MATERIAL CONTROL AND ACCOUNTABILITY

Assessment Guide

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Office of Cyber and Security Assessments
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MATERIAL CONTROL & ACCOUNTABILITY ASSESSMENT GUIDE

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Acronyms

ANSI	American National Standards Institute	FA	Facility Attachment
ASTM	American Society for Testing and Materials	FNMCP	Fundamental Nuclear Material Control Plan
AWCC	Active Well Coincidence Counters	GAAP	Generally Accepted Accounting Principles
CCTV	Closed Circuit Television		
CFR	Code of Federal Regulations	GSP	Graded Security Protection
CMPC	Classified Matter Protection and Control	GUM	Guide to the Uncertainty of Measurement
COMPASS	Comprehensive Analyses of Safeguards Strategies	HRP	Human Reliability Program
		IAEA	International Atomic Energy Agency
D&D	Decontamination and Decommissioning	ID	Inventory Difference
		IRA	Internal Review and Assessment
DA	Destructive Analysis	ISO	International Standards Organization
DAC	Daily Administrative Check	ITV	International Target Value
DOE	U.S. Department of Energy	LANMAS	Local Area Nuclear Material Accounting System
EA	Office of Enterprise Assessments		

Acronyms *continued*

LE	Limit of Error
LEID	Limit of Error of the Inventory Difference
LNPT	Limited-Notice Performance Test
MAA	Material Access Area
MBA	Material Balance Area
MBR	Material Balance Report
MC&A	Material Control and Accountability
NBL	New Brunswick Laboratory
NDA	Non-Destructive Assay
NIST	National Institute of Standards and Technology
NMIS	Nuclear Materials Identification System
NMMSS	Nuclear Material Management and Safeguards System
NNSA	National Nuclear Security Administration
NOL	Normal Operating Loss
NPT	Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NTC	National Training Center
NUREG	NRC Regulatory Guide
ODFSA	Officially Designated Federal Security Authority
OJT	On-the-Job Training
OPSEC	Operations Security
PA	Protected Area
PF	Protective Force
PPM	Protection Program Management
PSS	Physical Security Systems
RIS	Reporting Identification Symbol
RSRT	Radiological Source Registry and Tracking
SNAP	Shielded Neutron Assay Probe
SNM	Special Nuclear Material
SPO	Security Police Officer
S/R	Shipper/Receiver
SSP	Site Security Plan
TAG	Technical Advisory Group
TGS	Tomographic Gamma Scanner
TID	Tamper-Indicating Device
TMAA	Temporary Material Access Area
TSCM	Technical Surveillance Countermeasures
VA	Vulnerability Assessment

Definitions

ACCESS

a. The knowledge, use, or possession of classified or other sensitive information required by an individual to perform official duties that is provided to the individual on a need-to-know basis.
b. The ability and opportunity to obtain knowledge of classified information.
c. Situations that may provide an individual proximity to or control over special nuclear material.
d. The proximity to a nuclear weapon and/or special nuclear material in such a manner as to allow the opportunity to divert, steal, tamper with and/or damage the weapon or material.
e. Ability and means to communicate with (i.e., input to or receive output from), or otherwise make use of any information, resource, or component in a Classified Automated Information System.
f. Ability to enter a defined area.

ACCESS AUTHORIZATION

An administrative determination that an individual is eligible for access to classified matter or is eligible for access to, or control over, special nuclear material.

ACCESS CONTROL

a. The process of permitting authorized access or denying unauthorized access to information, facilities, nuclear materials, resources or designated security areas through information security, physical protection, nuclear materials control, personnel security, communications security, technical security, operations security, and/or other programs, procedures, and means.

Definitions *continued*

b. The process of limiting access to information or to resources on a Classified Automated Information System only to authorized users.

ACCESS CONTROL MEASURES
Hardware and software features, physical controls, operating procedures, administrative procedures, and various combinations of these designed to detect or prevent unauthorized access to classified information, special nuclear materials, Government property, Automated Information Systems, facilities, or materials, or areas containing the above, and to enforce utilization of these measures to protect DOE security and property interests.

ACCOUNTABILITY MEASUREMENT
A quantitative measurement of the amount of nuclear material in an item or location made to establish initial book values for the material or to replace the existing book value with a more recent measured value.

ACCURACY
a. Measure of the agreement between the true value and the measured value. (DOE)
b. Closeness of agreement between the result of a measurement and a true value of the measure. (ISO [International Standards Organization]/TAG [Technical Advisory Group])

ADJUSTMENT
An entry into the nuclear material accounting records to reflect an approved, justified, and documented change.

ADMINISTRATIVE CHECK
A review to determine that no irregularities appear to exist, no items are obviously missing, and no tampering is indicated.

ALARM LIMIT
A control limit established for an inventory difference which, when exceeded, requires immediate action and reporting. (Alarm limits are generally established at the 99 percent confidence level.)

APPARENT LOSS
The inability to physically locate or otherwise to account for any of the following:
a. Any identifiable or discrete item (e.g., batch, lot, or piece) containing nuclear material.
b. A nuclear material inventory difference in which the book inventory is larger than the physical inventory by an amount in excess of the established alarm limit.
c. A shipper/receiver difference involving a discrepancy in which fewer items were received than were shipped.
d. A shipper/receiver difference whose magnitude exceeds the combined limit of error for the shipment and for which the receiver measures less material than the shipper.

ASSESSMENT
a. An evaluation of the effectiveness of an activity/operation or a determination of the extent of compliance with required procedures and practices.
b. An evaluation of a Material Control and Accountability anomaly or Material Discrepancy Indicator (Material Control Indicators).
c. An appraisal of the credibility, reliability, pertinence, accuracy, or usefulness of information.
d. An evaluation of a physical security alarm.
e. A determination of the validity and priority of an incident.

Definitions *continued*

ASSESSOR
A qualified DOE employee or DOE contractor responsible for assessing, evaluating, and rating a safeguards and security program.

ATTRACTIVENESS LEVEL
A categorization of nuclear material types and compositions that reflects the relative ease of processing and handling required to convert that material to a nuclear explosive device.

AUTHORIZATION
Access rights granted to a user, program, or process.

BARRIER
A coordinated series of natural or fabricated impediments that direct, restrict, limit, delay, or deny entry into a designated area.

BATCH
A portion of source material or special nuclear material handled as a unit for accounting purposes at a key measurement point and for which the composition and quantity are defined by a single set of measurements. The source material or special nuclear material may be in bulk form or contained in a number of separate items.

BEGINNING INVENTORY
The quantity of nuclear materials on hand at the beginning of an accounting period.

BIAS
The deviation of the expected value of a random variable from the corresponding correct or assigned value. (10 CFR Part 74.4)

BOOK INVENTORY
The quantity of nuclear material present at a given time as reflected by accounting records.

BULK MATERIAL
Material in any physical form that is not identifiable as a discrete item, and thus must be accounted for by weight, volume, sampling, chemical analysis, or non-destructive analysis.

CALIBRATION
The process of determining the numerical relationship between the observed output of a measurement system and the value, based upon reference standards, of the characteristics being measured. (10 CFR Part 74.4)

CERTIFIED REFERENCE MATERIAL
A reference material, one or more of whose property values are certified by a technically valid procedure accompanied by or traceable to a certificate or other documentation for which each certified value is accompanied by an uncertainty at a stated level of confidence that is issued by a certifying body.

COMPENSATORY MEASURES
Temporary safeguards and security activities (e.g., expenditure of additional resources) designed to afford equivalent protection for safeguards or security interests when a protection system element has failed or a new requirement has been identified.

Definitions *continued*

CONFIRMATION MEASUREMENT
A qualitative or quantitative measurement made to verify the integrity of a tamper-indicating item by testing whether some attribute or characteristic of the nuclear material in the item is consistent with the expected attribute or characteristic of the material.

CONSERVATISM
The principle that estimates or errors in judgement should result in an understatement, rather than an overstatement, of net income and/or net assets.

CONSISTENCY
Comparability of entities, time periods, and presentation of accounting data.

CONTINUITY
An enterprise viewed as a continuing operation, possessing the resources to meet its obligations and commitments.

CONTROL LIMIT
The established value beyond which any variation, such as inventory difference, is considered to indicate the possibility of an assignable cause. Control limits established at the 95 percent confidence level are called "warning limits"; those at the 99 percent confidence level are called "alarm limits" (see Alarm Limit and Warning Limit).

CUSTODIAN
Any person who has possession of, is charged with, or otherwise has assigned responsibility for the control and accountability of classified matter or other security interest (see Nuclear Material Custodian).

DAILY ADMINISTRATIVE CHECK
A daily review to provide timely identification of obvious abnormalities or missing items, or to ascertain that there is no indication of tampering.

DEFENSE-IN-DEPTH
The use of multiple, independent protection elements combined in a layered manner so that system capabilities do not depend on a single component to maintain effective protection against defined threats.

DELAY
The effect achieved by physical features, technical devices, or security measures and forces that impedes an adversary from gaining access to an asset being protected or from completing a malevolent act.

DESTRUCTION
a. The physical alteration of Classified Automated Information System media or components such that they can no longer be used for storage or information retrieval.
b. Annihilation, demolition, or reduction to pieces or to a useless form.

DESTRUCTIVE ANALYSIS
The quantitative or qualitative determination of the kind and/or amount of nuclear material in a sample where sample aliquots are altered in composition and concentration by the addition of chemical reagents.

DETECTION
a. The positive assessment that a specific object is the cause of the alarm.
b. Announcement of potential malevolent act through alarm(s).

Definitions *continued*

DEVIATION
An approved condition that diverges from the norm that is categorized according to the degree of risk accepted as a variance, waiver, or exception.

DIVERSION
The unauthorized removal of nuclear material from its approved use or authorized location. NOTE: The definition of "authorized location" in the context of diversion of nuclear material is the responsibility of the cognizant DOE field element.

ENDING INVENTORY
The quantity of nuclear materials on hand at the end of an accounting period.

ESTIMATE
A technically defensible approximation of the quantity of special nuclear material (SNM) based on process parameters and/or material attributes. An estimate is used when a direct measurement of the SNM is not possible.

FULL DISCLOSURE
Adequate disclosure of all pertinent data necessary for a fair presentation in conformity with Generally Accepted Accounting Principles (GAAP).

GAIN (PHYSICAL INVENTORY-MC&A)
A negative inventory difference (ID), according to the following equation:

ID = Book Inventory - Physical Inventory
= [Beginning Inventory + Receipts - Shipments] - [Ending Inventory]

GRADED SAFEGUARDS
a. A system designed to provide varying degrees of physical protection, accountability, and material control to different types, quantities, physical forms, and chemical or isotopic compositions of nuclear materials consistent with the risks and consequences associated with threat scenarios.
b. Providing the greatest relative amount of control and effort to the types and quantities of special nuclear material that can be most effectively used in a nuclear explosive device.

HOLDUP
The amount of nuclear material remaining in process equipment and facilities after the in-process material, stored materials, and product have been removed. NOTE: Justified estimates or measured values of materials in holdup will be reflected in the facility's inventory records.

IN-PROCESS INVENTORY
The quantity of nuclear material in a process area at any specified time, excluding holdup.

INTERNAL TRANSFER
Transfer of nuclear material within the same reporting identification symbol.

INVENTORY
a. The quantity of goods or materials on hand. (Webster's Ninth New Collegiate Dictionary)
b. An itemized list of current assets. (Webster's Ninth New Collegiate Dictionary)

Definitions *continued*

INVENTORY DIFFERENCE
The algebraic difference between the nuclear material book inventory and the corresponding physical inventory, expressed mathematically as:

Book Inventory - Physical Inventory = Inventory Difference.

The term "total inventory difference" is sometimes used for Inventory Difference.

INVENTORY RECONCILIATION
The process of comparing, investigating discrepancies, and adjusting the book inventory to the corresponding physical inventory.

ITEM
a. A single piece or container of nuclear material that has a unique identification and a known nuclear material mass, and whose presence can be visually verified.
b. Any discrete quantity or container of special nuclear material or source material, not undergoing processing, having a unique identity, and also having an assigned element and isotope quantity. (10 CFR 74.4)

KEY MEASUREMENT POINT
A location where nuclear material appears in such a form that it may be measured to determine material flow or inventory. Includes, but is not limited to, the inputs and outputs (including measured discards) and holdings in material balance areas.

LIMIT OF ERROR
The boundaries within which the value of an attribute being determined lies within a specified probability, usually 95 percent. NOTE: The boundaries are defined to be plus or minus twice the standard deviation of the measured set, unless otherwise stipulated.

LOSS DETECTION ELEMENT
Any component of the safeguards system that can indicate an anomalous activity involving the control of possible loss of special nuclear material.

MATCHING
Revenue and related costs must be matched in determining net income for a specific period.

MATERIAL ACCESS AREA
A type of security area that is approved for use, processing, and/or storage of a Category I quantity or Category II with credible rollup to a Category I quantity of special nuclear material and which has specifically defined physical barriers, is located within a Protected Area, and is subject to specific access controls.

MATERIAL BALANCE
The determination of an inventory difference. (10 CFR Part 74.4)

MATERIAL BALANCE AREA
An area that is both a subsidiary account of materials at a facility and a geographical area with defined boundaries, used to identify the location and quantity of nuclear materials in the facility.

MATERIAL CONTROL AND ACCOUNTABILITY (MC&A) PLAN
A documented description of a site's or facility's material control and accountability program. NOTE: The material control and accountability plan may be presented as a separate document or incorporated as a part of another document.

Definitions *continued*

MATERIAL SURVEILLANCE
The collection of information through devices and/or personnel observation to detect unauthorized movements of nuclear material, tampering with containment, falsification of information related to location and quantities of nuclear material, and tampering with safeguards devices.

MATERIAL SURVEILLANCE PROCEDURES
Procedures to ensure that an area containing special nuclear material is observed by at least two cleared and knowledgeable authorized persons, who may be doing other work, but who can give an alarm in time to prevent the unauthorized removal or diversion of the special nuclear material or an act of sabotage involving special nuclear material. One of the persons must possess a Q access authorization, and the other must possess at least an L access authorization unless the surveillance entails access to Secret/Restricted Data, in which case both must possess Q access authorizations.

MATERIALITY
Relevance in informed professional judgement (see Full Disclosure).

MEASUREMENT
a. The set of operations having the object of determining a value of a quantity. (ISO/TAG 1992)
b. Includes sampling and means the determination of mass, volume, quantity, composition, or other properties of a material, where such determination is used for special nuclear material control and accounting purposes. (10 CFR Part 74.4)

MEASUREMENT ERROR
a. A deviation from correctness. (ANSI N15.41)
b. The result of a measurement minus a true value of the measure. (ISO/TAG)
c. The difference between an observed measurement and the unknown true value of the property being measured.

MEASUREMENT SYSTEM
All of the apparatus, equipment, instruments, and procedures used in performing a measurement. (10 CFR Part 74.4)

MEASUREMENT UNCERTAINTY
a. A concept used to describe the inability of a measurement process to measure exactly the correct value. (ANSI)
b. A parameter associated with the results of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the quantity measured. (ANSI)
c. A measure of the possible error in the estimated value of the quantity measured. (ISO/TAG)
d. The spread of values about which the value of the quantity measured may be expected to be found. (ISO/TAG)

NONDESTRUCTIVE ASSAY (NDA)
The quantitative or qualitative determination of the kind and/or amount of nuclear material in a sample without alteration or invasion of the sample.

NUCLEAR MATERIALS CONTROL
The part of the safeguards program encompassing management and process controls to:
a. Assign and exercise responsibility for nuclear material
b. Maintain vigilance over the material
c. Govern its movement, location, and use
d. Monitor the inventory and process status
e. Detect unauthorized activities for all nuclear material
f. Help investigate and resolve apparent losses of nuclear material.

Definitions *continued*

NUCLEAR MATERIAL CUSTODIAN
An individual assigned responsibility for the control of nuclear material in a localized area of a facility. NOTE: The localized area should be limited, where practical, to a single material balance area. Generally referred to as the MBA Custodian.

OBJECTIVITY
Data presented in conformity with GAAP and prepared for the common needs of all users.

PASSIVE NDA
Measures the naturally-occurring radiation emitted during the decay process of radioactive materials.

PERFORMANCE TEST
A test to confirm the ability of an implemented and operating system element or total system to meet an established requirement.

