor facility emergency plans must address conditions that indicate possible loss of control of SNM and must specify MC&A measures to be taken before resuming operations following an emergency. The contractor must establish procedures for emergency conditions and periods when MC&A systems are inoperative. These procedures must ensure that access to or removal of SNM would be detected during these periods. [See requirements for facility emergency plans in DOE O 151.1A, *Comprehensive Emergency Management System,* dated 11-1-00.]

g. For a contractor at a facility for which roll up (i.e., the accumulation of smaller quantities of SNM) to a Category I quantity is credible, the safeguards and security system must provide graded protection sufficient to ensure that the failure or defeat of a single component will not increase the level of risk for the system above an acceptable level. The vulnerability assessment process must include a determination of the extent to which the failure or defeat of a single component would increase this risk and whether the increase in risk is acceptable. When the increase in risk exceeds an acceptable level, compensatory measures must be taken immediately and upgrades to the system must be initiated. Results of the vulnerability must be provided to the DOE/NNSA field element for inclusion in the site safeguards and security plan.

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[1]Wherever field element is used in this CRD it includes operations offices, field offices, site offices, service centers, project offices and area offices.

[2]Wherever field element manager is used in this CRD it includes managers/directors of operations offices, field offices, site offices, service centers, project offices and area offices.

Table I-1. Nuclear Materials.

Material Type	SNM, Source, or Other	Reportable Quantity*	Weight Field Used for Element	Weight Field Used for Isotope	Material Type Code
Depleted Uranium (U)	source	kilogram	total U	U-235	10
Enriched Uranium[1]	SNM	gram	total U	U-235	20
Normal Uranium	source	kilogram	total U	—	81
Uranium-233	SNM	gram	total U	U-233	70
Plutonium-242[2] (Pu)	SNM	gram	total Pu	Pu-242	40
Plutonium-239-241	SNM	gram	total Pu	Pu-239 + Pu-241	50
Plutonium-238[3]	SNM	tenth of a gram	total Pu	Pu-238	83
Americium-241[4] (Am)	other	gram	total Am	Am-241	44
Americium-243[4]	other	gram	total Am	Am-243	45
Berkelium (Bk)	other	microgram	—	Bk-249	47
Californium-252 (Cf)	other	microgram	—	Cf-252	48
Curium (Cm)	other	gram	total Cm	Cm-246	46
Deuterium[5] (D)	other	tenth of a kilogram	D_2O	D_2	86
Enriched Lithium (Li)	other	kilogram	total Li	Li-6	60
Neptunium-237 (Np)	other	gram	total Np	—	82
Thorium (Th)	source	kilogram	total Th	—	88
Tritium[6] (H-3)	other	gram	total H-3	—	87

*Materials are reported to the nearest whole unit, except for Pu-238, deuterium, and tritium.

[1]Uranium in cascades is treated as enriched Uranium and should be reported as material type 89.

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

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

[4]Americium is only reportable when separated from plutonium.

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

[6]Units for reporting tritium to the Nuclear Materials Management and Safeguards System are set forth in DOE M 474.1-2, *Nuclear Materials Management and Safeguards System Reporting and Data Submission,* dated 2-10-98. If requested by the receiver, the shipper must report shipment data for tritium to 0.01 gram. Tritium contained in water (H_2O or D_2O) used as a moderator in a nuclear reactor is not an accountable material.

h. An MC&A program must be established for all nuclear materials on inventory at a site under a three-letter RIS. The DOE/NNSA field element manager or the head of the responsible DOE/NNSA Headquarters element may require that applicable nuclear material safeguards measures be maintained and/or implemented by the contractor for SNM of attractiveness level D or higher that has been removed from inventory as waste and for which a vulnerability resulting in an unacceptable level of risk has been identified. Materials previously removed from inventory are exempt from the requirements of this CRD provided they—

(1) were declared waste before November 22, 2000, the issuance date of DOE M 474.1-1A, *Manual for Control and Accountability of Nuclear Materials*;

(2) have been written off the MC&A records; and

(3) are under the control of a waste management organization.

Additionally, safeguards terminations approved before the issuance of DOE M 474.1-1B remain in effect and do not need to be reapproved.

i. Termination of safeguards exempts nuclear materials from the physical protection requirements for nuclear material [and the requirements of DOE M 474.1-1B and DOE O 474.1A]. Before safeguards can be terminated radiological sabotage risks associated with the materials must be evaluated and measures must be in place to ensure radiological protection requirements will be met after safeguards termination. After termination of safeguards, the materials will still need to be accounted for and protected per industrial security, waste management, and radiological sabotage requirements. Requirements for safeguards termination depend on the safeguard attractiveness levels of the material. Attractiveness levels are described in Table I-4. [Additional guidance on determining attractiveness levels is provided in the *Guide for Implementation of DOE 5633.3B, Control and Accountability of Nuclear Materials,* dated April 1995.]

(1) Safeguards can be terminated on nuclear materials provided the following conditions are met.

(a) The material must be attractiveness level E if it is SNM. The second column of Table I-2, contains additional and more descriptive information on lower-grade forms of SNM that can be classified as attractiveness level E for purposes of terminating safeguards and/or determining appropriate levels of safeguards protection.

(b) The material has been determined by DOE/NNSA to be of no programmatic value to DOE/NNSA.

(c) The material is transferred to the control of a waste management organization where the material is accounted for and protected as waste. The material must not be collocated with other accountable nuclear materials.

(2) In some cases, it may be necessary to dispose of nuclear materials of attractiveness level D or higher SNM. For such materials, the contractor must obtain DOE/NNSA approval before terminating safeguards. For contractor operated DOE facilities, termination of safeguards for such materials must be approved by the head of the responsible DOE program office after consultation with the Director, Office of Security. For contractor operated NNSA facilities, termination of safeguards for such materials must be approved by the Chief, Defense Nuclear Security, NNSA, after consultation with the Director, Office of Security.

When disposal of greater than a Category II quantity of SNM is being considered, the risk of theft of the material must be evaluated based on required industrial security and waste management controls. A copy of the risk assessment must be provided by the contractor through the DOE/NNSA field element manager to the responsible approving authority (i.e., the head of the DOE program office or the Chief of Defense Nuclear Security, NNSA) before approval of safeguards termination. Conditions (1)(b) and (1)(c) also apply to these materials.

j. Reduced safeguards can be applied to materials that both meet the criteria of Table I-3 and have been removed from processing material balance areas. Such materials are referred to as retained waste. Reduced safeguards and security requirements for such materials are as follows.

(1) Physical protection of retained waste must be commensurate with the safeguards category of the material defined in Table I-4.

NOTE: Protection measures against other risks, such as radiological sabotage and information security, may still be required based on results of vulnerability or risk assessments.

(2) Nuclear materials accountability information (e.g., material type, quantity, location) must remain on the site's inventory records and within the NMMSS.

(3) Measurement and physical inventory requirements for the material (identified in Table I-3) can be deferred to a time when—

(a) the material is removed from site or

(b) the material is reintroduced into a processing material balance area.

The site must provide sufficient physical control over the material to ensure that the contents of items or containers are not altered [e.g., use of tamper-indicating devices (TIDs), controls commensurate with the safeguards category level of the location, and limited personnel access].

(4) With respect to current and potential SNM-bearing inventory or byproduct materials selected for International Atomic Energy Agency (IAEA) safeguards, materials that meet the criteria in Table I-3 can be transferred to the retained waste category.

Reductions in safeguards for retained waste require the approval of the responsible DOE/NNSA field element.

k. A contractor operating a facility identified for decommissioning, closure, or deactivation is not exempt from compliance with requirements stated in this CRD [and DOE M 474.1-1B]. The contractor's MC&A program for the facility must be maintained at a level appropriate to the category and attractiveness level of the nuclear material on inventory until a termination survey determines that no nuclear material remains at the facility.

Such a determination may be made if no material remains or the only remaining material is waste that meets the definition of attractiveness level E and has been written off the MC&A books. [Requirements for termination surveys are contained in DOE O 470.1.] Before decommissioning, all nuclear material holdup must be measured and credited to the accountability books.

Unless demonstrated to be otherwise, the category of SNM in process holdup must be considered to be the category of the total SNM put into the process during its lifetime. After a contractor has transferred all its nuclear material except waste to another facility, the inventory balance is zero, and the termination survey has been completed, the contractor may still need to maintain a RIS account with NMMSS. [For such contractor facilities, transfers of nuclear material in waste to and from other RIS accounts will need to be reported to NMMSS using DOE/NRC F 741/741A, *Nuclear Material Transaction Report,* dated October 1988.]

l. When procedures, techniques, and standards promulgated by the American Society for Testing and Materials (ASTM) and the American National Standards Institute exist, they must be used to develop the basis for facility MC&A programs unless otherwise directed by DOE. Standards issued by IAEA and NRC can also be used when appropriate and when consistent with DOE regulatory goals.