PERFORMANCE TESTING
A process used to determine that the security features of a system are implemented as designed, and that they are adequate for the proposed environment. NOTE: This process may include hands-on functional testing, penetration testing, or software verification.

PHYSICAL INVENTORY
a. Determination on a measured basis of the quantity of special nuclear material on hand at a given time. The methods of physical inventory and associated measurements will vary depending on the material to be inventoried and the process involved. (10 CFR Part 74.4)
b. The sum of all the measured or derived estimates of batch quantities of nuclear material on hand at a given time within a material balance area, obtained in accordance with specified procedures. (IAEA INFCIRC 153 #113)
c. The quantity of nuclear material which is determined to be on hand by physically ascertaining its presence using techniques such as sampling, weighing, and analysis.

PORTAL MONITOR
Any electronic instrument designed to perform scans of items, personnel, and vehicles entering or leaving a designated area for the purpose of detecting weapons, explosives, and nuclear material.

PRECISION
A quantitative measure of the variability of a set of repeated measurements (DOE); also used to describe the internal consistency of repeated measurements.

PROCESS
A series of actions that achieves an end or result. (10 CFR Part 76.4)

PROCESS DIFFERENCE
The determination of an inventory difference on a unit process level with the additional qualification that difficult to measure components may be modeled. (10 CFR Part 74.4)

PROTECTED AREA
A type of security area defined by physical barriers (i.e., walls or fences), to which access is controlled, used for the protection of Category II special nuclear material and classified matter and/or to provide a concentric security zone surrounding a material access area (Category I nuclear materials) or a vital area.

Definitions *continued*

QUALIFIED
A term indicating the satisfactory completion of a training program based on knowledge and skills identified by a position job/function and task analysis.

RANDOM ERROR
a. The variations encountered in all measurement work, characterized by the random occurrence of both positive and negative deviations from a mean value.
b. The deviation of a random variable from its expected value. (10 CFR 74.4)
c. The result of a measurement minus the mean of a large number of repeated measurements. (ISO/TAG)

REFERENCE STANDARD
A material, device, or instrument whose assigned value is known relative to national standards or nationally accepted measurement systems. This is also commonly referred to as a traceable standard. (10 CFR Part 74.4)

SAFEGUARDS
An integrated system of physical protection, material accounting, and material control measures designed to deter, prevent, detect, and respond to unauthorized possession, use, or sabotage of nuclear materials.

SCRAP
a. Various forms of SNM generated during chemical and mechanical processing, other than recycle material and normal process intermediates, which are unsuitable for continued processing, but all or part of which will be converted to usable material by appropriate recovery operations. (10 CFR Part 74.4)
b. Byproducts from chemical and/or mechanical processing, not usable in their present forms, from which nuclear materials can be economically recovered.

SEPARATE ENTITY
Requires operations of each separate entity be segregated from other separate accounting units.

SHIPPER/RECEIVER DIFFERENCE
The difference between the measured quantity of nuclear material stated by the shipper and the measured quantity stated by the receiver.

STATISTICAL SAMPLING
A statistically valid technique used to select elements from a population, including probability sampling, simple random sampling, systematic sampling, stratified sampling, and cluster sampling.

SUBSTANCE OVER FORM
Requires that the economic substance of a transaction be recorded if it differs from the legal interpretation of the transaction.

SURVEILLANCE
The collection of information through devices and/or personnel observation to detect and assess unauthorized movements of personnel and nuclear material, tampering with containment, falsification of information related to location and quantities of nuclear material, and tampering with safeguards devices.

SURVEY
Audit and assessment activities by the DOE field element to evaluate the compliance of a contractor in meeting the intent of the DOE orders.

Definitions *continued*

SYSTEMATIC ERROR
A constant unidirectional component of error that affects all members of a data set.
a. An error that is not determined by chance but by a bias. (Webster's Collegiate)
b. The result of one or more assignable causes.
c. An error that affects all members of a data set. (Jaech)
d. The mean result of a large number of measurements minus the true value. (ISO/TAG)

TAMPER-INDICATING
An item containing special nuclear material that is either protected by a tamper-indicating device, or constructed such that removal of special nuclear material cannot be accomplished without permanently altering the item in a manner that would be obvious during visual assessment.

TAMPER-INDICATING DEVICE
A device that may be used on items such as containers and doors, which because of its uniqueness in design or structure, reveals violations of containment integrity. These devices on doors (as well as fences) are more generally called security seals.

THROUGHPUT
a. The measured output of nuclear material, including waste, from a material balance area.
b. May also be defined as the greater of additions or removals from a material balance area during a specific processing or inventory period.

TRACEABILITY
The ability to relate individual measurement results to national standards or nationally accepted measurement systems though an unbroken chain of comparisons. (10 CFR Part 74.4)

TRUE VALUE
a. Reference value.
b. Certified value.
c. An authoritative or consensus "best estimate."
d. The result of a superior measurement process.

TWO-PERSON RULE
As applied to the materials control program, an access control and materials surveillance procedure that requires that at least two authorized people be present in locations with unsecured quantities of nuclear materials in Category I amounts or Category II amounts with rollup potential to Category I (e.g., situations requiring two-person rule application include: (1) when vaults are entered, (2) when transfer of materials across material balance areas is done, and (3) when activities are performed involving the application or removal of tamper-indicating devices from items.) Other situations, such as use of CRYPTO keying materials, also require application of a similar two-person rule.

UNCERTAINTY
The extent to which a measurement result is in doubt because of the effects of random error variances and the limits of systematic errors associated with a measurement process, after the measurement result has been corrected for bias.

VARIANCE PROPAGATION
The determination of the value to be assigned as the uncertainty of a given measured quantity using mathematical formulas for the combination of errors from constituent contributors.

Definitions *continued*

VAULT
A windowless enclosure that is resistant to forced entry and has a DOE-approved system that detects unauthorized entry.

VERIFICATION MEASUREMENT
A quantitative re-measurement of the amount of nuclear material in an item; made to verify the integrity of an item that is not tamper indicating.

VULNERABILITY ANALYSIS
A systematic evaluation process in which qualitative and/or quantitative techniques are applied to detect vulnerabilities and to arrive at an effectiveness level for a safeguards and security system to protect specific targets from specific adversaries and their acts.

WARNING LIMIT
A control limit established for an inventory difference which, when exceeded, requires investigation and appropriate action. NOTE: For processing, production, and fabrication operations, warning limits are established with a 95 percent confidence level.

WASTE
Nuclear material residues that have been determined to be uneconomical to recover.

Section 1: Introduction

1.1 Purpose

The Material Control and Accountability (MC&A) Assessment Guide provides the assessor with a set of detailed guidelines and references that can be used to plan, conduct, and complete an assessment of an MC&A program. This guide serves to promote consistency, ensure thoroughness, and enhance the quality of the assessment.

This guide is a sub-tier document to two U.S. Department of Energy (DOE) documents that describe assessment and appraisal processes used by the DOE Office of Enterprise Assessments (EA), previously known as the Office of Health, Safety and Security.

- *Office of Health, Safety and Security, Independent Oversight Program Appraisal Process Protocols*, November 2012

- *Office of Security and Cyber Evaluations Appraisal Process Protocol*, March 2013.

The EA Appraisal Process Protocols document provides guidance for conducting safeguards and security assessments, as well as techniques, formats, and sample documents useful in planning, conducting, and reporting the results of safeguards and security assessments. Assessors should refer to the EA appraisal process protocols for general assessment guidance. The second Appraisal Process Protocol document describes the processes, techniques, and procedures used by the Office of Cyber and Security Assessments (formerly the Office of Security and Cyber Evaluations) to evaluate DOE's (including the National Nuclear Security Administration, or NNSA) and contractor organizations' security programs designed to protect special nuclear material (SNM) and sensitive information. These evaluations are accomplished through the conduct of appraisals that provide accurate, comprehensive information and analysis regarding the effectiveness of, and trends in, DOE programs and other functions of interest.

Although this MC&A Assessment Guide focuses on comprehensive assessments, the detailed information it provides is useful for other EA appraisals, including special assessments, follow-up reviews, assessments, special studies, and special reviews. Additionally, EA may conduct limited-notice performance tests (LNPTs), which are typically conducted over a two- to three-day time period and employ the use of trusted agents to support the effort. In the MC&A topical area, LNPTs are usually developed from one or more of the MC&A performance tests described in Appendix A of this guide. The overall guidance for LNPTs within EA is governed by a standard operating procedure, and LNPT documentation for all safeguards and security topics is provided on LNPT Data Collection Forms. Guidance for conducting LNPTs is provided in the *Limited-Notice Performance Test Inspectors Guide*, October 2014.

This MC&A guide is intended for novice and experienced assessors. For the novice, the information can serve as a valuable training tool, and with minimal assistance, the novice assessor should be able to use the guidelines and references to plan assessment activities, as well as collect and analyze data more efficiently and effectively. For the experienced assessor, information is organized to allow easy reference and to serve as a memory aid when conducting assessment activities.

The information in this guide encompasses the five specific MC&A subtopics: program management, material control, measurements, material accounting, and physical inventory. Although the guide covers a variety of assessment activities, it does not and cannot address all protection program variations and systems used at DOE facilities. The assessment guidelines may have to be modified or adapted to meet site-specific needs, and assessors may have to design new activities to collect information that is not specifically covered in the guide.

This guide is intended to complement DOE orders, manuals, and guides by providing practical techniques. Assessors must review site-specific contracts to determine the DOE orders with which the contractor must comply. The focus of the MC&A Assessment Guide is to provide assistance in assessing the effectiveness of all elements of an MC&A program, and every attempt has been made to develop specific guidelines in a format that offers maximum usefulness to assessors.

This guide is not a repetition of DOE requirements; the current applicable order is referenced in Section 2, Program Management. However, assessors should be aware that revisions to DOE orders may be issued after this guide has been published. Before each assessment, assessors should always verify that they have the current DOE orders and manuals to reference. Assessment data should be collected and analyzed commensurate with any new requirements.

Performance metrics, such as those documented in DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*, Attachment 3, may be used by a facility to demonstrate how the MC&A program will meet specific objectives, and can also be used by assessors to assist in the evaluation of each MC&A subtopic. Appendix F provides a matrix that organizes these metrics into specific assessment objectives; this matrix may be used by assessors to assist in evaluating a facility's performance against DOE order requirements. Alternative performance metrics to those described in the order may be documented in a facility's approved MC&A Plan and, in that case, should be used by assessors to evaluate program performance. In addition to the performance metrics documented in the order, guidance on meeting MC&A objectives is provided in DOE technical standard DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*.

There are terms used in each specific subsection of this guide that are frequently encountered during an assessment. These terms and corresponding definitions may be useful in resolving potential deficiencies encountered during an assessment. For example, the definition of *throughput* is absolutely essential when evaluating the magnitude of limit of error of inventory difference (LEID). Definitions are documented at the front of this guide.

1.2 Brief Overview of the MC&A Assessment

When selecting a facility for an assessment, EA determines which of the MC&A topics will be assessed and the number of MC&A assessors who will conduct the assessment. If several MC&A assessors participate in an assessment, a topic team lead will be appointed. The EA Assessment Chief may also identify areas that require specific emphasis (e.g., an issue highlighted in the Annual Report to the President or recent concerns at a similar site). Before the assessment, EA sends the site a "data call" request that identifies specific MC&A documentation to be provided to the assessment team prior to and/or during the assessment, and establishes points of contact to coordinate assessment logistics. For MC&A, the points of contact could include personnel from the field elements, MC&A department, and/or facilities.

The MC&A topic team lead will routinely contact the site MC&A points of contact to coordinate activities for the first visit. The points of contact will assist in any additional logistical arrangements for the assessment, such as access to material access areas (MAAs), additional MAA-specific training, facility tour logistics, etc. Since the assessment may occur at a time when the facility is performing certain activities (e.g., a physical inventory), it is appropriate for the topic team lead to discuss the timing of the assessment with the points of contact. On the first day of the assessment, it is important for the facility to provide a prepared briefing that describes the MC&A program. This presentation should include: the approval status of MC&A documents, a listing of approved equivalencies/exemptions, and the status of corrective action plans formulated to address findings from MC&A surveys and from previous EA assessments. The briefing should also describe the current MC&A organization structure (including funding), any changes to the MC&A system, and the operational status of the facility (including any process activities that may have changed the characteristics of existing material types or produced new material types). The briefing should also include the results of recent assessments and key deficiencies currently being addressed by the MC&A program.

Observing facility personnel performing planned MC&A activities minimizes the impact of the assessment on the facility and provides valuable performance assessment information to the assessment team. Thus, the assessment team leader should expect the facility to provide an updated daily schedule of MC&A activities that the site plans to conduct during the assessment. This schedule allows the assessment team to plan the observation of routine MC&A activities and site-generated performance tests, and to develop additional performance tests to be conducted by the team during the assessment. The site schedule also provides a baseline for planning a comprehensive, yet low-impact, assessment and developing the MC&A assessment schedule.

During the planning process, the assessors must decide how the assessment effort will be divided between each of the five subtopics and, within each subtopic, how the level of effort will be expended between documentation-based reviews and performance-based reviews. When planning is complete, a detailed assessment schedule will be prepared; the schedule must include time for document reviews, conduct of interviews, conduct of performance tests, facility tours, etc. This assessment schedule is reviewed by the EA Assessment Chief to ensure that it meets the overall EA assessment objectives.

Other key elements of the assessment process, such as daily validation meetings, summary validations, report writing, final assessment closure, and follow-up, are described in the *Office of Security and Cyber Evaluations Appraisal Process Protocol*.

1.3 Organization of this Guide

This guide is organized as follows:

- Section 1 – Introduction
- Section 2 – Program Management
- Section 3 – Material Control
- Section 4 – Measurements
- Section 5 – Material Accounting
- Section 6 – Physical Inventory
- Section 7 – Interfaces
- Section 8 – Analyzing Data and Interpreting Results
- Appendix A – Performance Tests
- Appendix B – Statistical Sampling
- Appendix C – Tabletop Exercises
- Appendix D – Assessing Sites with Only Category III and IV Material Balance Areas
- Appendix E – Interview Questions
- Appendix F – MC&A Assessment Objectives

Section 1 (Introduction) describes the assessment approach, characterizes the MC&A topic, describes the relationship between EA MC&A assessments and other MC&A programs, and provides an overview of four key MC&A assessment activities (i.e., tours and observations, interviews, document reviews, and performance testing).

Sections 2 through 6 provide detailed guidance for assessing each of the five major MC&A subtopics. Section 2 (Program Management) pertains to the management of the MC&A program, including documentation, training, internal reviews and assessments (IRAs), and occurrence reporting. Section 3 (Material Control) addresses the various methods used to ensure that material is appropriately maintained in authorized locations, and that movement of material is controlled. Section 4 (Measurements) examines the methods and systems used to determine quantities of nuclear material. Section 5 (Material Accounting) addresses the methods used at a facility to account for nuclear material. Section 6 (Physical Inventory) discusses the process of taking a physical inventory and reconciling inventory records.

Section 7 (Interfaces) contains guidelines to help assessors coordinate their activities both within subtopics and with other topic teams, and describes the integration process that allows topic teams to align their efforts and benefit from the knowledge and experience of other topic teams. This section identifies common areas of interface for the MC&A team, a rationale for this coordination, and how the integration effort contributes to the quality and validity of assessment results.

Section 8 (Analyzing Data and Interpreting Results) discusses how to evaluate identified deficiencies and overall MC&A system effectiveness, and assign ratings.

Appendix A (Performance Tests) describes the performance tests commonly used during evaluation of MC&A programs. These tests may also be used to develop site-specific LNPTs.

Appendix B (Statistical Sampling) addresses the selection of statistical samples, and discusses the relationship between sample size and detection probability and the assumptions used in determining statistical samples.

Appendix C (Tabletop Exercises) discusses how to use tabletop exercises to evaluate various MC&A elements that could take days or weeks to simulate. Tabletop exercises also allow the testing of larger groups of individuals in a timelier manner.

Appendix D (Assessing Sites with Only Category III or IV Material Balance Areas) describes changes to assessment protocols when there are no Category I or II quantities of material being protected (e.g., reduced material transfer requirements associated with Category III or IV materials, less frequent physical inventories).

Appendix E (Interview Questions) provides typical questions that assessors should ask of material balance area (MBA) custodians, tamper-indicating device (TID) administrators, MC&A managers, facility managers, and others during routine interviews.

Appendix F (MC&A Assessment Objectives) captures the performance metrics from Attachment 3 of DOE Order 474.2, Change 4, and sorts them into specific assessment objectives that an assessor may use when assessing various MC&A program elements.

1.4 Using the MC&A Subtopic-Specific Sections

Sections 2 through 6 are further divided into the following standard format:

- General Information
- Data Collection Activities
- Common Deficiencies/Potential Concerns
- References.

1.4.1 General Information

The General Information section of each assessment subtopic presents the objectives that must be accomplished through the element being assessed and summarizes the key elements of that subtopic. It is useful for the novice assessor to review the objectives described in this section before beginning the assessment. Reviewing the General Information section is also useful during the analysis portion of the assessment, as it helps the assessor gain perspective on deficiencies identified during the conduct of the assessment. A facility's failure to meet the objectives of a particular sub-element may indicate a less than satisfactory rating. A specific approach for assessing each of the five MC&A subtopics is provided in a flowsheet within each subtopic section (Sections 2 through 6) of the MC&A Assessment Guide. The flowsheet describes the information needed, as well as the documentation-based review and performance-based review aspects of the assessment.

1.4.2 Data Collection Activities

The Data Collection Activities section of each assessment subtopic provides guidance for performing the bulk of the assessment activities. Data collection and evaluation activities are divided into three sections: (1) Information Needed, (2) Documentation-Based Reviews, and (3) Performance-Based Reviews.

1.4.2.1 Information Needed

The Information Needed section provides a ready reference of the documents and interviews an assessor must request, review, and/or conduct in order to acquire the information necessary to adequately perform the assessment. Some of this documentation may have been provided by the facility in advance of the assessment; other information is reviewed during planning; and some information is reviewed during the actual assessment. The Information Needed section can serve as a checklist for the assessor to use during facility discussions to ensure that the necessary documentation is available for review. Interviews are conducted during the assessment to validate that personnel know and understand MC&A procedures, to ensure that personnel training has been effective, and to ascertain the degree of management commitment to the MC&A program.

1.4.2.2 Documentation-Based Reviews

The Documentation-Based Reviews section within each subtopic provides a structured approach that an assessor should review to ensure that DOE objectives are being addressed at the facility. This review approach provides for a "go, no-go" evaluation of the implementation of specific requirements. When determining which documents to review, the assessor must tailor the assessment to the type of facility. For example, shipments/receipts are reviewed as part of material accounting; however, at some facilities, minimal shipments or receipts are conducted, so this area may not warrant detailed assessment.

An assessor must prioritize document reviews based on available assessment time. During the planning process, the assessor should coordinate with facility personnel to establish specific times and specific documents to be reviewed. For example, physical inventory data and associated reconciliation documents for a particular MBA during specific inventory periods should be identified. This coordination ensures that the individual being interviewed has had time to assemble the necessary documentation.

1.4.2.3 Performance-Based Reviews

Each subtopic assessment area has a list of applicable performance tests that an assessor can choose to validate a facility's ability to meet MC&A performance objectives. Applicable performance tests are described in each subtopical area, summarized in the assessment flow diagram for that subtopic, and described in detail in Appendix A. This list of applicable performance tests provides the basis from which the assessor can fully develop performance tests that will evaluate the effectiveness of a facility as it performs MC&A functions. Scheduling of performance tests is determined during planning, and approximate times are given to the facility. For example, the assessor will tell the facility representative that an emergency physical inventory will be conducted Wednesday afternoon. However, the MBA to be inventoried will not be identified until late Wednesday morning to ensure a reasonable test of facility performance, and the emergency inventory might not begin until 3:00 p.m.

1.4.3 Common Deficiencies/Potential Concerns

The Common Deficiencies/Potential Concerns section addresses common deficiencies and concerns that EA has noted on previous assessments. Information in this section is intended to help the assessor further focus assessment activities. By reviewing the list of common deficiencies and potential concerns before gathering

data, assessors may focus on these elements during interviews, tours, and other data-gathering activities. General guidelines are provided to help the assessor identify site-specific factors that may indicate the likelihood of a particular deficiency and its potential impact.

1.4.4 References

The References section identifies articles and books that apply to the subtopic. Policy memoranda are normally found in the policy supplement appendix; however, references to pivotal memoranda of a permanent nature, procedural guides, and certain manuals may be found in the References section. References can provide additional supplemental information that could be useful during an assessment. For example, if an assessor is reviewing measurements and a concern arises as to the impact of a particular impurity on a specific chemical method, the references in the Measurement section would provide information to confirm or reject the concern.

1.5 Characterization of the MC&A Program

An MC&A program is designed to provide an information and control system for nuclear material. MC&A encompasses those systems and measures necessary to establish and track nuclear material inventories, control access, detect loss or diversion of nuclear material, and ensure the integrity of those systems and measures. Administrative controls include program and materials management, personnel training, system reviews and audits, and the combination of hardware and procedures to ensure that all nuclear material is accounted for.

An effective MC&A program includes:

- A current, approved, site-specific MC&A Plan that defines the approach and methods used in the MC&A system to achieve the site safeguards goals. In the MC&A Plan, the site (1) identifies the threats that MC&A protects against; (2) defines the roles and responsibilities of individuals performing MC&A activities; (3) documents the training, qualifications, and procedures used to implement the identified protection methods; and (4) develops a program to evaluate the effectiveness of the system in meeting the defined goals. The plan must effectively represent the MC&A activities observed during the assessment. The MC&A Plan may be part of the site security plan (SSP), and both the SSP and the site MC&A Plan should be reviewed for consistency in order for the MC&A program to be fully effective.

- Material movements controlled to provide assurance that nuclear material is maintained in authorized locations by authorized personnel. To ensure effective control of material movements, the site confirms that (1) transfer paths are defined, and protection measures (including secure storage, barriers, locks, doors, and surveillance) are implemented to ensure that material is only moved by way of authorized paths; (2) portal monitors and surveillance are used on authorized paths to ensure that only authorized movements occur; (3) restrictions, administrative controls, and internal controls are implemented to ensure that movements are authorized and controlled; and (4) records are maintained of all nuclear material received, shipped, or transferred between MBAs.

- Measured values for all SNM, unless the material is identified in the MC&A Plan as not amenable to measurement or an approved deviation exists. All measurement methods are governed by a measurement control program. To comply with the measurement control program, the site ensures that (1) measurement methods are selected and qualified for use based on the types and quantities of materials to be measured; (2) measurement control programs ensure ongoing validity of measurement data; and (3) measurement methods have established control limits and documented estimates of current measurement uncertainties.

- Material accounting functions in which information is collected, analyzed, summarized, and reported. Effective material accounting processes ensure that (1) an audit trail exists from reported information to the source documents; (2) data is protected against tampering; and (3) documentation of the methods used for accounting is available.

- A physical inventory program to ensure that all materials are inventoried, that no material is inventoried more than once during the performance of a physical inventory, and that inventory results are reconciled with the accounting records. Through the physical inventory program, the site ensures that (1) authorized locations for nuclear material within the facility are identified; (2) procedures are documented for each area of the facility; and (3) reconciliation of the accounting records with the physical inventory is documented and evaluated.

1.6 Information Gathering Approaches

Several techniques are used to collect information on the performance of a site's MC&A program, including tours and observations, interviews, document reviews, and performance testing. The types of information gained from each technique are discussed in the following paragraphs.

1.6.1 Tours and Observations

Tours and observations of operations help assessors gain an understanding of MC&A operations and MC&A process interfaces. Entry into MAAs may require 24-hour advance notice, issuance of dosimeters, facility orientation briefings, and being placed on the "Plan of the Day." Coordination to ensure compliance with entry requirements is essential. In most cases, key areas will be visited more than once, so ongoing facility access will be required. Tours allow assessors to:

- Familiarize themselves with the site and facility
- Observe the MC&A systems, especially MBAs, storage vaults, process data gathering equipment, analytical measurement equipment, computer equipment, access control, and containment
- Observe how procedures (such as inventory procedures) are implemented
- Verify that the MC&A systems are implemented and functional
- Discuss MC&A activities with operations personnel.

The assessment team should attempt to minimize impact on the facility, which can be accomplished by asking the facility what MC&A activities will be occurring during the assessment and planning the assessment accordingly. Observation of ongoing MC&A activities is cost-effective and has low facility impact. Typical facility activities include observation of measurements, vault openings, or nuclear material transfers. However, if specific MC&A activities are not scheduled during the assessment, assessors may request that these activities be performed for the purpose of conducting performance tests. Additionally, when possible, MC&A assessors should coordinate tours and visits to vault openings with other assessment team members to minimize intrusion into the facility's work routine.

1.6.2 Interviews

Interviewing the site personnel responsible for essential program elements is an important part of the assessment process. Interviews are not necessarily formal and frequently take the form of discussions during tours or performance tests. Assessors are encouraged to take advantage of every opportunity to ask questions of appropriate personnel. These individuals can usually provide the assessment team with essential information that will frequently support or clarify the documentation. Specifically, assessors may wish to interview:

- Senior program managers with funding responsibility
- Safeguards and security managers

- TID administrators, applicators, and custodians
- MC&A auditors, including assessment personnel
- MBA custodians and material handlers
- Process operators and operation supervisors
- Inventory and measurement personnel
- Accounting/accountability specialists
- MC&A training coordinators and instructors
- Vulnerability assessment (VA) personnel
- Security police officers (SPOs) who implement MC&A functions.

Interviews with personnel at all levels are recommended. Frequently, discussions with personnel involved with hands-on operations indicate whether the policies and directives of management are effectively communicated and implemented. Appendix E provides typical questions that may be asked of MBA custodians, TID custodians, and various managers during personnel interviews.

1.6.3 Document Reviews

Document reviews constitute a significant portion of an assessment. Documents must be current, approved at the appropriate management level, readily available for personnel to use, periodically updated, and, most importantly, representative of the actual practice that is documented. Assessors frequently validate these characteristics during tours and interviews with MC&A personnel. When a deficiency or discrepancy is found, it is important to determine whether the issue is a single occurrence or a generic problem. If it is a generic problem, a root cause analysis must be conducted.

1.6.4 Performance Testing

Performance testing is an important element of an EA MC&A assessment. Performance testing is the preferred method for evaluating system effectiveness; however, performance testing must be used cautiously for several reasons. First, performance testing is the most labor- and time-intensive of all data collection activities. Second, performance testing places the greatest demands on the resources of the assessed site and requires the highest degree of coordination and planning. Third, performance testing offers the greatest potential for generating safety or security problems. Thus, performance tests (or exercises, as they are commonly called) should be employed judiciously when the desired data cannot be gathered using other data collection tools. To minimize the impact on facility resources and to avoid the potential for safety and security problems, performance testing in some cases may be conducted using tabletop exercises. Appendix C outlines the format for conducting tabletop exercises.

Performance tests must always be carefully planned and coordinated with appropriate facility personnel before the assessment team arrives on site. Careful planning ensures the most efficient use of time and resources. This planning and coordination process continues after arrival up to the moment the test is administered. Some performance tests require that the personnel being tested remain unaware that a test is being conducted. Particular care must be exercised to ensure that these types of tests are coordinated and that all relevant safety factors are carefully considered. Appropriate personnel can be informed that equipment or procedural performance tests are being conducted without compromising the validity of the test.

The tests performed by the MC&A assessment team may involve equipment, personnel, procedures, or any combination therein. Ideally, the performance test will stress the system under examination up to the established limits of the site-specific threat. Tests should simulate realistic conditions and provide conclusive evidence relating to the effectiveness of the security system. Unfortunately, safety concerns, time and resource constraints, and the heightened security posture that results whenever an assessment is under way frequently minimize the ability to establish and simulate totally realistic conditions.

Performance testing of equipment and personnel is an essential part of an effective assessment. Equipment performance testing is designed to determine whether equipment is functional, has adequate sensitivity, and meets its design and performance objectives. It is not sufficient for a component to meet the manufacturer's standards if the component proves ineffective during testing. Personnel performance tests are intended to determine whether personnel know and follow procedures, whether procedures are effective, and whether personnel and equipment interact effectively.

Determining which, how many, and what type of MC&A performance tests to perform is usually based on information uncovered during document reviews, interviews, and other data collection activities. If this information leads assessors to believe that a weakness may exist in a particular area, or if the documentation or policies indicate a potential weakness, the suspected areas of weakness should be tested. When testing, the assessor should not concentrate solely on one particular aspect of a system or program at the expense of an overall perspective; on the other hand, it is not normally necessary to test all elements of a system or program. When a problem is detected, the assessor must investigate in sufficient depth to determine whether the deficiency is an isolated error or a trend symptomatic of poor training, improper procedures, management (perceived importance of safeguards activities), or other systemic cause.

In each MC&A exercise, the following functions should be tested to the extent possible, with the goal of assessing MC&A system effectiveness rather than a specific component:

- Command and control
- Use of information resources
- Defense-in-depth or redundancy of components, such that the loss of one element of the MC&A system does not result in defeat of the system
- Ability to follow existing plans and procedures
- Effectiveness of existing plans and procedures
- Interface with physical protection systems and protective forces.

EA assessors may develop exercise scenarios that test the DOE/NNSA field element and not the contractor. Such a test might include requesting the field element to perform inventory verification to evaluate the contractor's system.

A set of commonly used exercises/performance tests is provided in Appendix A. These tests can be applied directly or modified to address site-specific conditions or procedures. Since performance testing is one of the most important data collection activities used in evaluating MC&A and the information on testing is extensive, performance testing is addressed in detail in Appendix A and in each of the subtopic sections in this guide.

1.7 Relationship of EA Assessments to Other MC&A Programs

1.7.1 Nuclear Regulatory Commission Licensees

The Nuclear Regulatory Commission (NRC) is responsible for administering the MC&A regulations for the facilities under its jurisdiction. These facilities are referred to as licensees. DOE and its contractors are license-exempt.

The NRC MC&A regulations are promulgated in the Code of Federal Regulations (CFR), primarily in chapters 10 CFR 70, 10 CFR 74, and 10 CFR 76. There are similarities between the NRC and DOE requirements that are beyond the scope of this MC&A guide, but some particulars are noteworthy. The NRC requires its licensees to prepare a Fundamental Nuclear Material Control Plan (FNMCP). This document, when approved by the NRC, becomes a legal agreement between the NRC and the facility. If this plan is violated, the facility may be subject to administrative and criminal penalties. The FNMCP is similar to a DOE facility MC&A Plan; the FNMCP includes requirements for inventories, accounting, measurement and measurement control plans, vulnerability analyses, and material control activities.

The NRC has also developed regulatory guides (NUREGs) to assist both assessors and facilities in implementing MC&A programs (for example, see references in Section 4). The NUREGs describe such functions as measurements and measurement control, holdup measurement, and process monitoring. The NRC has also developed a NUREG that discusses acceptance criteria that form the basis for NRC's acceptance of the MC&A programs that facilities have promulgated in their FNMCPs. DOE assessors can use these documents as references to assist in determining MC&A system effectiveness.

In some ways, the EA assessment at DOE facilities is similar to an NRC inspection of a licensee. DOE MC&A assessors can be used to support NRC activities after a minimal review of the facility plan and a refresher briefing on NRC requirements. Thus, many of the assessment methods and tools in this plan can also be applied during NRC inspections.

1.7.2 International Atomic Energy Agency Member States

The Nuclear Non-Proliferation Treaty (NPT) is an agreement by signatory countries (referred to as member states) with the International Atomic Energy Agency (IAEA) to use nuclear material only for peaceful purposes. The IAEA reports to the United Nations General Assembly and, under special circumstances, to the Security Council of the United Nations.

Member states that sign the NPT agree to an assessment program of their nuclear materials to verify that material is accounted for and used properly. Each facility subject to assessment completes a Design Information Questionnaire. Subsequently, the IAEA prepares a Facility Attachment (FA) that is approved by the member state and facility, and becomes the basis for conducting IAEA inspections. This FA defines the assessment criteria, inventory frequency, measurements, and measurement control program. The FA is similar to a DOE facility MC&A Plan. Quantities of nuclear material (plutonium, uranium, and heavy water) are subject to IAEA reporting. The IAEA uses routine inspections and physical inventory verification inspections to verify material accounting. Additionally, the IAEA makes periodic statements about the facility MC&A program and prepares an annual MC&A report for activities in the member states. Physical security is not included in IAEA inspections.