2. GRADED SAFEGUARDS. The concept of graded safeguards is one of providing the greatest relative amount of control and effort to the types and quantities of SNM that can be most effectively used in a nuclear explosive device. The following paragraphs present basic information and requirements for determining nuclear safeguards categories.

a. The contractor must establish and follow a graded safeguards program for nuclear materials. Categories of nuclear material for implementation of DOE's graded safeguards program are shown in Table I-4. [Additional guidance on determining safeguards attractiveness for SNM is provided in *The Guide to Implementation of DOE 5633.3B, Control and Accountability of Nuclear Materials* (April 1995).]

b. The material category of an SNM location (e.g., material balance area, material access area, protected area, facility) must be determined to establish the required protection level. In many cases the material category is determined directly from Table I-4.

Directions for determining the material category when multiple material types and attractiveness levels must be considered are provided in the following paragraphs. When a contractor can demonstrate that the accumulation of small quantities of SNM is not credible, the summation of these quantities need not be used to define the category quantity.

Determination of category involves grouping materials by SNM type, attractiveness level, and quantity. Material quantities are element weights for plutonium and isotope weights for U-235 and U-233. Procedures for determining material category are as follows.

(1) One SNM Type, One Attractiveness Level. Sum the material in the attractiveness level and determine the category from Table I-4.

(2) One SNM Type, Multiple Attractiveness Levels (a Category III or greater quantity of B-level material included).

(a) Determine the amounts of SNM for materials in each of attractiveness levels B, C, and D.

(b) Calculate the "effective" quantity for attractiveness levels B and C by multiplying the quantity in attractiveness levels B and C by the appropriate factors in Table I-5.

(c) Sum the effective amounts in attractiveness levels B and C.

(d) Compare the total effective amount as calculated in paragraph 2b(2)(c) above to the amounts in attractiveness level B from Table I-4.

Table I-2. Attractiveness Level E Criteria for SNM.

Description/Form	Complies with DOE M 474.1-1B, Chapter I, Paragraph 1i	
	Maximum concentration* (wt%) for MC&A and physical protection termination	**Maximum SNM concentration* (wt%) for only physical protection equivalent to Category IV**
SNM solutions and oxides: nitrate, caustic or chloride solutions; contaminated/ impure oxides; metal fines and turnings; glovebox sweepings	0.1	N/A
SNM amenable to dissolution and subsequent separation: pyrochemical salts; chloride melt; hydroxide cake; floor sweepings; alumina; condensates; reduction residues; sand, slag, and crucible; magnesium oxide crucibles	0.1	0.2
SNM in organic matrixes or requiring mechanical separation disassembly and subsequent multiple recovery operations: HEPA filters, organic solutions, oils and sludges, graphite or carbon scrap, surface contaminated plastics, metal components, combustible rubber	0.2	1.0
SNM bound in matrix of solid, sintered, or agglomerated refractory materials: SNM embedded in glass or plastic, high-fired incinerator ash, spent resins, salt sludges, raffinates, and sulfides	0.5	2
SNM microencapsulated in refractory compounds or in solid-dilution: vitrified, bituminized, cemented, or polymer-encapsulated materials; SNM alloyed with refractory elements (tungsten, platinum, chromium, stainless steel); ceramic/glass salvage	1.0	(To Be Determined)

*SNM weight percent is based on element weight for plutonium and isotope weight for U-235 and U-233.

(e) Compare the amount of attractiveness level D to Table I-4.

(f) The material category is the highest level of material category determined using the procedures in paragraphs 2b(2)(a) through 2b(2)(d) or in paragraph 2b(2)(e).

(3) One SNM Type, Multiple Attractiveness Levels (less than a Category III quantity of B-level material included).

(a) Determine the amounts of SNM for all attractiveness levels.

(b) Compare the total amounts in each level to those in Table I-4.

(c) The material category level is the highest level of the material categories determined using the procedures in paragraphs 2b(3)(a) and 2b(3)(b).

(4) Multiple SNM Types.

(a) Determine the category for each SNM type following the above procedures.

(b) The category is that determined for the individual SNM type that requires the highest level of protection.

Table I-3. Technical Criteria for Retained Waste.

Description and Form	SNM Concentration Range (Wt %)*
SNM solutions and oxides	$>0.1 \leq 0.5$
SNM amenable to dissolution and subsequent separation	$>0.2 \leq 1.0$
SNM alloyed with aluminum, thorium, zirconium, spent fuel	≤ 1.0
SNM in organic matrixes; SNM requiring mechanical separation/disassembly and multiple recovery operations	$>1.0 \leq 5.0$
SNM bound in matrix of solid, sintered, or agglomerated refractory metals	$>2.0 \leq 7.5$
SNM microencapsulated in refractory compounds or in solid-dilution	$> 5.0 \leq 10.0$

*SNM weight percent is based on element weight for plutonium and isotope weight for U-235 and U-233.

Table I-4. Graded Safeguards.

	Attractiveness Level	Pu/U-233 Category (kg)				Contained U-235 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	
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	
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	
LOW-GRADE MATERIALS Solutions (1 to 25 g/L), process residues requiring extensive reprocessing, moderately irradiated material, 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	
ALL OTHER MATERIALS Highly irradiated forms, solutions (<1 g/L), uranium containing <20% U-235 or <10% U-233[2] (any form, any quantity)	E									Reportable Quantities

[1]The lower limit for Category IV is equal to reportable quantities in DOE M 474.1-1B, *Manual for Control and Accountability of Nuclear Materials,* dated 6-13-03.
[2]The 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.

Table I-5. Effective Quantities.

Attractiveness Level	Pu/U-233 Factor	U-235 Factor
B	1	1
C	1/3	1/4

3. MC&A REQUIREMENTS FOR SOURCE AND OTHER NUCLEAR MATERIALS.

a. Source and other nuclear materials listed in Table I-1 [with the exceptions of tritium, separated neptunium-237 (Np-237), and separated americium, as described in 3b and 3c below] are subject only to the following requirements.

(1) The accounting system must document inventories and material transfers at the RIS level.

(2) RIS level inventories and transactions must be reported to NMMSS. [See DOE M 474.1-2, *Nuclear Materials Management and Safeguards System Reporting and Data Submission,* dated 2-10-98.]

(3) Physical inventories must be conducted at a frequency and in a manner approved by the DOE/NNSA field element manager and must be documented in the site MC&A plan.

(4) Minimum MC&A requirements for potential substitution materials (materials that could be substituted for strategic material during physical inventories) collocated with SNM of significant strategic value are specified in Chapter II, paragraph 3a(2), of this CRD.

(5) The DOE/NNSA field element manager will determine all other MC&A requirements and document them in the site MC&A plan and transmit that information to the contractor.

b. Tritium is a nuclear material of strategic importance; therefore, graded safeguards programs for tritium must 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.

c. Separated Np-237 and americium (Am-241 and Am-243) are materials of safeguards interest. (In this context, "separated" refers to the recovered or product material generated from chemical and processing operations of the target/source material.)

(1) Separated Np-237 and americium are to be protected, controlled, and accounted for as if they were SNM.

(2) Departmental protection program strategies and graded safeguards thresholds for separated Np-237 and americium are to be identical to those for U-235. The category for these isotopes is determined using the U-235 side of Table I-4, Graded Safeguards.

4. LOSS DETECTION ELEMENT EVALUATION.

a. Vulnerability Assessment. A contractor managing a Category I facility must develop detailed vulnerability assessments for identifying and evaluating the facility capability to detect loss of a Category I quantity of SNM. The contractor must submit the vulnerability assessment to the head of the DOE/NNSA field element MC&A organization for approval before it is submitted as part of the site safeguards and security plan. The vulnerability assessment must address the same points established for preparation of the site safeguards and security plan. Vulnerability assessments must cover the full threat spectrum. [See *Design Basis Threat for Department of Energy Programs and Facilities (U)*, DOE Office of Security (1999).] Potential targets must include all Category I locations and any other areas for which a credible scenario for unauthorized accumulation of a Category I quantity of SNM has been identified.

Vulnerability assessments must be reviewed annually by the contractor and updated when system changes or new information indicates a potentially significant change in the risk of unauthorized removal of Category I quantities of SNM. Results of reviews, including changes in vulnerability assessments, must be documented by the contractor in the facility vulnerability analysis report.

b. Performance Testing. The contractor must develop a performance testing program to support and verify vulnerability assessments. [See DOE O 470.1 for additional information on requirements for the design, planning, and documentation of performance tests.]

(1) Performance tests must be designed to demonstrate that the system is functional and to ensure that the system performs as specified and/or required. In addition, the contractor must—

(a) identify those components of the MC&A system that provide the greatest effectiveness against theft and diversion;

(b) design, conduct, and document tests that substantiate component effectiveness; and

(c) integrate the results of these component tests into safeguards and security vulnerability assessments.