IAEA inspections are similar to EA MC&A assessments. In IAEA inspections, the MC&A program is evaluated, MC&A transfers are reviewed, measurements are performed, and the physical inventory is not only observed but also physically tested by IAEA assessors.

Since 1977, the U.S. has reported nuclear material data to the IAEA for its non-weapons program. Since 1994, the U.S. has placed excess nuclear material under IAEA safeguards. MC&A assessors need to be sensitive to these agreements and must note that some nuclear materials may not be readily available for assessment without advance notification to the IAEA. Thus, assessors may need to review the existing FA and recent IAEA inspection reports. Nuclear material under IAEA safeguards does not routinely comprise a significant portion of the EA assessment.

1.7.3 DOE/NNSA MC&A Surveys

EA addresses DOE and NNSA MC&A surveys in the Protection Program Management (PPM) Assessment Guide. Field element MC&A surveys are also discussed in Section 2, Program Management, of this MC&A Assessment Guide. DOE/NNSA requires field elements to periodically assess the nuclear material holdings of its contractor facilities. These surveys are very similar to EA assessments, but are intended to be comprehensive and take place over longer periods of time. Some DOE/NNSA field elements use this MC&A Assessment Guide as a reference for conducting their MC&A surveys.

Before an EA MC&A assessment, the MC&A assessor reviews the most recent MC&A surveys for the facility being assessed. All open survey findings are also reviewed. This review can include the Safeguards and Security Information Management System report, a presentation by the field element, or a presentation by the facility.

These reports could demonstrate that the field element places emphasis on compliance reviews that are very comprehensive in nature. In this case, the assessor would focus attention on performance reviews. In some cases, the survey report may have a rating that does not appear consistent with the findings, so the MC&A assessor would need to interview field element personnel and share the results with the assessment team for the PPM topic.

Section 2: Program Management

2.1 General Information

The Program Management subtopic addresses the MC&A organization and its established MC&A program using the graded safeguards approach. A site's Program Management element defines and documents the roles and responsibilities for all individuals who possess MC&A responsibilities, institutionalizes the MC&A program by developing and approving written plans and procedures, allocates sufficient resources to manage and operate the MC&A program, and monitors the performance of MC&A activities. The MC&A Program Management element assessment focuses on the scope and effectiveness of management relative to program planning, policy implementation, and program review to ensure that a graded, cost-effective MC&A program is implemented.

DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*, identifies six Program Management objectives that a site/contractor MC&A program must meet. An acceptable program:

- Ensures that documentation is sufficient to maintain a comprehensive, effective, and cost-efficient program to control and account for nuclear materials
- Defines MC&A system elements with performance goals that reflect consequence of loss or misuse of the material managed by the program
- Must be graded based on the consequence of loss and contain control and accounting mechanisms for nuclear materials
- Establishes and maintains an evaluation program that monitors the effectiveness of the MC&A system
- Responds effectively and efficiently to material loss indicators, anomalous conditions, and degradation of system performance
- Includes management that ensures the integration of MC&A with safeguards and security and other site programs.

Performance metrics, such as those documented in DOE Order 474.2, Change 4, Attachment 3, may be included in the MC&A Plan to demonstrate how the MC&A program will meet Program Management objectives, and can be used by assessors to assist in the evaluation of the Program Management subtopic. In addition to the performance metrics documented in the order, guidance on meeting Program Management objectives is provided in DOE technical standard DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*, Section 6.1, Program Management. Figure 2-1 summarizes the assessment activities that are most commonly performed by the MC&A topic team for each Program Management subtopical area.

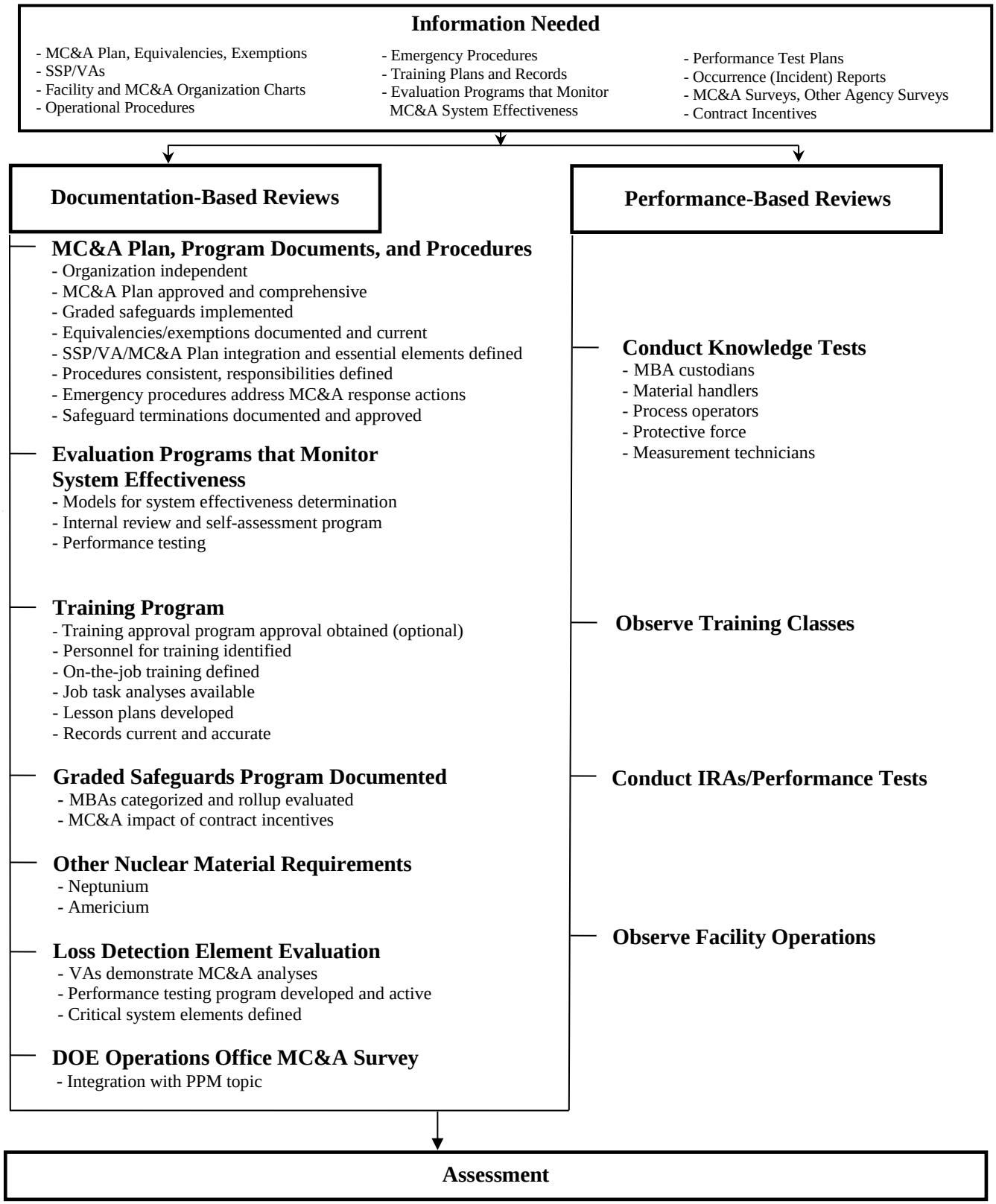

Figure 2-1. Assessing MC&A Program Management

2.2 Data Collection Activities

2.2.1 Information Needed

Information needed to evaluate a site's MC&A program can be obtained in a number of ways. A "data call" developed during the assessment planning phase can be provided to site personnel, requesting that appropriate documentation be made available to the assessors prior to and/or during onsite assessment activities. During assessment planning, assessors should interview points of contact, review available documentation, and participate in plant tours. In addition to reviewing documentation, assessors should identify key MC&A and management personnel to interview to gather additional insights into the program. These personnel can be identified using the site's MC&A Plan, organizational charts, procedures, training records, or other documents that describe key responsibilities. When assessing MC&A Program Management performance, assessors should include interviews with the following personnel (note that each site may have different titles):

- Selected top management
- Safeguards and Security Director
- MC&A manager
- MC&A manager's supervisors
- MC&A section leaders
- MBA custodians
- Assessment coordinator
- Training coordinator
- Procedures coordinator
- Process area managers
- DOE MC&A administrators.

The managers should be interviewed specifically for their commitment to MC&A and their abilities to obtain sufficient resources to maintain an effective MC&A program.

2.2.1.1 MC&A Plan, Equivalencies/Exemptions, and Graded Safeguards Basis Documents

The MC&A Plan is the key document for review and provides the basis from which EA formulates detailed assessment activities. The MC&A Plan describes how the overall program is implemented, including systems and programs to meet the objectives of the material control, measurements, accounting, and physical inventory elements of MC&A. The plan identifies the essential elements of the MC&A system and points to applicable operations procedures. Performance goals for essential elements are also defined in the MC&A Plan.

A facility may propose an alternative or equivalent means of providing adequate safeguards and security to meet a specific requirement of safeguards and security program directives. The MC&A Plan should include or reference applicable equivalencies/exemptions. If not already included in the MC&A Plan, this additional information should be obtained to ensure that it was processed in accordance with DOE Order 251.1C, *Departmental Directives Program.*

The MC&A Plan should detail how the facility will follow a graded safeguards program for all of its nuclear materials, which requires the facility to establish MBAs based on categorization and attractiveness of material so that appropriate protection levels are maintained. Nuclear material categories and attractiveness levels are described in Table C of Attachment 2 in DOE Order 474.2, Change 4. Occasionally, categorization is difficult due to mixed types of nuclear materials, and assessors must make independent calculations to validate the MBA category and attractiveness levels. Assessors should request a physical inventory listing and internal

transfers for several MBAs, and validate that the types and quantities of material in the MBAs are consistent with their categorizations.

2.2.1.2 SSP/VAs

SSPs and VAs are vital documents that are required per DOE Order 470.4B Administrative Change 1, *Safeguards and Security Program*. The SSP defines the overall site security posture while the VA discusses the essential elements of the MC&A program and how they are integrated into the sites' overall protection strategy. Both documents should be reviewed by the MC&A assessor to ensure that MC&A is fully integrated and considered in the SSP and VA.

2.2.1.3 Facility and MC&A Organization Charts

The facility organization charts for the entire organization should be available since MC&A interfaces with security, operations, measurement, emergency, and analytical personnel. A typical MC&A Plan will contain organization charts for the MC&A organization, but it may be necessary to acquire other documentation to determine how MC&A is implemented at a site.

2.2.1.4 Operations Procedures

Assessors should review operations procedures to determine whether the MC&A program is adequately integrated into day-to-day facility operations. Intra-plant memos may be reviewed to determine how MC&A is integrated into the operation on an ongoing basis and to evaluate the facility's reaction to ongoing MC&A concerns.

Assessors should consider interviewing MBA custodians as one method of determining how MC&A requirements are implemented at the facility. A generic questionnaire (shown in Table 2-1 at the end of this section) can be used as a basis for conducting the interview.

2.2.1.5 Emergency Procedures

Assessors should review emergency procedures to evaluate the facility's plans for responding to potential emergency situations, such as an inadvertent criticality alarm, safety evacuation, or threat.

The facility is required to have an emergency plan and procedures outlining how to respond to and resolve anomalous conditions that indicate a possible loss of control of nuclear material.

2.2.1.6 Training Plans and Records

Facilities typically have a formal training program that outlines the requirements for all personnel involved in MC&A in accordance with objectives identified in DOE Order 474.2, Change 4, and the requirements in DOE Order 470.4B Administrative Change 1. The facility training program may be approved under the training approval program that is administered by the DOE National Training Center (NTC). Criteria established at the NTC require the facility to include a training plan that stipulates how the training needs of the organization are to be addressed and outlines the training requirements for all personnel who are involved in MC&A functions.

2.2.1.7 Evaluation Programs that Monitor MC&A System Effectiveness (Self-Assessments)

Assessors should review the plans, procedures, and follow-up actions that are used to determine and monitor MC&A system effectiveness. This program may include self-assessments and results of MC&A performance

tests, while some sites may assign a team to periodically assess the overall MC&A system effectiveness. Results of such assessments may identify systemic issues at the facility, as well as specific areas that should be included in the assessment. Most organizations have some type of central, integrated system to identify and follow the status of deficiencies identified during self-assessments, field element surveys, and assessments. Assessors should determine what system or systems are being used, and review the associated documentation. Some facilities use a comprehensive system that includes all safeguards and security-related deficiencies. At other facilities, each organization, such as MC&A, has a separate tracking system. If the site uses the Comprehensive Analyses of Safeguards Strategies (COMPASS) model to evaluate effectiveness, assessors should review the most recent COMPASS reports and supporting documentation.

2.2.1.8 Performance Test Plans

Assessors should obtain documentation of the MC&A performance testing program, including specific performance test plans for essential MC&A elements. Assessors should also review performance test results to determine how ongoing MC&A effectiveness is assessed through routine tests.

2.2.1.9 Occurrence/Incident Reports

Assessors should evaluate the facility's incident investigation and reporting program, which can be accomplished by reviewing occurrence reports for applicability to MC&A anomalous conditions.

The field element must independently evaluate the significance of incidents, in addition to any other evaluations or investigations by other DOE organizations or the Federal Bureau of Investigation. Reporting and investigation may also be required for nuclear materials in events involving radiological sabotage.

2.2.1.10 MC&A Surveys by DOE and Other Agencies

Assessors should review MC&A surveys to: (1) provide feedback to the PPM topic team on survey effectiveness; and (2) further focus the assessment on areas that may be particularly weak. Other agency surveys, audits, and reports may be applicable to MC&A. In particular, the DOE Inspector General, Government Accountability Office, Defense Nuclear Facilities Safety Board, or facility financial audits may identify MC&A issues that could require EA follow-up. After reviewing these reports, assessors may identify additional deficiencies to be examined by other topical teams or other MC&A assessors.

2.2.1.11 Contract Incentives

Each contractor has a specific contract that details the requirements for performing work at the site. Many contracts have specific provisions related to safeguards and security, and may contain specific provisions related to MC&A. These provisions should be reviewed to determine key drivers for the MC&A program that could serve as an assessment area to be reviewed. Assessors should determine whether contractor management is evaluated not only for cost effectiveness, but for the effectiveness of MC&A systems implemented at the site.

2.2.2 Documentation-Based Reviews

MC&A activities must be supported by adequate documentation. A significant portion of an assessment will entail reviewing site/facility documents to determine whether the MC&A program is being effectively implemented. These documents describe the MC&A organizational structure, and define the roles and responsibilities of individuals performing specific MC&A functions. There should be a set of approved procedures that institutionalize these responsibilities, as well as an approved training program that ensures that personnel are appropriately trained or otherwise qualified to perform their duties. Within the MC&A

organizational structure, there should be elements that are responsible for monitoring and testing the performance of the MC&A program elements, including identifying and reporting unusual events. The documentation should provide evidence that a system is in place to ensure changes to site operations are evaluated for impact to MC&A programs prior to implementation. A corrective action program should also be in place that monitors the status of MC&A improvements designed to eliminate deficiencies identified by both internal and external reviews.

2.2.2.1 MC&A Plan and Procedures

A key aspect of an assessment program is to determine a facility/site's compliance with the provisions incorporated in the MC&A Plan and implementing procedures. Facilities must have a current and approved MC&A Plan that addresses all of the basic MC&A functions. Organization charts should demonstrate MC&A organizational independence, while the MC&A Plan defines the operating policies for the various MC&A functions conducted at the facility and the procedures to implement those policies. Assessors should verify that each policy has a procedure and that requirements in the MC&A Plan and implementing procedures are consistent. Procedures should define the authorities and responsibilities of the MC&A personnel, and procedures should address the implementation of all MC&A elements. The plan may include a description of all key measurement points where accountability measurements occur. All plans and procedures should be maintained under a configuration management program. DOE line management approval of the MC&A Plan should be based on performance test and assessment data that demonstrate that MC&A systems are effectively implemented as described in the plan.

Compliance with the graded safeguards program must ensure that SNM, as defined in Table A of Attachment 2 in DOE Order 474.2, Change 4, is properly accounted for and protected, with gradation based on the consequence of loss. A review of the MC&A Plan and its integration with the accounting system will generally document compliance with this requirement. Physical inventory listings should be reviewed to ensure that MBAs are properly categorized based on the quantity and attractiveness level of materials present. Assessors should verify that MBAs are afforded the proper level of physical protection commensurate with the MBA category level (e.g., Category I MBAs are maintained within an MAA with access controls and surveillance).

Emergency plans should exist and address credible MC&A emergencies. Emergency plans must outline all responsibilities for personnel who respond to emergencies, address command and control functions and nuclear material alarm evaluations, and define the interface with other organizations, such as environment, health, safety, security, and operations. MC&A involvement should be evident in the facility emergency procedures.

Operations procedures that supplement MC&A procedures must be consistent with all MC&A documentation, must describe how to perform the MC&A functions for which employees are responsible, and should be readily available for reference. The procedures demonstrate a complete audit trail for all nuclear material from receipt through disposition and a records management system that complies with DOE standards. At many facilities, all procedures, instructions, and other documentation may be available only on computers, so computers must be readily available to all employees.

Assessors should compare the SSP to the MC&A Plan for consistency in defining targets, threats, and responses. VAs analyze the facility safeguards posture and identify the risk of theft or diversion of nuclear material. The assessor should review the SSP/VA to determine the MC&A input into this document and, where probabilities of detection are assigned for MC&A activities, should validate those probabilities and provide input to the PPM topic team. MC&A essential elements should be defined, and results of MC&A program element tests should be integrated into the safeguards and security VAs. The facility must take corrective actions for any vulnerability identified during system testing. The MC&A program should define MC&A critical system elements and, as a minimum, should include the following:

- Access controls
- Material surveillance
- TIDs
- Portal monitoring
- Accounting record system
- Inventory confirmation/verification measurement
- Inventory difference (ID) control limits.

Each approved MC&A equivalency and exemption should be reviewed to determine whether it contains appropriate justification, whether all required approvals and concurrences were obtained, and whether the equivalency/exemption is still warranted. Any special conditions associated with approved equivalencies or exemptions from requirements should be verified during data collection to ensure that the conditions of the approval are being met. Any pending equivalencies/exemptions should also be reviewed to determine their impact on the current assessment. Assessors should evaluate whether management has appropriately considered the cost effectiveness and any additional risks that have been assumed by implementing MC&A equivalencies and exemptions.

Assessors should review documentation associated with any terminations of safeguards on nuclear materials. Assessors should verify that: (1) the material was identified as attractiveness Level E, or (2) for higher attractiveness levels, the facility obtained the concurrence of the Officially Designated Federal Security Authority (ODFSA). Assessors should also review activities associated with decontamination and decommissioning (D&D), and the site should survey all pieces of equipment for potential nuclear material holdup. Additionally, assessors should examine the rationale for downgrading areas to a lower protection category, and review how "downgrading" activities are completed. Special interest should be directed to ventilation, off-gas, and common building "header" systems.

2.2.2.2 Evaluation Programs that Monitor MC&A System Effectiveness

Assessors should review the documentation used to evaluate MC&A system effectiveness, including evaluation methodologies and supporting backup data. Additionally, assessors should review the self-assessment program to determine whether self-assessments are performed regularly and whether all aspects of the MC&A program are reviewed. Selected self-assessment reports should be reviewed to determine whether root causes are identified when deficiencies are found. It is also helpful to compare the results of facility self-assessments to assessment findings or other audit results to learn whether the self-assessments are as effective as the audits.

Assessors should also determine who actually performs the self-assessments. If the persons who actually perform MC&A functions conduct the self-assessments, some form of independent verification or evaluation of the results should be conducted.

Assessors should determine whether deficiencies identified during self-assessments are entered into a tracking system, and how corrective actions are selected and achieved. Assessors should also review the tracking system used to monitor the conduct and results of self-assessments, as well as corrective action plans for deficiencies to determine whether deficiencies are analyzed and prioritized.

MC&A performance test plans should be comprehensive and fully support and validate the VAs. Performance tests must be designed to demonstrate that MC&A systems are functional and perform as intended. Tests should be effective evaluations of the MC&A components and should be conducted at a frequency consistent with an approved performance test program plan. The program design must focus on testing individual detection elements as well as integrated systems (e.g., individual TIDs should be

validated, as well as the overall system that controls TIDs from procurement through destruction). When reviewing system effectiveness determinations, assessors should identify areas that are performing poorly and determine what steps management has taken to correct the deficient areas.
Assessors should examine the facility's administrative controls, which are based on the facility's assessment program. Each facility possessing nuclear materials is required to have a documented program to periodically review and assess the quality and integrity of the MC&A system. The frequency and content of MC&A system assessments must be approved by the field element manager. The assessment program must address both normal and emergency conditions, and must identify the system elements, components, procedures, and practices that require periodic review and assessment. The facility should have documented assessments for the startup of new facilities and when significant changes occur in the operating status of facilities, operations, or the MC&A system. Assessment documents should identify the MBA, elements assessed, interviews and performance tests conducted, deficiencies identified, root cause analyses performed, and corrective actions required. The facility must have a tracking system for follow-up, and the field element must approve the assessment plan. The assessments should be completed as scheduled, and all assessment reports should be issued in a timely manner. MC&A assessment personnel should be competent, knowledgeable of MC&A, and qualified. Assessors should also identify personnel who should be included in the human reliability program (HRP) and share these results with the Personnel Security topic team.

Assessors should also determine whether schedules and milestones have been established, and whether specific responsibilities to ensure completion have been assigned down to the individual level. Finally, assessors should determine whether root cause analyses are being performed. If so, assessors should request documentation on root cause analyses for significant deficiencies listed in the tracking system, as well as the rationale for the chosen course of action. As a related activity, assessors may elect to review how any additional resources needed for corrective actions are introduced into the budget process.

2.2.2.3 Training Program

The facility is required to have an MC&A organization with trained and qualified personnel who administer and oversee MC&A functions at the facility. In addition, operations units performing MC&A functions must maintain trained support personnel. The training program is an integral part of the MC&A Program Management subtopic.

The MC&A training plan should define formal classroom instruction, on-the-job training (OJT), computer-based training, and any specific offsite training, as well as define re-qualification or re-training needs and schedules. Instructors must be qualified for the subject matter they are teaching and must be able to demonstrate their proficiency. Records should show that job analyses have been performed for each MC&A activity. In addition, comprehensive lesson plans must be available for each training topic. These lesson plans should include statements of objectives, materials needed, and teaching methods (e.g., lectures, demonstrations, and hands-on practice). Regardless of which method is used, mechanisms should be implemented to determine whether trainees have mastered the objectives and are qualified to perform MC&A activities. The training profile maintained for each employee must indicate the specific training, training date, and results of any administered tests. Any re-training or offsite training and results should also be included in the records. These records may be filed in a central training office, the MC&A department, or the employee's departmental office. The training program must also include a system that identifies those individuals who require periodic re-training or re-qualification before the specified period elapses. Personnel who typically should be included in the training program are:

- MC&A personnel
- MBA custodians
- TID custodians, applicators, and verifiers
- MC&A accounting personnel

- Measurement personnel
- Process operators
- Material handlers
- Statisticians
- Certain protective force (PF) personnel.

Depending on the scope of the assessment, assessors should request and review the training records for several personnel who have MC&A responsibilities. Assessors may also evaluate the training programs to determine whether they are achieving their stated objectives. The exact scope of this effort depends on the status of the facility and the results of prior assessments. Typically, if prior assessments found that the training program met its stated objectives, the current assessments might consist of a few interviews and a limited records review. A similar approach would be taken for the review of training materials. If new personnel were assigned to an MC&A function or new training materials were developed, these additions would be logical targets for the current oversight assessment.

2.2.2.4 Other Nuclear Material Requirements

Other nuclear materials to be accounted for are defined in Table B of Attachment 2 in DOE Order 474.2, Change 4. Neptunium-237, americium, source, and other materials are generally subject to minimum protection requirements. When neptunium-237 and americium are separated, they must be controlled and accounted for as SNM, as defined in Table C of Attachment 2 in DOE Order 474.2, Change 4. Assessors should determine that the facility has provided at least the minimum MC&A safeguards required for these materials – that is, these materials are listed in the accountability records, periodically inventoried, and included in Nuclear Material Management and Safeguards System (NMMSS) reporting. Assessors should also ascertain whether the field element manager has determined other specific requirements for these materials.

2.2.2.5 Loss Detection Element Evaluation

Assessors should evaluate the facility's approach to loss detection. All facilities that possess Category I quantities of material must develop and perform VAs to ensure that they can adequately detect losses of material. The VAs must address the same points established for the preparation of the SSP. The site is required to annually review and update the VAs in order to incorporate changes in safeguards systems or risks. Additionally, the head of the field element's MC&A organization must approve the VA before it can be submitted as part of the SSP.

2.2.2.6 Occurrence Investigations and Reporting

Assessors should evaluate the facility's incident investigation and reporting program. Occurrence reports should be reviewed for applicability to MC&A anomalous conditions. Each MC&A anomaly should be reviewed to ensure that the occurrence was categorized appropriately, proper notifications were made in a timely manner, and root cause analyses were performed.

The field element must independently evaluate the significance of incidents, in addition to any other evaluations or investigations by other DOE organizations or the Federal Bureau of Investigation. Reporting and investigation may also be required for nuclear materials in events involving radiological sabotage.

2.2.2.7 DOE Operations Office MC&A Surveys

MC&A topic assessors review the field element's MC&A survey reports and share the results with the PPM topic team. The evaluation of the field element MC&A survey group should be based on whether:

- Surveys were conducted on time and reports were issued in a timely manner.
- Surveys were sufficiently comprehensive to adequately rate the facility MC&A program.
- Survey findings were tracked and resolved in a timely manner.
- Survey ratings were consistent with survey report narratives and work papers.
- Surveys included independent performance testing.
- Surveys included obtaining independent measurements.
- Surveys included the status of previous EA MC&A findings.
- Survey results were provided to the facility in a timely manner so that corrective actions could be implemented.

The MC&A assessment team should determine whether the status of the contractor's system has been accurately communicated to DOE Headquarters.

Assessors should also review the role of DOE oversight by interviewing selected DOE field element personnel to determine how DOE implements its responsibilities. Specific items to cover include how DOE reviews the contractor MC&A program functions during surveys, how DOE tracks program status, and how DOE and the facility interact on a day-to-day basis. Additionally, key facility managers should be interviewed to gather their views on the same subjects.

2.2.3 Performance-Based Reviews

In addition to reviewing documentation to evaluate how well a facility's MC&A program is being implemented, assessors must test and/or observe some elements of the program to validate that systems are performing effectively. These tests may include personnel interviews, observation of performance in the field, special inventories, measurements, and introduction of anomalies to test personnel response to abnormal situations. Some or all of the activities described in this section may be used by assessors to verify MC&A program performance.

2.2.3.1 Conduct Knowledge Tests

Assessors may choose to administer knowledge tests, normally to a randomly selected sample of MBA custodians, material handlers, process operators, and/or PF personnel. Assessors may ask the training instructor to administer a written test. Test questions can be selected from the facility's training library or prepared by the assessors based on the facility's procedures and other training materials. When assessors administer their own knowledge tests, they must validate the test with knowledgeable facility personnel to ensure that the questions are valid and meaningful, and that an acceptable pass/fail criterion has been established. For this reason, assessors usually have the facility administer a subset of its existing test questions.

2.2.3.2 Observe Training Classes

After reviewing the facility's training plan and schedules during assessment planning, assessors should observe a class being conducted, either a previously-scheduled class or one specifically requested by the assessment team. Observation allows the assessor to evaluate instructor qualifications, comprehensiveness of the training, adherence to the lesson plan, and in some cases, application of remedial training. This performance test is particularly important if assessors find indications that a facility's employees are not sufficiently trained.

2.2.3.3 Conduct IRAs/Performance Tests

As part of the evaluation of the Program Management subtopic, assessors may ask the facility to conduct one of its pre-approved performance tests for EA to observe. Assessors may also ask the facility to perform one of the tests conducted as part of the facility VA.

Assessors could also request that facility personnel conduct a self-assessment so that assessors can validate assessment personnel qualifications and observe performance in the area being evaluated. If the opportunity arises, assessors could observe a scheduled self-assessment that is conducted during (or near) the onsite assessment activities.

2.2.3.4 Observe Facility Operations

Observation of facility MC&A activities that are defined in operating procedures is a key aspect of the performance review. Assessors would observe procedure compliance and effectiveness of operations that may include:

- Conduct of nuclear material transfers
- Conduct of physical inventory
- Conduct of bulk or volume measurements
- Conduct of nuclear material measurements
- Conduct of process and item monitoring activities.

2.3 Common Deficiencies/Potential Concerns

2.3.1 MC&A Programs Compromised

The DOE complex has experienced several safety, operational, production, environmental, and material stabilization concerns during the past decade. As facilities have developed plans to recover from these concerns, there have been instances where the MC&A requirements were compromised, often without adequate compensatory measures, assessments, and/or appropriate levels of approval; examples include failure to take physical inventories, perform measurements, and conduct internal reviews. Without an adequate MC&A system, there is no assurance that all material is accounted for. While an assessor must be sensitive to safety and operational issues, the facility MC&A program must demonstrate a proactive approach to these issues. Requests for equivalencies/exemptions, additional VAs, and increased performance testing are examples of activities that can be performed to deal with such issues when MC&A systems have the potential for compromise. In addition, facilities must have plans to restore the MC&A system to normalcy after a compromise. These issues can be evaluated by reviewing DOE MC&A surveys, internal assessment reports, and occurrence reports, and through general interviews with management.

2.3.2 Inadequate Staffing

Some facilities simply do not have a sufficient number of experienced and qualified staff to accomplish MC&A functions. A related problem occurs when a facility's MC&A managers cannot effectively manage the program, either because they supervise too many people (excessive span of control), or because they have other duties that deflect their attentions from their MC&A responsibilities. In some cases, the site may have adequate staff but may have a non-optimal skill mix, resulting in shortages in certain areas and/or delays in performing certain functions. Staffing concerns are evaluated by examining the MC&A activities that are not being completed or are being completed inadequately.

2.3.3 Lack of MC&A Participation in VAs

A comprehensive VA of MC&A functions must be approved by the ODFSA before it can be included in the SSP. However, VA teams often do not include an MC&A-oriented individual to properly assist in assessing MC&A functions. MC&A activities that support VAs must have assigned detection probabilities based on performance testing. Often, in order to gain approval for the VA, a facility may assign these probabilities subjectively, resulting in a VA that may not indicate the full implications of risk at the facility. Assessors can generally identify this situation during reviews of VA data and interviews with the personnel responsible for completing the VA.

2.3.4 Deficient MC&A Documentation

Facilities must maintain documentation, including an MC&A Plan that describes the MC&A program as implemented and ensures that all changes to the program are properly recorded and reflect the current operating mode. It is not uncommon for an assessor to find that the MC&A Plan is incomplete, lacks depth or references, cites supporting documents that are not consistent with the plan, or has not been properly approved. Such deficiencies in the MC&A Plan may result from a lack of understanding of this important base document or the field element's failure to interact with the facility to ensure that the MC&A Plan is comprehensive, current, and approved.

Other documentation problems may be caused by operations personnel who are unfamiliar with MC&A requirements or MC&A personnel who lack sufficient familiarity with operational processes to ensure that MC&A requirements are adequately addressed. Either problem may result in improper nuclear material transfers, failure to obtain appropriate measurements, improper conduct of nuclear material inventories, or failure to apply other safeguards measures as required. Deficiencies in MC&A documentation are identified as part of the compliance reviews performed under the Program Management element or during performance testing of MC&A operational activities.

2.3.5 Deficient Contract Incentives for MC&A

Facility contracts contain incentives for motivating contractors to perform work for DOE, and contractors often prioritize their work efforts in areas that offer the largest incentive fees. If contract incentives for MC&A activities are relatively small or nonexistent, the MC&A program may be weak. Equally important, if senior contractor managers perceive that MC&A requirements hamper the achievement of their operational or production goals, a weak MC&A program may result. Deficiencies are detected during data collection activities when assessors review the contract incentives that influence contractor MC&A performance, both positively and negatively.

2.3.6 Deficient Training Program

Each facility is required to maintain training and retraining programs to ensure that personnel performing MC&A functions are trained and qualified to perform their duties and responsibilities. Deficiencies that have occurred include the failure to conduct proper job task analyses, provide adequate training or retraining, maintain training records, and provide meaningful testing and retraining. These deficiencies are usually caused by a lack of management attention and an assumption that "once trained, always trained." A deficient training program results in personnel not performing MC&A activities correctly, thus minimizing the protection of SNM provided by the MC&A program. Interviews with personnel who perform MC&A functions will generally reveal the quality of the MC&A training program, and knowledge-testing of personnel assists in determining the effectiveness of the training program.