(2) Performance testing must include not only those elements that can detect a threat in time to prevent it, but also those elements that can effectively account for SNM to ensure that safeguards and security systems are functioning properly.

(3) Performance testing program design must focus on testing individual detection elements. Elements identified in a vulnerability assessment that contribute to detection capability must be tested on a frequency based on the level-of-threat risk established by the vulnerability assessment.

(4) The design of performance tests should consider prudent judgment and use of resources. The scope and extent of testing should be based on the graded safeguards concept; the testing program should include more testing for higher-category facilities than for lower-category facilities.

(5) Contractors must take corrective actions for findings and vulnerabilities identified during system testing.

(6) Performance testing must include testing to determine whether safeguards and security systems have failed including testing for the loss of SNM. (The capability of the accounting system to provide information about the quantity and the identifying characteristics of the potential missing material should also be tested.) Corrective action plans for systems that have failed must be developed and interim compensatory measures put in place by the contractor.

c. MC&A Performance Requirements. Table I-6 contains minimum performance requirements for the following MC&A system elements:

- access controls,
- material surveillance,
- TIDs,
- portal monitoring,
- accounting record system,
- inventory confirmation/verification measurements, and
- inventory difference control limits.

(1) The selected system elements must be validated through performance testing.

(a) A minimum frequency for testing of these elements must be established and documented in the MC&A plan.

(b) If these system elements fail to meet performance requirements, a corrective action plan must be developed by the contractor and, where necessary, compensatory measures must be taken.

(c) Access control and material surveillance testing must be facility-specific; the contractor must document the scope and the extent of the testing and obtain approval of the scope and extent from the DOE/NNSA field element manager.

(d) The accounting systems performance requirement must be verified against all items selected for physical inventory and/or transfer.

(e) Performance must be verified at least annually except for facilities whose physical inventories are conducted less than once a year. For such facilities, performance must be verified by the contractor at the same frequency as inventories are conducted.

(2) When errors in accounting records are found, they must be corrected; when more than 1 percent of the items selected are in error, corrective actions must be taken for the accounting system as a whole.

(3) To comply with the TID performance requirement, TIDs must be inspected for all items selected for physical inventory and/or transfer.

(4) Performance must be verified at least annually except for facilities whose physical inventories are conducted less than once a year. For such facilities, performance must be verified by the contractor at the same frequency as inventories are conducted.

(5) Testing to ensure TIDs are properly in place must include checking to see that the TID has been properly applied and the integrity of the TID has not been violated. Testing for this requirement is not intended to require destruction of properly applied TIDs whose integrity has not been violated. [Additional guidance for testing metal detectors is given in *Performance Assurance Program, Protection Program Supplement* (Office of Safeguards and Security, 1996).]

(6) In performance requirements for inventory differences, the term “active inventory” means the sum of additions to inventory, beginning inventory,

ending inventory, inventory adjustments, and removals from inventory, after all common terms have been excluded. (In this context, "common terms" are any material values that appear in the active inventory calculation more than once and come from the same measurement.)

(7) The DOE/NNSA field element manager may establish additional or more stringent performance requirements for system elements at his/her facilities. Other paragraphs in this CRD contain requirements that can be readily performance tested. Testing of system elements associated with these requirements should be a regular part of the performance testing program.

5. REPORTING INCIDENTS OF SECURITY CONCERN. The contractor must identify MC&A loss detection elements for each material balance area and must establish a graded program for monitoring these elements and associated data to determine the status of nuclear material inventories and to identify security incidents. Security incidents must be reported to the DOE/NNSA. [See DOE N 471.3, *Reporting Incidents of Security Concern,* dated 4-13-01.]

6. ADMINISTRATIVE CONTROLS. A contractor managing a facility with nuclear materials must establish a program to periodically review and assess the integrity and quality of its MC&A program and practices. The assessment program must address both normal operations and emergency conditions. The frequency and content of these assessments must be on a graded basis and approved by the DOE/NNSA field element manager. [See DOE O 470.1.] The results of all assessments must be reported to the contractor's management, and assessment reports that could potentially reveal sensitive information should be reviewed for classification. Each noted deficiency must be addressed and corrected. The assessment must be performed by personnel who are knowledgeable of MC&A.

Reviews must be conducted before startup of new facilities or operations and when changes occur in facilities, operations, or MC&A features that might alter the performance of the MC&A system. At a minimum, the assessment program must address the following issues.

a. Identification of abnormal situations.

b. Loss mechanisms, loss detection capabilities, and localization of inventory differences.

c. Selection, maintenance, calibration, and testing functions to ensure proper equipment and system performance.

d. MC&A system checks and balances, including separation of responsibilities and duties, used to identify irregularities and detect tampering with materials or MC&A system components.

Table I-6. Performance Requirements for MC&A Elements.

Access Controls. Performance tests must be designed and conducted to fully evaluate the effectiveness of access controls for Category I and II quantities of SNM. At least 95 percent of the tests conducted must demonstrate the detection of unauthorized access to Category I and II quantities of SNM.

Material Surveillance. Performance tests must be designed and conducted to fully evaluate the effectiveness of material surveillance activities for Category I and II quantities of SNM. At least 95 percent of the tests conducted must demonstrate the detection of unauthorized actions related to the control of Category I and II quantities of SNM.

TIDs. The tamper-indicating device (TID) record system must accurately reflect the location and identity of TIDs for at least 99 percent of the TIDs inspected. The TID program must ensure that TIDs are properly in place for at least 95 percent of the TIDs inspected.

Portal Monitoring. In addition to performance testing necessary to verify that vulnerability assessment or DOE/NNSA field element detection requirements are being met, testing of portal monitors (SNM and metal) must include all applicable tests described in ASTM guides. When standards set in applicable ASTM guides are not met, compensatory actions must be taken.

Accounting Record System. The accounting record system must accurately reflect item identity and location for at least 99 percent of items selected.

Inventory Confirmation/Verification Measurements. For Category I and II items, acceptance/rejection criteria for verification measurements and, where possible, for confirmatory measurements, must be based on the standard deviation for the measurement method under operating conditions. Control limits for such criteria must be set at no wider than three times the standard deviation for the method. The contractor must obtain DOE/NNSA field element approval of the control limits. When limits based on three standard deviations are unreasonably large, the DOE/NNSA field element manager, may require tighter limits.

Inventory Difference Control Limits. For Category I and II material balance areas, limits-of-error must not exceed 2 percent of the active inventory during the inventory period or a Category II quantity of material. For Category III and IV material balance areas, limits-of-error of inventory differences shall not exceed a specified percentage of the active inventory during the inventory period to a maximum of a specified quantity; the contractor must obtain DOE/NNSA field element manager approval of the specified percentage and maximum quantity.

e. Change controls, including authorization requirements, to detect unauthorized or inappropriate modification of system components, procedures, or data. The change control system must address requirements for review; authorization; documentation; notification; and controls on equipment selection, procurement, and maintenance.

f. Procedures or checks to ensure the reliability and accuracy of MC&A data and information.

g. Performance testing conducted by the facility. This portion of the assessment should address the design of performance tests and the results obtained by the testing program since the last assessment.

h. Procedures for emergency conditions and for periods when MC&A system components are inoperative.

i. Material containment, material access, and material surveillance procedures.

j. Physical inventory program and reconciliation practices.

k. Accounting system procedures, capabilities, and sensitivities.

l. Identification of personnel with MC&A responsibilities who should be included in the facility personnel security assurance program. [See DOE O 472.1C, *Personnel Security Activities,* dated3-25-03.]

m. Measurement control program.

n. TID programs.

In addition to the assessments described above, an organization independent of MC&A must conduct internal audits of the contractor's MC&A function to assess compliance with internal plans and procedures. The contractor must seek DOE/NNSA field element manager approval of the frequency of these audits.

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CHAPTER II. MATERIALS ACCOUNTABILITY

1. GENERAL. This chapter describes the requirements for nuclear materials accountability. These requirements must be applied in a manner consistent with the graded safeguards concept. The chapter is divided into five functional areas: accounting systems, physical inventories, measurement and measurement control, nuclear material transfers, and material control indicators.

2. ACCOUNTING SYSTEMS. The site/facility contractor must have a system for tracking nuclear material inventories; documenting nuclear material transactions; issuing periodic reports; and assisting with the detection of unauthorized system access, data falsification, and material gains or losses. The accounting system must provide a complete audit trail for all nuclear material from receipt through disposition. The contractor must use the Generally Accepted Accounting Principles promulgated by the Financial Accounting Standards Board in the design and operation of the nuclear material accounting system, unless otherwise directed.

   The site/facility nuclear materials accounting system must include checks and balances and be structured to ensure timely detection (normally within 24 hours, but in no case later than in the subsequent inventory reconciliation) of errors or discrepancies in records associated with a Category I or II quantity of SNM, including, where possible, detecting falsified data and identifying the responsible persons. The system must also be capable of detecting omissions and other data discrepancies and ensuring completeness of accounting records.

   a. Accounting Systems Database and Procedures. The contractor must maintain procedures that describe the structure and operation of the nuclear materials accounting system. The procedures must accurately reflect current nuclear material accounting practices. Specific requirements for accounting procedures include the following:

      (1) descriptions of the inventory database (including procedures for updating and reconciling inventory data with the results of physical inventories) and the required data elements for each applicable material type;

      (2) identification of the accounting reports and their frequency, distribution, and timeliness consistent with accounting requirements;

      (3) identification of the organizational responsibilities for management and operation of the accounting system; and

      (4) recording, reporting, and submitting data to the NMMSS by material type and reporting unit. [See DOE M 474.1-2.]

b. Account Structure.

(1) A facility must consist of one or more material balance areas established to identify the location and quantity of nuclear materials in the facility. The contractor must maintain readily retrievable accountability data by material balance area that reflects quantities of nuclear materials on inventory, quantities of nuclear materials received and shipped, and other adjustments to inventory.

(2) The material balance area account structure must sort data by material types, processes, and functions; provide the capability to localize inventory differences; and provide a system of checks and balances for verifying the accuracy of the accountability data and records.

(3) A material balance area boundary must not cross a materials access area boundary. Each material balance area must consist of a single geographical area and be an integral operation.

(4) Contractor management must designate an individual in each material balance area to ensure that MC&A requirements are implemented in that material balance area.

(5) The material balance area custodian is responsible for controlling nuclear material located in the material balance area, preparing and signing internal material transfer documents, and conducting and reconciling material balance area physical inventories.

(6) A material balance area custodian must not be responsible for multiple material balance areas when transfers of nuclear material occur between those material balance areas (i.e., a single custodian must not serve as both shipper and receiver for material transfers).

c. Records and Reports.

(1) The contractor must maintain records, submit data, and issue reports as required by this CRD and facility procedures. The reports must accurately describe all nuclear material transactions and inventories. Inventory adjustments must be identified by material balance area and must be reported as required in this CRD.

(2) Nuclear materials records must be updated by authorized personnel only. The records system must provide an audit trail for all transactions affecting the nuclear materials database.

(3) The material balance area records system must be capable of being updated daily or on demand for all nuclear materials transactions. (This requirement is for updating records based on reports or information; it does not pertain to how quickly a facility must be able to complete measurements.) The records system also must be capable of generating book inventory listings of all SNM within 3 hours. For all other nuclear material, the records system must be able to generate book inventories within 24 hours. The accuracy of the accounting record system must be validated according to testing methodology, testing frequency, and record maintenance requirements. [See DOE O 460.1B, *Packaging and Transportation Safety,* dated 4-4-03.] Performance requirements for accounting record system accuracy are contained in Chapter I, paragraph 4, of this CRD.

3. PHYSICAL INVENTORIES. The contractor must implement a physical inventory program for SNM that complies with the following requirements. Inventory requirements for separated Np-237 and americium are the same as for SNM.

a. Periodic Physical Inventories.

(1) Conduct of Physical Inventories. Inventories must be based on measured values, including measurements or technically justifiable estimates of holdup. Process monitoring techniques may be used for material that is undergoing processing and recovery operations and is inaccessible for measurements. The contractor must have documented plans and procedures that define responsibilities for performing inventories and specify criteria for conducting, verifying, and reconciling inventories. The contractor may use statistical sampling, based on graded safeguards, to verify the presence of items during inventories. Parameters for statistical sampling plans must be defined by the contractor and approved by the DOE/NNSA field element. The contractor must specify in its sampling plans the population, confidence level, minimum detectable defect, definition of a defect, and action to be taken if a defect is encountered.

The following are minimum sampling parameters for safeguards categories.

Category	Confidence Level	Minimum Detectable Defect
I	95 percent	3 percent
II	95 percent	5 percent
III & IV	95 percent	10 percent

The inventory population must be stratified according to item category as shown above. Separate samples must be derived for each inventory stratum.

(2) Physical Inventory Frequencies. The contractor must perform physical inventories of Category I and II material balance areas that involve activities other than processing at a frequency determined by the DOE/NNSA field element manager, but at least semiannually. The contractor's management must ensure that physical inventories are performed bimonthly in Category I and II material balance areas where processing occurs. In processing areas where process controls provide equivalent levels of theft and diversion detection, physical inventories may be performed upon completion of the material campaign.

In such cases, the contractor must seek DOE/NNSA field element manager approval of a processing plan before starting the campaign. The process plan must identify compositions and quantities of material to be processed, projected processing timetable, process control measures used, and procedures necessary for material controls during process interruptions. Other factors to be considered for frequency determination include personnel radiation exposure, the operational mode of the facility, and credible protracted diversion scenarios.

At least annually, the contractor must perform a simultaneous physical inventory of all Category I and II material balance areas for which the established inventory frequency is annual or more frequent. Material balance areas with extended inventory frequencies of greater than 1 year are excluded from this requirement.

For each facility, physical inventories for SNM must be performed for Category III and IV material balance areas at a frequency to be determined by the DOE/NNSA field element manager, but at least biennially.

Category IV source and other nuclear material in Category I and II material balance areas must be inventoried on a schedule defined by the DOE/NNSA field element manager, but at least biennially, except when the source and/or other nuclear material is a credible substitution material.

When substitution materials are collocated with SNM, contractors must inventory substitution materials with the same frequency as the SNM and use inventory measurement methods that can distinguish between SNM, source, and other nuclear material. Except for materials required to be protected as SNM and potential substitution materials collocated with SNM, source and other materials outside Category I and II material

balance areas will be inventoried at a frequency approved by the DOE/NNSA field element manager and documented in the MC&A plan.

In addition to the requirements listed above, inventory checks for Category IA items not in storage must be performed weekly for physical count verification and monthly for serial number verification. Inventory checks for stored Category IA items must consist of a physical count whenever the storage area is accessed and a serial number verification on a monthly basis.

(3) Extensions to Inventory Frequency Requirements. Extensions to inventory frequencies must be approved by the DOE/NNSA field element in accordance with the alternative inventory control provisions in Table II-1. The contractor must determine inventory values in time to complete inventory computation and reconciliation and determine inventory differences within the DOE reporting requirements specified in this CRD and approved inventory frequencies.

For Category I and II storage areas, Table II-1 may be used to determine the frequency of physical inventories based on the successful implementation of alternative inventory control measures. Inventory periods specified for each alternative measure are additive so long as the measures function independently.

Total inventory extension is equal to the summation of inventory periods for all alternative measures used, with a maximum allowable period of 5 years. Table II-1 is designed so that longest inventory extensions are given for measures that provide material attribute information. Items added to these storage areas must have appropriately measured values. If inventory extensions are granted for Category I or II storage areas other than in accordance with the provisions of Table II-1, a deviation must be submitted.

The contractor must seek the approval of the DOE/NNSA field element manager to extend inventory periods beyond 2 years, with a maximum inventory period of 5 years, for Category III and IV storage areas that have alternative inventory control measures.

(4) Physical Inventory Reconciliation Program. The contractor must implement a physical inventory reconciliation program in which the book inventory for each material balance area is compared with and, if necessary, adjusted to the physical inventory. The reconciliation must be completed within 15 calendar days following receipt of all inventory information, measurement data, and sample analyses. Any inventory differences must be identified and reported as required.

b. Special Inventories. The contractor's management must establish and implement procedures for conducting special inventories at the request of the cognizant DOE/NNSA field element or as a result of routine disassembly of critical assemblies, changes in custodial responsibilities, missing items, inventory differences exceeding established control limits, and abnormal occurrences.

c. IAEA Inventories. Physical inventories performed during IAEA inspections may, with the concurrence of the DOE/NNSA field element manager, serve in place of a scheduled physical inventory.

Table II-1. Inventory Periods Based on Alternative Measures for Category I and II Storage Locations.

Alternative Inventory Control Measures*	Inventory Periods
Formidable barriers	1 year
Hazardous environment	1 year
Bulk containment	1 year
Vault enhancement above baseline requirements	9 months
Continuous monitoring of physical or mechanical parameters	1 year
General (area-wide) confirmatory measurements	1 year
Continuous item observation (e.g., video/image, laser surveillance)	2 years
Continuous item monitoring (e.g., monitoring of serial number, TIDs, movement)	2 years
Mass (load cell)	2 years
Confirmatory measurements on individual items (e.g., thermal, gamma, or neutron emission)	3 years
Quantitative measurements on individual items	May qualify as a continuous inventory**

*When multiple measures are used for storage materials balance areas, the inventory periods are additive as long as the alternative measures function independently.