2.3.7 Multiple Contractors Performing MC&A Activities

In some cases, multiple contractors perform specific MC&A activities (e.g., one contractor may maintain accountability records, while a separate contractor "owns" the nuclear material). In these cases, the assessor must determine which contractor (or contractors) is responsible for the deficiency. As deficiencies are identified at sites where multiple contractors perform MC&A activities, EA conducts reviews to determine how the multiple-contractor interface contributed to the observed deficiency.

2.3.8 Deficient MBA Categorization

MBA categorization is important because of the different levels of protection required for each category. A common deficiency in MBA categorization involves misapplying the definitions that are used to determine the category and attractiveness levels of materials. In order to affect MBA categorization, a facility may mix non-nuclear material with nuclear material to reduce the attractiveness level of items so that when a large number of items are combined in an MBA, the category of the MBA decreases (e.g., from Category I to Category II). A decrease in the MBA category level allows a reduction of the security posture. The assessor needs to ascertain whether this type of activity masks the true categorization of the MBA in which the material resides. Failure to understand the categorization and attractiveness level requirements may cause the facility to misapply MC&A and protection requirements for the involved MBA. This problem becomes evident when assessors review and compare MBA inventories, MBA categorizations, and material descriptions.

2.3.9 Failure to Follow Safeguards Termination Requirements

DOE nuclear facilities will continue to transition from production sites to material consolidation and storage sites, and to conduct environmental restoration efforts. Consequently, safeguards for some SNM will be terminated. The attractiveness level of the material for which safeguards are to be terminated must be documented, and the categorization must be supported. In some cases, the ODFSA must approve the safeguards termination. Concerns arise when categorization criteria are misapplied and material disposition is not properly handled, or when VAs are not conducted when termination is considered for Category II or greater quantities of SNM. Failure to adhere to the specific termination of safeguards requirements could place SNM at risk by permitting a Category I quantity to be located outside an MAA or a Category II quantity to be located outside a Protected Area (PA). Reviewing approved writeoffs and supporting documentation will indicate the types and quantities of nuclear materials involved so that assessors can determine whether safeguards were terminated properly.

2.3.10 Deficient D&D Activities

Sites undergoing D&D operations may have to downgrade security areas in order to facilitate D&D activities. However, concerns arise when categorization criteria are misapplied, material disposition is not properly handled, or VAs are not conducted when an area is considered for downgrading. Failure to adhere to specific safeguards requirements could place SNM at risk by permitting a Category I quantity to be located outside an MAA or a Category II quantity to be located outside a PA. Assessors should review activities associated with D&D to ensure that the site has surveyed all pieces of equipment for potential nuclear material holdup. Assessors should also examine the rationale for downgrading areas to a lower protection category and review how downgrading activities are completed.

2.3.11 Deficient Performance Testing Programs

The site's performance testing program is a major tool that allows site management to evaluate the effectiveness of their own MC&A program and ensure that it maintains integrity. Deficiencies in performance testing may include poor quality tests, failure to test all critical system elements, failure to integrate tests to ensure overall protection of SNM, and failure to conduct an adequate number of tests. These deficiencies may be caused by a

lack of management attention, failure to obtain or allocate knowledgeable personnel, or failure to recognize the importance of performance testing. Deficiencies in performance testing can invalidate VAs or misidentify potentially critical MC&A system elements. These problems can often be identified during review of facility performance testing data, or by performance tests conducted by the assessment team.

2.3.12 Deficient Occurrence/Incident Investigation and Reporting

Each facility must identify MC&A loss detection elements and establish a program for monitoring these elements to determine the status of nuclear material inventories and to identify reportable occurrences. MC&A and facility personnel tend to delay reporting due to optimistic views that internal review and investigations will identify and correct anomalies. Delays in reporting occurrences preclude the field element from independently evaluating the significance of the occurrence and potentially reporting it to DOE Headquarters and program offices. The MC&A organization must receive all operational and security incident reports to determine whether SNM was at risk and notify the affected site office.

2.3.13 Deficient Review and Assessment Program

Assessments are necessary to ensure that all elements of the MC&A program function as required, and the lack of an effective self-assessment program can result in deficiencies going undetected and uncorrected for extended periods. Typical deficiencies in the assessment program include a lack of comprehensiveness in the assessments, a lack of sufficient or properly qualified staff to conduct the reviews, a failure to conduct adequate performance tests, a lack of commitment to the approved schedule, and inadequate follow-up for identified deficiencies. Failing to conduct performance tests when new operations are started or significant changes in operations are made, or conducting improper tests, often results from the inability of staff to fully comprehend the complexities of performance testing. These noted deficiencies often result in degradation of the MC&A system and become evident during document reviews and personnel interviews. In many cases, document reviews reveal the lack of comprehensiveness in the self-assessment program and the lapses in the assessment schedule. It is important that assessment personnel are competent, and that they have training in auditing protocols and certification by a credible auditing entity. A review of training records and interviews with assessment personnel will indicate whether personnel are adequately qualified.

2.3.14 No Root Cause Analysis of Deficiencies

A potentially serious management deficiency is the organization's failure to determine the underlying cause of deficiencies. This deficiency usually results in the same deficiencies recurring. In many cases, the organization corrects the surface problem or symptom rather than identifying and correcting the underlying cause—the root cause. If performed correctly, a root cause analysis may reveal the causes of errors (e.g., ambiguous procedures or insufficient training). Unless management accurately determines the root cause of identified deficiencies, similar deficiencies will likely recur.

2.3.15 Inadequate Corrective Action Plans

The lack of adequate corrective action plans is a common and potentially serious problem that can result in deficiencies not being corrected. Organizations often do not effectively accomplish one or more of the following actions: (1) analyzing (root cause and cost effectiveness) and prioritizing deficiencies so that resources can be used to correct the most serious issues first; (2) establishing a corrective action schedule with milestones so that progress can be monitored and slippages identified early; (3) assigning responsibility for completion to specific organizations and individuals; (4) continually updating the plan as known deficiencies are corrected and new ones are identified; (5) ensuring that adequate resources are applied to correcting deficiencies; (6) ensuring that the identified problem is not common in other areas of the facility; and (7) ensuring that corrective actions have been completed and fully implemented. Frequently, facility managers

devote their resources to correcting symptoms rather than the root causes of the deficiencies. In some cases, management allows operational performance incentives to override MC&A requirements.

2.3.16 Deficient MC&A System Effectiveness Determinations

Sites that incorporate models to determine MC&A system effectiveness may use either quantitative or qualitative data that produce overall ratings as qualitative (e.g., excellent, good, poor) or quantitative (e.g., 1 = poor, 10 = excellent). The methodologies employed may be subjective (e.g., based on a group discussion of performance data) or objective (e.g., no findings = 10 and deduct 1 point for each finding). The variety of methodologies presents a challenge for assessors who must not only dissect the methodology used, but also understand the implications of bias and sensitivity to each model used.

Several pitfalls must be avoided when rating an MC&A system as High, Medium, or Low, as both underrating and overrating the program are possible. A facility may want to underrate itself to draw attention to the program as a means of encouraging management to allocate resources to an area. A facility may also overrate its program so as not to draw management attention to it. Thus, the more realistic, quantitative, and current the data, the more objective the rating becomes.

With a quantitative system that employs weighted averages, a sensitivity analysis must be completed to ensure that objectives are met. For example, if an important element is totally ineffective, the model should show a marked decrease in overall effectiveness; if only a slight decrease is noted, the weights may be incorrect or there may be too many elements rated which dilute the overall significance of a single element.

If a model uses key elements as well as sub-elements (a methodology used by COMPASS), some sub-elements may be used in multiple elements. This strategy may truly represent the MC&A system, but the evaluation of the sub-elements should be independent and data should be available for each sub-element. If no data was generated for a sub-element during the evaluation period, the evaluation must take this into consideration when assigning overall ratings; for example, if a sub-element was not assessed, it could be given a "0" or the same rating as the previous period. The assessor must evaluate the implications of this determination.

If a key element, such as termination of safeguards, is not "used" during an evaluation period (i.e., no material was terminated), the overall system effectiveness should not be impacted, either positively or negatively, in an effectiveness determination.

2.4 References

CG-SS-4, DOE Classification Guide for Safeguards and Security Information
DOE Order 151.1C, *Comprehensive Emergency Management System*
DOE Order 227.1, *Independent Oversight Program*
DOE Order 232.2, Administrative Change 1, *Occurrence Reporting and Processing of Operations Information*
DOE Order 251.1C, *Departmental Directives Program*
DOE Order 470.3B, *Graded Security Protection (GSP) Policy*
DOE Order 470.4B, Change 1, *Safeguards and Security Program*
DOE Order 472.2, Change 1, *Personnel Security*
DOE Order 473.3A, *Protection Program Operations*
DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*
DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*

Table 2-1. MBA Custodian Interview Questions

1. For what MBA(s) are you the custodian?
2. What line organization do you work for?
3. How long have you been an MBA custodian? Same MBA?
4. What is the function of this MBA?
5. What kinds of nuclear materials are contained in the MBA?
6. What is the category of the MBA?
7. For Category I MBA:
    - Containment features?
    - Access procedures?
    - Surveillance procedures?
    - Daily Administrative Check procedure?
8. Do you have procedures for this MBA? Where are the procedures maintained?
9. Do you assist in preparing the procedures?
10. Do you have access to any procedures other than your MBA procedure?
11. Do you have an inventory listing of nuclear materials in your MBA?
12. Do you assist in taking the physical inventory?
13. When was the last inventory of your MBA conducted?
14. What kind of training have you received?
15. Do you get refresher training? How?
16. Do you deal with TIDs in your MBA? Applicator? Witness?
17. What is the frequency of activity in your MBA?
18. How do transactions involving your MBA get recorded in MC&A accounting records?
    - Transfers and receipts?
    - TID removals and applications?
    - Measurement results?
19. When was the last self-assessment conducted of your MBA?
20. Are you the custodian for other MBAs?
21. Who is your alternate?
22. What was your job before you became an MBA custodian?
23. If there was one thing you would want to change about your job, what would it be?

Section 3: Material Control

3.1 General Information

The Material Control subtopic ensures that nuclear material is not removed from an authorized location without approval or timely detection. The program is intended to provide protection for all nuclear material consistent with the graded safeguards concept. Containment measures typically consist of several layers of protection that may include MAAs, PAs, MBAs, storage repositories, and processing areas. DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*, identifies five Material Control objectives that a site/contractor MC&A program must meet. An acceptable program will:

- Detect, assess, and deter unauthorized access to nuclear material.
- Detect, assess, and communicate alarms to response personnel, in time to impede unauthorized use of nuclear material.
- Provide loss detection capability for nuclear material and, when not in its authorized location, be able to provide accurate information needed to assist in locating the material in a timely manner.
- The material containment and surveillance program, in conjunction with other security program elements, must have the capability to detect, assess, and respond to unauthorized activities and anomalous conditions/events.
- In coordination with security organizations, material control measures assure that appropriate protection and controls are applied to nuclear materials according to the quantity and attractiveness of the material.

Performance metrics, such as those documented in DOE Order 474.2, Change 4, Attachment 3, may be addressed in the MC&A Plan to demonstrate how the MC&A program will meet the five Material Control objectives, and can be used by assessors to assist in the evaluation of the Material Control subtopic. In addition to the performance metrics documented in DOE Order 474.2, Change 4, guidance on meeting Material Control objectives is described in the DOE Technical Standard, DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*, Section 6.2, Material Control. Alternative performance metrics to those described in DOE Order 474.2, Change 4, may be documented in the approved MC&A Plan. These alternate metrics will be used for evaluating compliance with the Material Control objectives.

Some material control measures pertain to physical security systems as well as MC&A, and the assessment responsibility may be delegated to either topic team, or both. As a general rule, the Physical Security Systems (PSS) topic team examines hardware, such as SNM and metal detectors, and interacts with the MC&A topic team as necessary. The topic leads of these two teams routinely coordinate their activities to avoid missing important elements or duplicating effort.

Experience has shown that reviewing documentation and subsequently evaluating the Material Control objectives is an effective way to organize material control program assessment activities. For the program to be adequate, the material control measures must be documented in plans, policies, and procedures, and must be effectively implemented.

Each facility is required to have measures for controlling access to vital areas. Nuclear materials accountability is accomplished through establishing defined MBAs. Access controls may vary from complex systems for Category I MBAs to administratively controlled systems for Category IV MBAs. All Category I facilities are required to have MAAs and PAs to facilitate the protection of SNM.

Each facility is required to have a material surveillance program. Surveillance programs include automated or direct visual observation. The most prevalent material surveillance mechanism throughout the DOE complex is the two-person rule. For Category I SNM, individuals with two-person rule responsibilities are enrolled in the HRP. Surveillance requirements are more comprehensive for Category I and II quantities of SNM than for Category III and IV quantities.

Material containment is facilitated through delineation of MAAs, PAs, and MBAs. It is incumbent on the MC&A function to establish the relationship between MBAs and MAAs, and to ensure that an MBA does not cross an MAA boundary. For each area, the MC&A program is required to define the authorized activities, the location of materials, material types and amount authorized, surveillance mechanisms, and material controls in effect. Storage repositories are also a vital component of containment systems. Storage repositories may have both a records system documenting ingress and egress, and defined procedures for conducting inventories and daily administrative checks (DACs). Processing areas often have similar requirements; however, the requirements are typically more specific and tailored to the particular nuclear material processing operation. To maintain effective control of process materials, the amount of nuclear materials contained or used in processing should be limited to what is necessary for operational requirements. Otherwise, nuclear materials should be stored in repositories or kept in enclosures designed to ensure that access will be limited to authorized individuals.

An important aspect of material control is detection and assessment. Detection and assessment mechanisms include:

- **TID program.** This program complements the inventory verification and confirmation program. The TID program is administered by the MC&A organization, but implementation is usually the responsibility of the MBA custodian.

- **Portal monitoring.** Conducted at all routine MAA and PA exits, portal monitoring includes routine searches of all personnel, vehicles, and packages. Portal monitoring devices must be capable of detecting metal, SNM, and shielded SNM.

- **Waste stream monitoring.** All liquid, solid, and gaseous waste streams, including environmental releases, are required to be monitored. A response plan for evaluating and resolving discharges exceeding approved limits must be included in the waste monitoring program.

- **DACs.** The DAC program can be utilized at Category I MBAs or where the potential for rollup to a Category I quantity of SNM exists. These checks typically consist of item counts, TID verification, records review, and a thorough examination of the material control measures for each Category I area.

Material control program elements must ensure that nuclear materials are adequately protected consistent with the graded safeguards concept. Program effectiveness may be assessed by analyzing the successive layers of protection that an insider would have to defeat or circumvent in order to remove or divert materials.

Information about the facility's material control program is generally obtained by reviewing policies and procedures; interviewing managers, staff, and operating personnel responsible for MC&A activities; observing material control practices; and conducting performance tests. This assessment process provides assessors with a sense of how well the material control program is structured, documented, and implemented.

Figure 3-1 summarizes the assessment activities that are most commonly performed by the MC&A topic team for each Material Control subtopic area.