**If the measurements are both item- and material-specific and there is a level of confidence that the measurements are correct, the monitoring may qualify as a continuous physical inventory. To be considered a continuous physical inventory, automated measurements must be made on all items on a second-to-second basis.

d. Inventory Verification/Confirmation Measurements.

(1) The contractor must establish and implement a system for performing measurements as part of a physical inventory. Verification measurements must be made on SNM items that are not tamper indicating. Confirmation measurements must be made on tamper-indicating SNM items. Such measurements may use a statistically based sampling plan applied in a manner consistent with the graded safeguards concept. The contractor must develop sampling plans, which the DOE/NNSA field element manager must approve. (NOTE: These plans must be based on the defined population and must not be a subset of the sample selected for physical inventory. Separate sampling plans must be implemented for verification and confirmation measurements to ensure that a sufficient number of non-tamper-indicating items are measured.) Sampling plans must specify the population, confidence level, minimum detectable defect, definition of a defect, and action to be taken if a defect is encountered. Minimum sampling parameters for safeguards categories are as follows.

Category	Confidence Level	Minimum Detectable Defect
I	95 percent	3 percent
II	95 percent	5 percent
III & IV	95 percent	10 percent

The inventory population must be stratified according to item category as shown above. Separate samples must be derived for each stratum.

Sampling plans for performing verification and confirmation measurements may supplement physical inventories that are conducted to verify the presence of 100 percent of inventory items. After notifying the contractor, the DOE/NNSA field element manager may establish a material quantity threshold for requiring inventory verification and confirmation measurements. For materials not amenable to verification measurement, confirmatory measurements of two material attributes must be substituted for verification measurements. Materials not amenable to verification measurement must be identified and documented in the MC&A plan.

(2) The contractor must establish documented acceptance or rejection criteria for inventory confirmation and verification measurements based on valid technical and statistical principles. For Category I and II items, acceptance and rejection criteria must be consistent with the performance requirements for confirmation and verification measurements stated in

Table I-6. The contractor must prepare and implement a response plan for evaluating and resolving all verification and confirmation measurements that fail to meet acceptance criteria. Items that fail to meet confirmation or verification measurement acceptance criteria must not be processed before the discrepancy is resolved.

4. MEASUREMENT AND MEASUREMENT CONTROL. Measurement and measurement control programs must be implemented by the contractor at all facilities with nuclear material. Measurement programs used to determine Category I or II inventories of SNM or used to determine a Category I or II SNM throughput over a 6-month period must meet the requirements set forth in paragraphs 4(a) through 4(e) below, consistent with facility-specific measurement program objectives. Measurement programs used to determine Category III or IV inventories of SNM must address the topics set forth in paragraphs 4(a) through 4(e) below, but the specific measurement and measurement control requirements will be provided to the contractor by the DOE/NNSA field element. Nuclear materials not amenable to verification measurement by the site must be identified in the facility's MC&A plan. Inventory values for these materials must be based on measured values made at other sites or technically justified estimates. Justification and supporting documentation for these inventory values must be included as part of the MC&A plan.

   a. Organization. Measurement and measurement control programs must be independent from operations.

   b. Selection and Qualification of Measurement Methods. The contractor must select, qualify, and validate measurement methods capable of providing the required levels of precision and accuracy. The contractor's management is responsible for selecting and qualifying a measurement method. Target values for precision and accuracy of nuclear material measurements endorsed by recognized national and international nuclear organizations must be considered as performance goals for facility measurement systems. Alternative measurement performance goals must be defensible and documented. The contractor must seek approval for precision and accuracy requirements from the DOE/NNSA field element and document them in the MC&A plan. The contractor must have procedures to ensure that only qualified measurement methods are used for accountability purposes.

   c. Training and Qualification of Measurement Personnel. The contractor must ensure that individuals responsible for performing nuclear material measurements have sufficient knowledge to perform the measurements in an acceptable manner.

      (1) Training. The contractor must have a documented plan for training measurement personnel. The plan must be reviewed annually and updated as necessary to reflect changes in measurement technology and must specify training qualification and requalification requirements for each measurement method.

(2) Qualification. The contractor must have a documented qualification program to ensure that measurement personnel demonstrate acceptable levels of proficiency before performing measurements and that measurement personnel are requalified according to requirements in the training plan. Measurement personnel must demonstrate proficiency in destructive analysis of nuclear material at a minimum of once per day for each method they will use that day.

d. Measurement Systems. Nuclear material measurement systems must provide accurate nuclear material values for inventories and transactions.

(1) Sampling. Sampling programs must be implemented to ensure that portions of bulk material taken for measurement are representative of the bulk material. The contractor must have a documented sampling plan for each measurement point used for accountability purposes. The plans must be based on valid technical and statistical principles and must take into account material type, measurement requirements, and any special process or operational considerations.

(a) The basis for the sampling plan must be documented and validated through studies of the materials or items being sampled.

(b) The sampling plan must specify, at a minimum, the sampling procedure, number and size of required samples, mixing time and procedure (when applicable), provisions for retaining archive samples, and estimates of variance associated with the sampling method.

(c) Sampling procedures must be documented and reviewed annually or whenever changes are made to the sampling process or in material type or composition of the material being sampled.

(2) Measurement Methods. The contractor must develop, document, and maintain data on measurement methods for all nuclear material on inventory except those materials not amenable to measurement. These methods must be written to provide clear direction to the analyst or operator and must be validated initially and revalidated whenever changes are made.

(a) In determining inventory values and consistent with the graded safeguards concept, measurement methods must be selected in a manner that minimizes the contribution of measurement error to the uncertainty of the inventory difference.

(b) Verification measurements, when used to adjust accountability records, must have accuracy and precision comparable to or better than the original measurement method.

(c) The method used for confirmatory measurements must be capable of determining the presence or absence of a specific attribute of the material, consistent with valid acceptance and rejection criteria.

(d) All measurement methods must be calibrated using standard or certified reference materials or secondary standards traceable to the national measurement base and must be revalidated as necessary.

(e) Measurement equipment and instruments must meet precision and accuracy requirements under in-plant conditions.

(f) Documentation of measurement data must be maintained to provide an audit trail from source data to accounting records.

e. Measurement Control Programs. The contractor must develop and implement control programs for all measurement systems used for accountability purposes. Control programs must ensure the effectiveness of measurement systems and the quality of measured values used for accountability purposes. Control programs must also produce precision and accuracy values for use in determining inventory difference control limits and shipper/receiver limits of error. A measurement control program, as referred to herein, must include, at a minimum, the following elements.

(1) Scales and Balances Program. All scales and balances used for accountability purposes must be maintained in good working condition, recalibrated according to an established schedule, and checked for accuracy and linearity on each day that the scale or balance is used for accountability purposes.

(2) Analytical Quality Control. Data from routine measurements must be analyzed statistically to determine and ensure accuracy and precision of the measurements.

(3) Sampling Variability. The uncertainty associated with each sampling method, or combination of sampling and measurement methods, must be determined and maintained on a current basis.

(4) Physical Measurement Control. The precision and accuracy of volume, temperature, pressure, and density measurements must be determined and ensured.

(5) Instrument Calibration. Instruments must be calibrated using appropriate standards, when available. At a minimum, measurement values must be compared with more accurate measurement system values on a prescribed basis; the frequency is defined by demonstrated instrument performance.

(6) Reference Materials (Standards). All calibration and working standards used in a measurement control program must be traceable to the national measurement base through the use of standard reference materials or certified reference materials and must have smaller uncertainties associated with their reference values than the uncertainties of the measurement method in which they are used. Working standards used in a measurement control program must be representative of the type and composition of the material being measured when the material matrix affects the measured values.

(7) Sample Exchange Programs. The contractor's measurement control program must include participation in appropriate interlaboratory control programs to provide independent verification of internal analytical quality control.

(8) Statistical Controls. For each measurement method used for accountability purposes, control limits must be calculated and monitored and documented procedures must exist to correct out-of-limits conditions. Control limits must be established at the two-Sigma level (warning limits) and three-Sigma level (alarm limits). Control data exceeding the two-Sigma limits must be investigated, and when warranted, timely corrective action must be taken. If a single data point exceeds the three-Sigma level, the measurement system in question must not be used for an accountability measurement until the measurement system has been demonstrated to be within statistical control. For measurement methods relying substantially on operator technique, control limits must include uncertainties for each analyst/method combination. Statistical control limits must be monitored to ensure that they are consistent with target values approved by the DOE/NNSA field element manager.

(9) Measurement Method Qualification. The contractor must have a documented method qualification program to ensure its measurement method demonstrates acceptable performance before being used for accountability measurements. For destructive analysis and nondestructive assay of nuclear material, performance must be demonstrated at least once per day for each method being used. For nondestructive analysis measurement systems for which meeting this requirement is impractical or unnecessary, the control measurement frequency must be at least one of every five measurements unless otherwise approved by the DOE/NNSA field element manager.

(10) Measurement Control Procedures. The contractor must develop documented measurement control procedures for all measurement methods used for accountability. The facility contractor must have a program to ensure that measurement control procedures are followed.

(11) Statistical Programs. The facility contractor must have a documented program for the statistical evaluation of measurement data for determining control limits and precision and accuracy levels for each measurement system used for accountability. The program must ensure the quality of measurement and measurement control data and provide estimates of uncertainty on inventory and inventory control statements.

The statistical program, at a minimum, must contain the following elements:

(a) valid statistical techniques to determine the total random error and the measurement biases generated for each measurement system or sampling/measurement system and to determine control limits, rejection limits, and outlier criteria;

(b) a valid statistical technique to develop sampling plans for inventory and measurement of nuclear material;

(c) analysis of measurement control data and reporting to the responsible organization at specified times and frequencies; and

(d) documentation of all major assumptions made in each data evaluation process.

5. NUCLEAR MATERIAL TRANSFERS. The contractor must have a program to control and account for both internal and external facility transfers of nuclear materials. This program must include documented procedures that specify requirements for authorization, documentation, tracking, verification, and response to abnormal situations that may occur during transfer of nuclear materials. [See DOE M 474.1-2 for directions on preparing and submitting DOE/NRC F 741/741A and DOE forms required for documenting external transfers for materials accounting purposes.] The requirements for shippers and receivers in paragraph 5a below apply to the contractor when the contractor acts as shipper and/or receiver for nuclear material.

a. External Transfers.

(1) The shipper must obtain written verification and maintain documentation that the intended receiver is authorized to accept the material before the material is transferred.

(2) Transfers of nuclear material between facilities having different RISs must be documented on DOE/NRC F 741/741A by the contractor. These forms must be prepared and distributed to the principals of the transaction and the cognizant DOE/NNSA field element, preferably on the day of the transfer but within 24 hours or on the first workday after the transfer if it occurs on a nonworkday. (DOE/NNSA field element managers may direct DOE contractors to discontinue routine distribution of DOE/NRC F 741/741A to their offices.)

(3) Immediately after receipt, shipments must be subjected to a transfer check. Transfer checks must consist of confirmation of shipping container or item count, validation of TID integrity and identification (if applied), and comparison with shipping documentation to ensure the shipment was received intact. For external transfers, all SNM containers must be tamper indicating. For purposes of transfer checks, receipt occurs when the transfer vehicle is unloaded or the transfer vehicle's integrity is breached (TIDs removed or broken) at the receiving facility. The contractor must have documented procedures that specify actions to be taken in the event discrepancies are detected. Records of transfer checks are subject to audit and must be retained at least until the next annual DOE safeguards survey. (For accountability purposes, material in transit at the end of a reporting period must be included in the receiver's reported inventory even though physical receipt of the material has not yet occurred.)

(4) For all unirradiated Category I and II quantities of SNM transferred between facilities having different RISs, the receiver must perform a verification or accountability measurement except when the RISs are both located on the same site and have the same site contractors. Accountability measurements differ from verification measurements in that accountability measurements are entered into the receiver's accountability records, whereas for verification measurements the shipper's values are entered into the receiver's accountability records. Transfer of nuclear material produced to program specification and intrinsically tamper-indicating may be verified by performing a confirmatory measurement rather than a verification/accountability measurement unless the DOE/NNSA field element manager requires verification/accountability measurements.

Use of confirmatory measurements in lieu of verification/accountability measurements for such items requires a shipper/receiver agreement approved by both the shipper's and receiver's DOE/NNSA field element manager.

For Category III and IV transfers, the DOE/NNSA field element manager may require that measurements be made consistent with the strategic,

nonproliferation, and/or monetary value of the material or as required for environmental, safety, and operational controls. Material received must not be put into the process until the required verification/accountability measurements have been completed unless a deviation is approved or the criteria defined in paragraph 5a(4)(f) apply.

When verification/accountability measurements are required and materials are to be put in the process before the verification/accountability measurements have been made, an agreement should be reached between the shipper and receiver as to how significant shipper/receiver differences will be handled.

(a) The shipper must independently determine the measured values before shipment unless the integrity of the item and of the existing measured values have been ensured. The shipper's measured values must be documented on DOE/NRC F 741 and DOE/NRC F 741A, if applicable.

(b) The receiver's confirmation and verification/accountability measurements (when required) for Category I and II quantities of SNM transfers must be accomplished in accordance with the requirements in Table II-2. The receiver's verification/ accountability measurements for transfers involving other categories of nuclear material, when required by the DOE/NNSA field element manager [see paragraph 5a(4)], must be performed in accordance with the requirements in Table II-2. The DOE/NNSA field element manager may require that precision and accuracy goals be met for measurement of shipments and receipts. If the receiver's verification/accountability measurements cannot be accomplished consistent with requirements in Table II-2, the confirmatory measurements outlined in paragraph 5a(4)(e) apply.

(c) For shipment of unirradiated SNM containing greater than 250 grams of a single SNM type and for each discrete item exceeding 250 grams, limits of error at the 95 percent confidence level must be assigned to shipper and receiver accountability/ verification measurements for both the element and isotope values. Limits of error need not be reflected on the DOE/NRC F 741/741A for external transfers for which accountability measurements cannot be performed. For other shipments, the shipper and receiver may estimate the limits of error. Limits of error are also required for all measurements of external transfers of tritium that exceed 2 grams except as noted above.

Table II-2. Shipper/Receiver Measurement Requirements.

Material Category and Attractiveness Level	Material[1] Confirmation	Verification/Accountability[2] 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 statistical bases within 180 days or on input to process

[1]Confirmatory measurement by nondestructive analysis, gross weight check, and item count (if not done as part of transfer checks). Confirmatory measurements are not required for all materials. When confirmatory measurements are required, they must be performed within the time frames of this table.

[2]Quantitative determination of material quantities (within designated measurement uncertainty limits). Accountability measurement values are entered into receiver's accountability records. For verification measurements, the shipper's values are entered into the receiver's accountability records. Verification/accountability measurements are not required for all materials. When verification/accountability measurements are required, they must be performed within the time frames of this table.

(d) Documented acceptance/rejection criteria must be established and used to evaluate confirmatory measurement data. A response plan for investigation and resolution of confirmatory measurements that fail acceptance criteria must be developed and implemented; all outliers must be investigated and resolved.

(e) If delays in completing the receiver's verification/accountability measurement will result in a protracted delay in closure of the transaction, a confirmatory measurement may be used to effect a "safeguards closure" of the transaction. The transaction is documented by an "A-S" entry on DOE/NRC F 741 and DOE/NRC F 741A, if required [see DOE M 474.1-2]. A safeguards closure may be used when the integrity of the shipment is ensured and only verification/accountability measurement differences are possible between shipper and receiver. If the receiver's verification/ accountability measurement performed after a safeguards closure indicates a shipper/receiver difference, the difference may be resolved by mutual agreement of the shipper's and receiver's DOE/NNSA field element managers and

an adjustment (correcting entry) to the DOE/NRC F 741 and/or DOE/NRC F 741A, if required.

The safeguards closure may be applied only when all of the following conditions have been met.

1 No discrepancies are found in the verification of the piece count, identification number, and integrity of the TIDs and gross weight of the items or containers received, and there is no evidence indicating theft or diversion of the material.

2 The shipper's and receiver's confirmation measurements measure the same nuclear material attribute; the results of the methods can be compared on a technically valid basis, and the results of the measurements are within the established limits of agreement.

3 A shipper/receiver agreement establishing the criteria for closing transactions based on confirmatory measurements, approved by both the shipper's and receiver's DOE/NNSA field element manager, is in effect for the transaction.

(f) Limited processing is acceptable for materials not amenable to nondestructive assay in order to perform a receipt measurement, as approved by both the shipper's and receiver's DOE/NNSA field element managers. Limited processing can include homogenization and dissolution.

(5) SNM in foreign reactor fuel returns must either be measured or the risk of diversion of material from the fuel must be documented, and the contractor must seek DOE/NNSA approval by the responsible Under Secretary, or his/her designee, through the appropriate chain of command, for the acceptance of the fuel without measurement.

b. Internal Transfers.

(1) The contractor must provide a graded system of measurements and records to reflect the flow of material between material balance areas within that facility and between it and other facilities on the same site

(2) The contractor's facility control system must be designed to monitor transfer activities and to deter and detect unauthorized removal of material during transfers. It should flag abnormal situations (e.g., inappropriate transfers of quantities or materials or unauthorized personnel receiving or shipping materials).

(3) Transfers must be documented on nuclear material transfer forms or electronic equivalents that contain required information, prepared and distributed within established time frames, and signed by authorized custodians or their alternates.