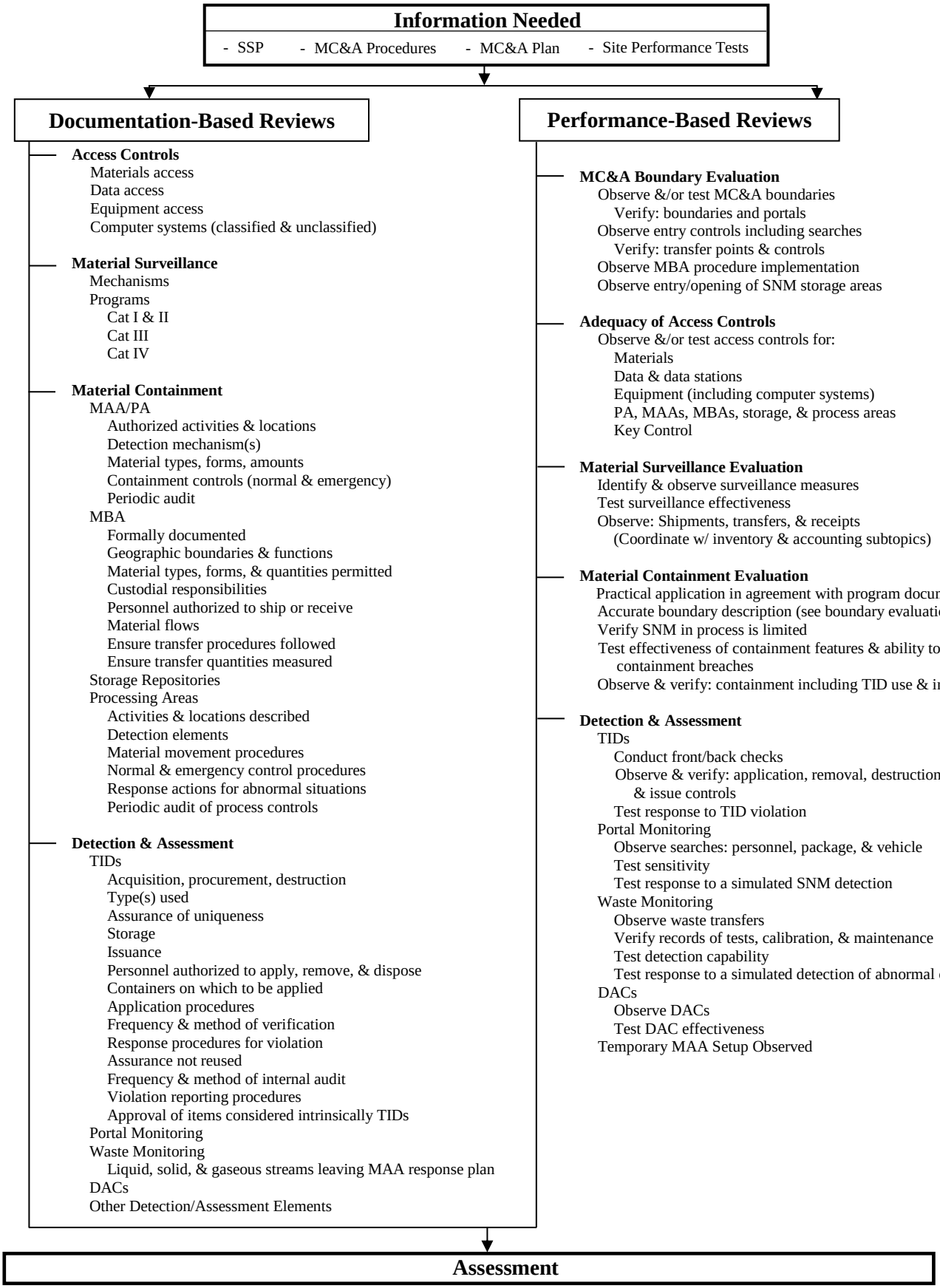

Figure 3-1. Assessing Material Control

3.2 Data Collection Activities

3.2.1 Information Needed

In preparation for the actual assessment effort, assessors need to review certain site-specific documents that should provide the details of how the material control program is implemented at the facility. These site-specific documents may include:

- SSP
- MC&A Plan (sections relating to material control)
- MC&A procedures (e.g., containment, surveillance, access control, nuclear material transfer, and MBA operating procedures)
- Facility material control performance test plans and test results
- IRA results
- Field element survey reports.

In reviewing this documentation, assessors should develop an understanding of the material control mechanisms and practices in use at the site. The documentation review should also help assessors determine how and how well the material control program interfaces with other MC&A program elements. During the assessment, it is important to note any discrepancies between the documented program and the program as actually implemented and observed.

When assessing MC&A material control practices, assessors should include interviews with the following personnel (note that each site may have different titles):

- Operations personnel and managers
- Safeguards & Security Director
- MC&A manager
- Material handlers
- MBA custodians
- Assessment coordinator
- Training coordinator.

Assessors should use initial briefings and interviews at the site to resolve questions that result from document reviews, and should identify any additional documentation (for example, procedures, memoranda, and lists) that is required to conduct the assessment. Additional details that may be covered at this initial meeting include:

- Identifying individuals who will be assigned as points of contact for material control assessment activities
- Discussing material transfers, including activities for shipments and receipts, waste discards, and any planned activities
- Assessing the facility's current material control posture
- Providing logistics for conducting material control performance tests

- Identifying special considerations or facility conditions that could impact data collection or the assessment plan
- Considering any additional information not contained in the documents that were reviewed.

3.2.2 Documentation-Based Reviews

To evaluate the compliance of the facility material control program, assessors should determine whether the program documentation is complete, current, and approved by the appropriate oversight personnel. Some aspects of material control are implemented by organizations other than the MC&A group; for example, procedures related to material control may be developed by security or operations organizations as well as the MC&A organization. Regardless of which organization develops or implements procedures, assessors should review these documents to determine whether applicable material control measures are addressed appropriately.

Assessors should review the facility's plans and procedures to determine whether they meet applicable requirements and are consistent with the security and MC&A plans. The assessor should also determine whether:

- Personnel who perform MC&A functions are knowledgeable of, and have access to, the applicable procedures.
- Procedures have been distributed to all personnel who must implement them.
- Personnel correctly understand and implement the procedures.

3.2.2.1 Access Controls

Assessors should determine whether the facility has established a graded program for controlling access to nuclear materials, accountability data, and items or equipment vital to the MC&A program. Assessors should also determine whether the program, as documented, is capable of ensuring that only authorized personnel have access to nuclear materials, data, and equipment. The program should be examined to determine whether it addresses procedures and mechanisms to detect and respond to unauthorized access.

Assessors should review processing areas and operations to determine what quantities of nuclear material are reasonable to sustain operating schedules. Assessors should also ensure that excess materials are not stored in processing areas, but in appropriate storage repositories equipped with mechanisms to limit access to authorized individuals.

Assessors should determine whether Category I quantities of SNM are used or stored within an MAA enclosed within a PA, with ingress and egress restricted to defined portals and pathways subject to material and personnel controls. Additionally, assessors should review material categories using the Graded Safeguards Table and the MBA structure to ensure that appropriate access controls are in place for Category I, II, III, and IV quantities of material. For Category III and IV areas outside of a PA, assessors should review VAs to determine whether accumulation of a Category I quantity has been addressed and evaluated as "not credible."

Assessors should review the equipment and procedures used to control access to processing areas. The review should include access authorization lists, entry controls, personnel identification and verification systems, and access logs. Typical methods for controlling entry to processing areas include locks, keys, card readers, badge systems, and administrative controls. For these mechanisms, the procedures and equipment should be effective for their intended purposes and should be consistent with provisions stated in formal documentation.

Assessors should determine whether access controls are sufficient to prevent unauthorized personnel from gaining access to MC&A data or data-generating equipment, and to prevent personnel with authorized access from performing unauthorized activities. Assessors should review procedures and equipment to

determine whether material control measures are sufficient to ensure that only authorized persons have access to computer systems that contain MC&A data; this aspect of the assessment requires coordination with the cyber security assessment team.

Assessors should review the access controls established for special data-generating equipment, measurement equipment, and data recording devices. The controls should provide assurance that the integrity of data and equipment is maintained. This aspect of the assessment requires coordination with the Measurement/Measurement Control subtopic.

Assessors should also review the controls used to ensure that the correct MC&A data is entered and that any changes are fully auditable. This aspect of the assessment requires coordination with the Accounting subtopic.

3.2.2.2 Material Surveillance

Requirements for material surveillance are divided into surveillance mechanisms and surveillance programs, and are applicable to storage repositories as well as processing areas. Assessors should determine what surveillance mechanisms are employed by the facility. Automated mechanisms should be assessed to ensure that they provide coverage for the identified areas, detect anomalies, and report alarm conditions.

The material surveillance program may include one or more of the following surveillance mechanisms:

- Intrusion alarms in unoccupied areas
- Personnel observations (e.g., two-person rule)
- Automated surveillance (e.g., digital imaging)
- Health and safety alarms
- Shelf monitors
- Item motion detectors
- Process monitoring controls and instrumentation.

Personnel surveillance/observation is usually accomplished by some form of the two-person rule. This surveillance mechanism is the most common method of providing material surveillance for material in processing areas, and for accessing or conducting activities in storage repositories. Procedures for the two-person rule should specify what is required (constant visual contact, two persons in same room, two persons in same vault, etc.).

Assessors should ensure that surveillance procedures provide for investigation, notification, and reporting of anomalies. Card reader systems, SPO procedures, and double-lock systems are common methods for enforcing the two-person rule.

Assessors may review access logs and records for selected areas to determine whether entry requirements are implemented per procedure.

Assessors should interview operations managers, material handlers, and MBA custodians to determine whether staff members understand the material surveillance measures for their areas and how to implement them. Process logs, inventory records, and other types of operational information are mechanisms that might identify anomalies. Assessors should determine whether this type of documentation is available and whether procedures specify that investigations be initiated when anomalies are identified.

MC&A program documentation should describe the material surveillance methodologies and operational control points upon which the program is based. Assessors should determine whether the procedures for Category I and II quantities of SNM require the following:

- Only knowledgeable and authorized personnel with appropriate clearances are assigned surveillance responsibilities.
- Controls are in place to ensure that one individual cannot gain access to SNM.
- Surveillance mechanisms are in effect when storage repositories are not locked and alarmed.
- All persons in a secure storage area are under constant surveillance.
- Surveillance mechanisms are available to ensure that there is no unauthorized accumulation of a Category I quantity of SNM outside an alarmed storage area.
- For Category II, III, and IV MBAs, the MC&A program routinely monitors movement of SNM to prevent rollup from occurring outside appropriate security areas.
- SNM in use or process is under surveillance, under alarm protection, or protected by alternative means approved by the DOE field element.

Assessors should review the surveillance procedure for Category III quantities of material to ensure that it specifies that when the material is not contained in locked storage, the material must be attended, be in authorized locations, and not be accessed by unauthorized individuals. For Category IV quantities of material, assessors should review the site-specific procedure approved by the field element for adequacy.

3.2.2.3 Material Containment

To adequately protect SNM, facilities are required to implement controls that ensure Category I quantities are used, processed, or stored only within an MAA. The MAA must be enclosed in a PA. All Category I facilities should have at least one MAA. Category II quantities of SNM are required to be used, processed, or stored in a PA.

Assessors should identify all MAAs and their boundaries to determine whether the MAAs are within PAs, as required. This identification can usually be accomplished through a review of documentation (including floor plans), interviews, and a tour of the areas. Assessors should verify that sufficient controls are implemented to ensure that Category I quantities of SNM are used, stored, or processed only within an MAA. The MAA is an important material containment feature that must have clearly defined barriers and designated portals. Therefore, assessors should:

- Determine whether barriers are sufficient to provide assurance that SNM cannot be removed from an MAA without detection.
- Review MAA protective systems to determine whether all personnel, vehicles (if any), and hand-carried items are searched to prevent SNM removal, and whether all emergency exits are alarmed.
- Examine procedures to determine whether access to MAAs is limited to designated portals, and whether the authorization and identity of all personnel entering the MAA is verified.

The MBA is the fundamental component around which a site nuclear material accountability program is structured. Therefore, assessors should:

- Identify the location, boundaries, and category designation of each MBA. Category I MBAs must be contained within an MAA. The MAA boundary should coincide with an MBA boundary at locations where material is being transferred in or out of an MAA. Category II MBAs must be contained within a PA.

- Ensure control measures are in place for nuclear material in use and in storage that deter, detect, assess, and report loss or misuse.

- Determine whether the facility's MBA structure is capable of localizing IDs and can demonstrate that a loss of a Category I quantity will be detected within sufficient time to allow effective reporting and execution of response measures, with a 95 percent probability unless otherwise specified in the SSP. This effort should be coordinated with the Accounting subtopic. MBAs should be reviewed to determine whether a qualified MBA custodian is designated for each MBA.

- Ensure that procedures specify administrative controls, material flows, material transfer requirements, and measurement requirements for material crossing MBA boundaries. The MBA structure must limit the MBAs to integral operations and a single geographical area. Assessors may choose to review selected MBAs to determine whether these requirements are met.

- Ensure that, unless alternative measures are described in the MC&A Plan, an MBA custodian is not responsible for multiple MBAs when transfers of nuclear material occur between those MBAs (i.e., a single custodian must not serve as both shipper and receiver for material transfers for the same nuclear material).

- Review the equipment and procedures used to control access to material in MBAs. Assessors should identify all routine and emergency portals and pathways associated with the MBA to determine whether they are consistent with the requirements prescribed for the MBA.

Containment measures are also required for storage repositories. Containment for storage repositories in a secure mode is achieved through barriers and intrusion systems. When in the access mode, most facilities implement a two-person rule in Category I or II storage areas and, at a minimum, administrative control in Category III or IV storage areas.

Assessors should review the controls at storage areas for compliance with approved plans and procedures to determine whether controls allow only authorized individuals to access storage repositories. Assessors should also ensure that procedures are in place to authenticate material movements into or out of the repository, document ingress and egress, conduct inventories and DACs, and report and investigate abnormal conditions.

Assessors should identify the location, quantity, and category limits of materials used or stored in processing areas by interviewing MC&A personnel and MBA custodians and by touring the processing areas.

Assessors should review the controls that are intended to monitor rollup and ensure that category limits are strictly observed. Inventory records, transfer logs, or other documents should be used to verify that these limits are not exceeded.

Assessors should verify that Category I processing areas are within an MAA; Category II processing areas are within a PA; Category III processing areas are within an appropriate security area; and Category IV processing areas are consistent with approved safeguards and security plans. Assessors should pay

particular attention to temporary use areas (e.g., temporary MAAs and other areas where SNM may be transferred temporarily for special operations or testing) to determine whether they meet the applicable requirements and that the activity has an approved security plan that contains applicable MC&A elements.

Assessors should ensure that the mechanism for termination of safeguards is documented and implemented, and that controls on nuclear material are only terminated when approved by DOE line management. Until that approval has been received, the MC&A program is maintained at a level commensurate with the category and attractiveness of the material deemed to have been present, and the material is not collocated with accountable nuclear materials. For controls to be terminated, nuclear materials must be transferred to a waste organization reporting identification symbol (RIS) under DOE waste management regulations.

3.2.2.4 Detection and Assessment

Elements of detection and assessment include the TID, portal monitoring, waste monitoring, item monitoring, process monitoring, and DAC programs. Because of the close relationship between material control and security systems and the overlap in applicable orders, the MC&A and PSS assessors should coordinate assessment activities for portal monitoring.

When assessing TIDs, the assessor should:

- Determine whether the TID program is appropriately documented, and is effectively implemented.

- Review the facility's TID program, which should be clearly defined and documented. (Note: Portions of the TID program may be documented in policy and procedures separate from the MC&A Plan.)

- Review the procedures that implement the program: TID acquisition, distribution, application, removal, storage, inventory, and anomaly reporting. The review should focus on whether the procedures are clear, complete, and consistent with the TID policy.

When assessing portal monitoring, the assessor should:

- Identify all routine exits of MAAs or PAs and verify that provisions are in place for conducting searches of all exiting personnel, packages, or vehicles. The method and frequency of source checks and calibration should be specified, as well as reporting procedures and the procedures to be followed if any of the monitoring equipment becomes inoperative or dysfunctional.

When assessing waste monitoring, the assessor should:

- Review the documents that establish the facility waste monitoring program. The documents should require that all liquid, solid, and gaseous waste streams leaving an MAA be monitored for SNM. The waste monitoring program documents should identify all waste streams and define the monitoring method(s) for each. These documents should specify:

    - Measurement and measurement control requirements for the monitoring systems
    - Measurement systems calibration requirements
    - Measurement standards
    - Calibration records and maintenance requirements
    - Controls over the waste monitoring equipment
    - SNM detection capability and requirements.

- Review the response plan to ensure that it has been developed and to determine whether it meets applicable requirements. Specifically, assessors should determine whether the plan is capable of evaluating and resolving situations involving any discharge that exceeds the facility-specific limits approved by the field element.

- Verify that the plan addresses occurrence reporting.

- Look at the history of waste discharges to determine whether recent operational changes significantly impact the facility's capability to detect unauthorized removals of SNM. The collection of this data should be coordinated with the Material Accounting subtopic.