(4) Materials must be subjected to a transfer check within 1 workday after receipt. These checks must include verification of shipping container or item count, TID integrity (if applied), and identification number. These transfer checks must be compared with appropriate documentation. Irradiated SNM requires only a transfer check.

(5) If the isotope content of SNM (excluding uranium enriched below 20 percent U-235 or below 10 percent U-233) transferred between material balance areas is 50 grams (fissile) or more, the material must be transferred on a measured value. Approval of confirmation/verification measurement requirements for internal transfers must be obtained by the contractor from the DOE/NNSA field element, including when measurements are not required.

(6) The contractor must establish and use document acceptance/rejection criteria to evaluate measurement data for internal material transfers. In addition, procedures must specify notification and response requirements if nuclear material removal or another abnormal situation is detected. [See DOE N 471.3.]

6. MATERIAL CONTROL INDICATORS. The contractor must implement a program to assess the material control indicators described below and to ensure detection of losses and unauthorized removals of nuclear materials. The contractor also must have documented plans that specify responsibilities and procedures for evaluating material control indicators. The requirements for shippers and receivers in paragraph 6a, below, apply to the contractor when the contractor acts as shipper and/or receiver for nuclear material.

a. Shipper/Receiver Difference Assessment. The contractor must have written procedures for evaluating shipper/receiver differences and for investigating and reporting significant shipper/receiver differences.

(1) A shipper/receiver difference is defined to be significant when it meets the following criteria.

(a) It involves a discrepancy in the number of items, regardless of the quantity of nuclear material.

(b) It is statistically significant. (Determination of whether shipper/receiver difference is statistically significant is only

required for those shipments for which verification/accountability measurements are made by both the shipper and receiver.) A shipper/receiver difference is defined to be statistically significant when the magnitude of the difference exceeds either of the following:

1 the limit obtained by a statistical combination of the valid limits of error for the shipper and receiver's measured values

or

2 the square root of 2 (approximately 1.4) times a single valid limit of error when either the shipper's or receiver's limit of error is not valid. (When both shipper's and receiver's limits of error are determined not to be valid, the limits of error must be recalculated and the statistical significance of the shipper/receiver difference must be reevaluated.)

(2) Shipper/receiver difference data must be subjected to trend analysis to detect measurement bias or material loss. Analyses must be designed to detect statistically significant cumulative shipper/receiver differences and to trigger investigations when these differences are detected.

(3) The receiver must notify its DOE/NNSA field element and the shipper of any shipper/receiver difference determined to be significant. Both shipper and receiver must investigate their measurements and limits of error. Such investigations must be completed as required by the MC&A plan. [See also DOE N 471.3] All investigations must be documented.

(4) Significant shipper/receiver differences involving a discrepancy in number of items must be reported. [See DOE N 471.3.]

(5) When shipper/receiver differences are determined to be statistically significant, but the quantities and strategic or monetary values are insufficient to warrant an investigation and subsequent correction to transfer documents, and when the receiver is DOE or one of its contractors or subcontractors, the difference need not be investigated and each party must record its own quantitative value. In the context of this paragraph, differences of less than 50 grams fissile or less than 5 grams of tritium are considered to be insufficient to require an investigation unless there are special circumstances. Authority to invoke the stipulations of this paragraph rests mutually with the shipper's and receiver's DOE/NNSA field element managers.

(6) Statistically significant shipper/receiver differences may be resolved through any of the following methods.

(a) If both the shipper's and receiver's DOE/NNSA field elements obtain adequate assurance that the measurements and limits of error are valid, and the investigation indicates that theft or diversion has not occurred, the shipper and receiver must record their own quantitative values.

or

(b) If either the shipper or receiver agrees to accept the other's value, the shipper or receiver must prepare a corrected copy of the shipping document using the other's data.

or

(c) If the investigation does not result in a satisfactory resolution, the shipper and receiver must resolve the difference through arbitration.

(7) The receiving facility contractor must not process SNM contained in a shipment involving an unresolved significant shipper/receiver difference unless a shipper/receiver agreement allowing this has been approved by both the shipper's and receiver's DOE/NNSA field element managers.

b. Inventory Difference Evaluation.

(1) The contractor must have a documented program for evaluating all SNM inventory differences, including those involving missing items. Programs for evaluation of inventory differences for other nuclear materials may be established at the option of the DOE/NNSA field element. The contractor must have procedures for establishing control limits and requiring investigation when those limits are exceeded. All inventory differences that exceed control limits must be reported. [See DOE N 471.3, DOE M 474.1-1B, and DOE O 474.1A.] Assessments of inventory differences must include statistical tests (e.g., tests of trends and biases) and must be applied, as appropriate, to both total inventory difference and actual inventory difference on both an individual and a cumulative basis for each processing material balance area.

(2) Procedures for establishing control limits for inventory differences of SNM must be based on variance propagation using current data. The data should reflect operating conditions for the material balance period of the inventory. Other methodologies may be used but they must be approved

by the DOE/NNSA field element manager and must be justified based on factors such as limited data, low transfer rates, and/or material category. For Category IV material balance areas, control limits may be based on professional judgement with the approval of the DOE/NNSA field element. Significant differences between historical limits and limits based on variance propagation must be investigated for the purpose of validating, revising, and refining the variance propagation model.

(3) The contractor must have documented procedures for responding to and reporting missing items and inventory differences in excess of control limits. The reporting and investigation of inventory differences must be consistent with the requirements specified in Chapter I, paragraph 5, of this CRD.

c. Evaluation of Other Inventory Adjustments.

(1) The contractor must establish a documented program for evaluating all inventory adjustments entered in the accounting records. The program must have written procedures, including equations for applying radioactive decay and fission transmutation adjustments. A program for holdup adjustments must be justified on the basis of measurements or other factors. The contractor must outline procedures for the statistical review of inventory adjustments using techniques such as tests of trends, biases, and correlation.

(2) The contractor must implement procedures to ensure that all inventory adjustments are supported by measured values or other technically justifiable bases. The program must include procedures for measuring and monitoring environmental waste such as stack effluent and liquid waste streams as required by environmental protection program directives and regulations.

(3) The contractor must establish procedures for reporting reviews of inventory adjustments, including abnormal situations, to the DOE/NNSA field element.

CHAPTER III. MATERIALS CONTROL

1. GENERAL. This chapter describes the requirements for nuclear material control, consisting of four functional areas: access controls, material surveillance, material containment, and detection/assessment. The contractor must formally document the graded nuclear materials control program in the MC&A plan. [Requirements for the control of SNM are stated in both DOE M 473.1-1, *Physical Protection Program Manual,* dated 12-23-02, and DOE M 474.1-1B. Some requirements are in one directive, but not both.] When the contractor is precluded from performing physical inventories as required by this CRD, material control and protection features must be enhanced to ensure inventory integrity.

2. ACCESS CONTROLS. The contractor must have a graded program for controlling personnel access to nuclear materials; nuclear materials accountability, inventory, and measurement data; data-generating equipment; and other items/equipment of which misuse could compromise the safeguards system. A contractor that has multiple Category III and IV locations containing attractiveness level B and C material outside a protected area must ensure that these areas do not contain a total inventory of Category II or greater quantity of SNM unless a vulnerability assessment demonstrates that an unauthorized accumulation of a Category I quantity of material from these facilities is not credible. The contractor must incorporate personnel security assurance programs as a component in the prevention of SNM theft or diversion. Personnel security assurance programs also must be considered in assessments of vulnerabilities related to theft of Category I quantities of SNM. The contractor must test access control systems and procedures. [See DOE O 470.1.]

   a. Materials Access. The contractor must have a documented program to ensure that only properly authorized personnel have access to nuclear materials. This program must address procedures and mechanisms to detect and respond to access by unauthorized personnel. To minimize the potential for unauthorized access to nuclear material, the amount of material in use must be limited to that necessary for operational requirements, and excess material must be stored in repositories or kept in enclosures designed to ensure that access will be limited to authorized individuals. [See Table II-1 in this CRD; DOE O 473.1, *Physical Protection Program,* dated 12-23-02; and DOE O 472.1C, Attachment 13, for additional access control and storage requirements for SNM. See DOE M 473.1-1 for access authorization requirements for SNM categories.]

   b. Data Access. The contractor must have a graded program to ensure that only authorized persons have the ability to enter, change, or access MC&A data and information.

   c. Equipment Access. The contractor must have a graded program to control access to data-generating and other equipment used in material control activities. Such equipment includes measurement equipment, data-recording devices, and TIDs.

d. Other Considerations. Access control programs similar to those described in paragraphs 2b and 2c above must protect against data and equipment falsification or manipulation and must detect unauthorized activities during emergency or other unusual conditions.

e. Unclassified Computer Systems. Where MC&A data and data-generating equipment involve unclassified computer systems, these systems must meet unclassified cyber security requirements. [See DOE O 205.1, *Department of Energy Cyber Security Management Program,* dated 3-21-03.]

3. MATERIAL SURVEILLANCE. The contractor must establish a graded nuclear materials surveillance program capable of detecting unauthorized activities or anomalous conditions and reporting material status. The surveillance program must address both normal and emergency conditions and must provide for periodic testing. The contractor must plan and document testing for material surveillance systems and procedures. [See DOE O 470.1.]

a. Material Surveillance Mechanisms. Material surveillance methodologies must consist of either automated means (e.g., monitoring devices, sensors, or other instrumentation), visual surveillance/direct observation (e.g., two-person rule, monitoring by external personnel), or other alternative safeguards measures that provide the necessary detection. In the case of direct observation, the observer must have the means to recognize, correctly assess, and report activities that are unauthorized or inconsistent with established safeguards requirements. Inventory records, process logs (where available), or other information may also be used to detect anomalies and trigger investigations.

b. Material Surveillance Programs. Surveillance procedures must describe the methodologies and operational/control points on which the program is based and must provide for investigation, notification, and reporting of anomalies.

(1) Category I and II. Material surveillance programs for Category I and II quantities of SNM must ensure that materials are in authorized locations and that they detect unauthorized material flows and transfers. Category I locations must be evaluated to determine the ability of the system to assess material losses from material access area and protected area boundaries. Category II locations must be evaluated to determine the ability of the system to assess material losses from the protected area boundary.

Material surveillance programs for all areas containing Category I or II quantities of SNM must include the following.

(a) Only appropriately authorized and knowledgeable personnel (i.e., individuals who are capable of detecting incorrect or unauthorized actions) must be assigned responsibility for surveillance of SNM.

(b) Controls must be sufficient to ensure that one lone individual cannot gain access to a secure storage area.

(c) All persons in secure storage areas must be under constant surveillance (e.g., two-person rule or equivalent surveillance) at any time the storage area is not locked and protected by an active alarm system.

(d) Surveillance must be sufficient to ensure that unauthorized or unaccompanied authorized personnel cannot enter the storage area undetected when the door is unlocked or open.

(e) When two persons are assigned responsibility for maintaining direct control of items outside an alarmed storage area within a materials access area or protected area, either the two authorized persons must be physically located where they have an unobstructed view of the items and can positively detect unauthorized or incorrect procedures or there must be a system of hardware, procedures, and administrative controls sufficient to ensure no unauthorized accumulation of a Category I quantity without timely detection.

(f) SNM in use or process must be under material surveillance, under alarm protection, or (with the approval of the DOE/NNSA field element manager) protected by alternative means that can be demonstrated to provide equivalent protection.

(2) Category III. The material surveillance program for Category III quantities must ensure that when materials are not in locked storage, they are attended, are in authorized locations, and are not accessed by unauthorized persons.

(3) Category IV. The material surveillance program for Category IV quantities must be site-specific and the contractor must seek approval from the DOE/NNSA field element manager.

4. MATERIAL CONTAINMENT. The contractor must have a documented program to provide controls for nuclear materials operations relative to materials access areas, protected areas, material balance areas, other authorized storage repositories, and processing areas.

a. Material Access Area and Protected Area. The contractor must have controls to ensure that Category I quantities of SNM are used, processed, or stored only within a material access area contained in a protected area and that Category II

quantities of SNM are used, processed, or stored only within a protected area. The containment program must—

(1) identify authorized activities and locations for nuclear materials;

(2) identify mechanisms used to detect unauthorized activities;

(3) identify material types, forms, and amounts authorized to be removed from the materials access area or protected area;

(4) identify containment controls for normal and emergency conditions; and

(5) require a periodic audit of the containment program to ensure compliance and system effectiveness.

b. Material Balance Area. The contractor must have controls to ensure that nuclear materials are used, processed, or stored within a material balance area and are controlled in accordance with the graded safeguards concept. These controls must ensure that materials are removed only through authorized pathways or portals and are subject to the transfer and verification procedures identified in Chapter II, paragraph 5, of this CRD. Controls for material balance areas must—

(1) be formally documented;

(2) identify geographical boundaries and functions of the material balance areas;

(3) identify material types, forms, and quantities permitted in each material balance area;

(4) describe administrative controls for each material balance area;

(5) define custodial responsibilities for nuclear materials contained within a material balance area;

(6) identify personnel authorized to receive or ship nuclear material;

(7) identify material flow into and out of the material balance area;

(8) ensure that material transfer procedures are followed; and

(9) ensure that material quantities transferred across material balance area boundaries are based on measured values consistent with Chapter II, paragraph 5b(5).

c. Storage Repositories. The contractor must comply with requirements for controls on storage repositories. [See DOE M 473.1-1.]

d. Processing Areas. The contractor must have controls for nuclear materials being used or stored in processing areas. The controls for in-process areas must—

(1) describe activities and locations for storing material,

(2) identify components used to detect unauthorized activities or conditions,

(3) include procedures for moving material into or out of the processing area,

(4) describe control procedures for normal and emergency conditions and for maintenance activities,

(5) describe response actions to be taken in abnormal situations, and

(6) provide for audit of the processing controls on a periodic basis to ensure system effectiveness.

5. DETECTION/ASSESSMENT. The contractor must have the capability to detect and assess the unauthorized removal of nuclear materials, consistent with the graded safeguards concept. The system must be interfaced with the contractor's physical protection and other organizational systems, as appropriate, and must be able to detect removal of SNM from its authorized location (theft/diversion/errors) and notify the protective force and other organizations to respond when such events are detected.

a. TIDs. The contractor must have a documented program, administered by the MC&A organization, to control TIDs and ensure that TIDs are used to the extent possible to detect violations of container integrity. Testing of TID integrity, location, and application and the TID record system must be conducted. The TID control program must specify, as a minimum, the following elements:

(1) acquisition/procurement/destruction,

(2) types of TIDs used,

(3) unique TID identification,

(4) storage,

(5) issuance,

(6) personnel authorized to apply, remove, and dispose of TIDs,

(7) containers on which TIDs are to be applied,

(8) procedures for application of TIDs,

(9) frequency and method of TIDs verification,

(10) response procedures for TIDs violations,

(11) assurance that TIDs cannot be reused after violation,

(12) frequency and method of internal program audits,

(13) procedures for reporting TID violations, and

(14) DOE/NNSA field element-approved list of all containers considered to be intrinsically tamper indicating.

b. Portal Monitoring. Detection levels for portal monitors must be based upon detection of the typical SNM product in the area and the credible number of removals associated with theft of a Category I quantity of material. All detectors and related calibration standards must be maintained and controlled to ensure portal monitors are capable of meeting detection requirements. [Additional portal monitoring requirements set forth in DOE M 473.1-1.] Periodic performance testing of portal monitors must be conducted in accordance with Chapter I, paragraph 4b, of this CRD. Performance testing must meet planning and documentation requirements. [See DOE O 470.1, Chapter II.] Performance requirements for portal monitors (both SNM and metal) are contained in Chapter I, paragraph 4b. Controls must be established to prevent unauthorized access to portal monitor instrumentation and cabling. A written response plan must be prepared and implemented to provide evaluation and resolution of all alarm conditions, including notification in the event of unresolved alarms or malevolent actions. [See DOE N 471.3.] Controls must be established to ensure detection capabilities during emergency conditions.

c. Waste Monitors.

(1) All liquid, solid, and gaseous waste streams leaving a materials access area must be monitored to detect the theft or diversion of SNM. Facility waste-monitoring equipment must be maintained and controlled to ensure that the equipment is capable of detecting specified amounts of SNM. Instrumentation used to monitor waste and equipment removed from a materials access area must be able to detect, in combination with other detection elements, the removal of a Category I quantity of SNM through a credible theft or diversion scenario.

(2) The contractor must establish and implement a response plan for evaluating and resolving situations involving any discharge exceeding facility-specific limits. The plan, which must be approved by the DOE/NNSA field element manager, must include procedures for reporting

in accordance with the requirements contained in Chapter I, paragraph 5, of this CRD if the situation is not satisfactorily resolved or if there is an indication of malevolent action. [See also DOE N 471.3.]

d. Daily Administrative Checks. A contractor's facility-specific daily administrative checks program must be implemented for each Category I material balance area (or multiple material balance areas where roll up to a Category I quantity of SNM is credible). The DOE/NNSA field element manager must determine and approve the scope and extent of the checks on the basis of recognized vulnerabilities. The administrative checks program must specify the detection objectives, performance procedures, documentation requirements, and response actions.

e. Other Detection/Assessment Mechanisms. The contractor must establish systems capable of detecting and/or assessing SNM removals consistent with the loss detection elements evaluation requirements of this CRD. These monitoring and control systems must provide sufficient information to correctly assess the alarm, localize the removal, and estimate the quantity and form of the diverted or stolen material.

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