When assessing DACs, the assessor should:

- Review the facility's methodologies, procedures, and requirements for conducting DACs of Category I MBAs.
- Ensure that the scope and extent of the DACs are approved by the field element.
- Determine whether the DAC program is capable of detecting obvious anomalies and tampering.
- Ensure that nuclear material is not in unauthorized locations.

3.2.3 Performance-Based Reviews

Performance is the ultimate determination of material control program effectiveness. While the DOE order is intended to establish the minimal requirements of an effective program, compliance does not ensure effectiveness, and non-compliance does not mean the program is ineffective. This section focuses on how well the material control program works.

One indicator of program effectiveness is the facility's own performance testing program. Without an effective performance testing program, the facility cannot ensure the effectiveness of the material control program. Performance tests must be designed and conducted to fully evaluate the effectiveness of material surveillance activities for Category I and II quantities of SNM.

Assessors should determine whether the facility has established such a performance testing program and whether at least 95 percent of the tests conducted demonstrate the detection of unauthorized actions related to the control of Category I and II quantities of SNM.

Assessors should conduct independent performance tests of the program elements. Performance tests are valuable mechanisms that will assist the assessor in evaluating the effectiveness of the facility material control program, as well as its systems and components. The performance tests that are chosen should exercise the facility's personnel, equipment, and/or procedures used to implement material control measures. The tests should employ any of the various scenarios for defeating the established material control system(s). Tests might include attempts to remove SNM from the area, or to move the material to an unauthorized location.

3.2.3.1 MC&A Boundary Evaluation

The PF and PSS topic teams normally cover the effectiveness of PA, MAA, and vault boundaries. However, the MAA and SNM vaults are areas where the MC&A assessor may be able to identify particular areas of concern. Further, the MC&A assessor is the only one who can identify concerns about MBA and process area boundaries.

Assessors should observe all of these boundaries and determine whether the necessary controls are in place and operating effectively. DACs typically include the requirement to check the integrity of walls and other

boundary elements. Testing of this element might include simulating a breach of the MAA wall to determine whether personnel will identify and report the problem.

3.2.3.2 Adequacy of Access Controls

Facilities are required to have a graded program to ensure that only authorized persons have the ability to enter, change, or access MC&A data and information. Assessors may choose to test these measures by requesting that one or more unauthorized individuals access the accountability computer system or attempt to exceed authorized privileges (e.g., attempts to alter or enter data by individuals not given that authority).

Surveillance measures are required to ensure that unauthorized or unaccompanied authorized personnel cannot enter the storage area undetected when the door is unlocked or open. Assessors should run specific tests for this requirement, which may include attempted entries into SNM storage areas that violate access controls or the two-person rule requirement.

Assessors should determine the validity/adequacy of access controls, including access lists, key control for nuclear material access, approval mechanism, escort procedures, clearance program interface, HRP enrollment, two-person rule application, knowledge verification, and other qualification requirements.

Access logs are routinely maintained for personnel who are not normally assigned to the MAA. Measures commonly used to control access to MAAs include badge checks, card readers, authorization lists, and search equipment. Assessors should determine whether the measures that are used are adequate and effectively implemented. Requesting that an unauthorized individual gain access is one possible test of these measures.

3.2.3.3 Material Surveillance Evaluation

Assessors should:

- Establish which mechanisms the site has identified to be in effect for each of its authorized SNM storage or handling areas.

- Determine whether each mechanism/system is actually in effect and observe its operation.

- Review and evaluate the effectiveness of each mechanism in practice (including the two-person rule, where implemented). If possible, devise one or more simple tests to determine whether the mechanisms are effective. One such test involves the attempt of one of the two-person rule team to get the other to leave the area. Another test could have one individual attempt to cause a break in the observation capability of the other.

Process monitoring systems can monitor/track material quantities and location; SNM transfers; quantities transferred; and processing, handling, sampling, or mixing activities. Where process monitoring systems are in use, the site should have established performance requirements and should have tested the systems supporting those requirements. Assessors should review these tests for effectiveness and results, and should consider conducting one or more independent tests of the systems.

3.2.3.4 Material Containment Evaluation

Material containment features, especially in processing areas, should be evaluated. The assessor should:

- Assess the effectiveness of procedures for transfer control, evaluating and monitoring rollup, and emergency evacuation and response. Inter-MBA transfers of nuclear materials must be independently checked to ensure that transfers are authorized and that the material being transferred agrees with the accounting data.

- Ensure that existing measures are consistent with provisions identified in formal documentation.

- Assess the material access, surveillance, and containment features at selected processing areas (if the assessor does not have time to review all processing areas). The areas should be selected on the basis of their importance, location, material category, attractiveness, and containment measures in place.

3.2.3.5 Detection and Assessment Mechanisms

The TID record system is required to accurately reflect the identity of TIDs in at least 99 percent of the cases, and the TID program must ensure that TIDs are properly applied in at least 95 percent of the cases.

The records must meet the accuracy requirement for identifying serial numbers and locations of the TIDs, and the TIDs must be properly applied using the required application techniques and safeguards procedures, and must be intact. A high failure rate indicates that the program is ineffective.

Assessors should observe both the implementation of TID procedures and the test personnel who normally implement the procedures. This observation might involve written tests or observations of normal procedures, such as TID application, removal, or inventory. Assessors may also review the program for training TID custodians and applicators.

A facility TID program usually prescribes the use of records and forms for TID issuance, application, inventory, removal, and destruction. Assessors should:

- Select a sample of TID numbers and records, and compare the various record systems for consistency.

- Verify applied TIDs with records (for example, check to determine whether TID identification numbers on containers or locations are identical to the identification numbers in record systems). This check is commonly conducted using "a front and back check" and involves a two-step approach: (1) selecting a sample of installed TID data from the records system and comparing it with the actual item data, and (2) collecting TID and item data, and comparing both to information in the records system.

- Examine TIDs on containers during tours of process or storage areas to determine whether they have been properly applied and are on the types of containers defined in the facility's TID program.

- Interview selected TID custodians and review their records to ascertain what controls are in place to ensure that access to TIDs, logs, and usage forms is limited to authorized personnel.

NOTE: It is important to establish/define what constitutes a TID program error before conducting the test/evaluation. Since the TID program is an important component of the inventory program, any performance tests to determine whether the TID program meets its goals of being applied correctly 95 percent of the time and being identified correctly 99 percent of the time should be coordinated with the assessment of the inventory.

The assessment emphasis for portal monitoring is on equipment performance and procedure effectiveness. Effective interface and coordination with the PSS and PF topic teams are essential for this assessment activity. Assessors, in coordination with the PSS topic team, may:

- Observe routine portal operations to verify compliance with procedures. Particular attention should be paid to factors that could degrade performance, such as poorly designed traffic flow, or rushed or inattentive SPOs.
- Observe the operation of SNM detectors (portal or hand-held) used for searching personnel, vehicles, and packages for SNM at exits of MAAs, PAs, storage repositories, or other areas. Exit searches are intended to detect removal of SNM.

- Determine whether search practices are consistent and adequate.

- Ensure that the site testing program for portal monitors (SNM and metal) includes all applicable tests described in American Society for Testing and Materials (ASTM) guides. If these standards are not met, compensatory actions are required and should be performance tested.

- Review the installation of SNM detectors to determine whether the detectors can be bypassed. SNM detectors are sensitive to background radiation; therefore, assessors should review the provisions for ensuring that background radiation does not degrade performance. Calibration data should be reviewed, and the calibration of selected detectors should be performance tested. SNM detector alarms may be audio, visual, or both, and may be monitored locally or remotely. The procedures for responding to all types of alarms should be reviewed and tested to ensure that they are effective. If assessors choose to test the exit searches, the tests should be coordinated with the PSS topic team. Such tests may involve the use of sources to simulate SNM.

Metal detectors are typically used in conjunction with SNM detectors to detect metallic shielding of SNM when exiting from an MAA or PA, and for metal contraband when entering an MAA or PA.

If assessors conduct performance tests of the sensitivity and calibration of metal detectors, the tests should be coordinated with PSS and PF teams. Metal detection should be sensitive (at the specified level) anywhere in the detection zone. Some facilities desensitize the detectors at shoe level to accommodate steel-toed shoes. In addition, metal detectors are sensitive to the speed and configuration of the metal passing through the detector. These conditions present a potential vulnerability and should be tested by assessors. The response to alarms may also be reviewed and tested.

Assessors should review the installation of metal detectors, paying particular attention to large masses of metal near the detectors that may affect sensitivity or cause excessive nuisance alarms. Assessors should also focus on identifying means by which metal detectors may be bypassed (for example, putting items around or above the detection volume) if the metal detector is not visually monitored by SPOs.

3.2.3.6 Waste Monitoring

The instrumentation (along with other detection elements) used to monitor waste and equipment removed from an MAA must be able to detect the removal of a Category I quantity of SNM. Assessment of waste monitoring systems may be coordinated with the evaluation of measurement systems.

Specific test scenarios may be devised for selected waste streams to evaluate detection effectiveness. In testing the waste monitoring program, assessors must ensure that all applicable safety precautions are considered while developing and actually conducting the performance test.

Facilities are required to monitor all liquid, solid, and gaseous waste streams leaving an MAA for SNM. The assessor should:

- Select one or more MAAs and determine whether all waste streams are monitored and whether measurement and measurement control requirements are met.

- Verify that appropriate standards were used during the calibration of measurement systems and that the calibrations records were maintained.

- Verify that the facility maintains and controls waste monitoring equipment and that such equipment is capable of detecting the specified amounts of SNM. In some instances (e.g., exhaust stack monitors), only a sample of the flow stream is taken. In such instances, it is necessary to relate the quantity of material detected to the quantity removed, so the assessment of the waste monitoring systems might involve document and record reviews as well as performance tests.

3.2.3.7 Daily Administrative Checks

Assessment of the DAC program involves a review of containment measures and procedural compliance in processing areas and storage repositories, or item inventory verification. Assessors should:

- Observe DAC practices in selected MBAs to verify compliance with procedures.

- Determine whether the procedures are sufficient to provide assurance that there are no obvious abnormalities or missing items and that there is no apparent evidence of tampering.

- Determine whether the DAC verifies the presence of SNM and whether MBA records reflect the quantity present in processing areas.

- Test the DAC program by simulating one or more types of abnormal situations that the DAC is designed to detect.

Since processing areas usually contain limited amounts of Category I quantities of SNM, item inventory is the most common DAC procedure performed. A variation of the item inventory procedure may be used for storage repositories, especially if the repository has been accessed. Where the item inventory procedure is used, assessors should determine whether:

- The DAC method is effective.
- The DAC meets the requirements for detection and assessment.
- The results of the inventory are fully documented.

If the DAC program uses an item inventory procedure, the facility's ability to generate inventory listings should be tested. Assessing DACs associated with containment measures normally focuses on the integrity of TIDs, locks, or other restraint devices, along with alarm log entries. Assessors should: (1) review these measures for effectiveness, and (2) examine a sample of DAC records to determine whether they are complete and prepared daily or upon entry to the storage area. Particular attention should be paid to provisions for conducting the DACs when the regular custodian is absent.

Assessors should interview or test custodians and alternates to determine whether they are knowledgeable of the DAC procedures, process, and requirements. Assessors should also review the response plan for evaluating and resolving anomalies. Finally, assessors should determine whether there are any MBAs that

do not normally have a Category I quantity, but might have one on a temporary basis. The provisions for conducting DACs should be reviewed for one or more of these areas during the period in which they contain a Category I quantity.

3.2.3.8 Temporary Material Access Area (TMAA) Setup

If a facility has provisions for TMAAs, the frequency with which such an MAA is established must be determined. Assessors might examine the accounting records or interview the MBA custodian. Assessors might also ask the facility to set up a TMAA to evaluate the process. This type of performance test can be integrated with the PF and PSS topic teams and can be very effective. Alternatively, the facility may have a TMAA scheduled during the assessment period or could modify its existing schedule to set up a TMAA during the assessment period for assessors to observe.

3.3 Common Deficiencies/Potential Concerns

In addition to the potential concerns listed in this subsection, assessors should consider the deficiencies listed in the PSS and PF Assessment Guides.

3.3.1 MBAs Crossing an MAA Boundary

Deficiencies may occur when a facility establishes an MBA boundary that crosses an MAA boundary. These deficiencies may allow a Category I quantity of SNM to be located outside an MAA or a Category II quantity of SNM outside of a PA. Locating SNM outside of an MAA or PA boundary may occur when a facility does not have a sufficient number of MBA custodians to handle the nuclear material transaction workload (additions, removals, and inventories) or has not appropriately defined an MBA to minimize nuclear material transfers. These deficiencies/concerns may be identified by comparing an authorized SNM location listing to an MBA listing or while assessing SNM locations during area tours.

3.3.2 Inadequate Daily Administrative Checks

The DAC program is facility specific, with the scope and extent of checks approved by the DOE field element based on recognized vulnerabilities. Deficiencies in DAC programs have been identified at a number of facilities and are generally associated with inadequate documentation, poor implementation, and incomplete procedures. In addition, DACs are sometimes inconsistent when a lesser category MBA becomes Category I for special conditions, for multiple MBAs where rollup to Category I is credible, and when the personnel who are routinely responsible for implementation are absent. These deficiencies usually stem from poor procedures, inadequate training, and management inattention. An inadequate DAC program degrades the detection capability of this material control mechanism and degrades the protection afforded to the SNM.

3.3.3 Weak or Inconsistent Material Surveillance

The implementation of material surveillance measures is often weak and/or inconsistent. For example, DACs are often performed using checklists, which, even when adequate, do not provide assurance as to the conscientiousness of the personnel utilizing them or personnel knowledge regarding what is intended to be accomplished or how. Similarly, facilities often implement some form of two-person rule to satisfy material surveillance requirements, but personnel are unsure of their surveillance duties, how to recognize unauthorized or abnormal conditions, and what their response requirements are. In cases where the physical layout of a process area or storage vault complicates the effective use of a two-person rule, it may be necessary to supplement personnel efforts with additional, possibly automated, mechanisms. Weak or improper implementation of surveillance mechanisms diminishes the benefit of this protection element and degrades the overall safeguards and security program effectiveness. Material surveillance deficiencies are usually caused by

a lack of training; redundancy when a few individuals perform the same routine tasks for extended periods; deficient procedures; or a lack of follow-up, oversight, and performance testing.

3.3.4 Excessive Reliance on the HRP for Material Surveillance

There has been an increasing trend toward using the HRP as a replacement for some standard safeguards and security program elements. Some facilities have moved away from traditional approaches to material surveillance (e.g., the two-person rule), and have begun to cite their HRP as justification for weak surveillance measures and delayed detection of theft or diversion efforts. Facilities should establish a material surveillance program capable of detecting unauthorized activities or anomalous conditions and reporting material status. An effective material surveillance program can be accomplished by either automated surveillance or visual surveillance/direct observation (e.g., two-person rule). DOE policy states that "material control measures assure that appropriate protection and controls are applied to nuclear materials according to the quantity and attractiveness of the material."

Category I or II SNM in use or process is required to be protected by material surveillance procedures, alarm protection, or (with the approval of responsible heads of field elements) alternative means that can be demonstrated to provide equivalent protection. The lack of a fully effective material surveillance program, with or without the HRP, degrades the facility's ability to provide timely detection of theft or diversion efforts. This condition normally results from a management emphasis on production goals, misunderstanding of the requirements of the HRP or a material surveillance program, or an effort to minimize expenditures. The deficiencies can be detected by observation, facility performance testing, or during interviews with personnel.

3.3.5 Inadequate Performance Testing of Material Surveillance Measures

The material surveillance program is required to address both normal and emergency conditions, and must provide for periodic testing. Facilities must plan and document the testing of material surveillance systems and procedures. While most facilities have established their material surveillance program on the basis of analysis and possibly even detailed and documented VAs, many have not planned, conducted, or documented performance tests to validate the effectiveness of their surveillance program. Without a viable material surveillance testing program, the effectiveness of the material surveillance program cannot be assured. The lack of performance testing results from a lack of awareness, potential costs, or failure to fully implement the DOE order requirements for the material surveillance program.

3.4 References

10 CFR 710

P. E. Fehlau, "An Applications Guide to Pedestrian SNM Monitors," Los Alamos National Laboratory Report LA-10633-MS (February 1986)

P. E. Fehlau, "An Applications Guide to Vehicle SNM Monitors," Los Alamos National Laboratory Report LA-10912-MS (March 1987)

P. E. Fehlau, "1990 Update for the Applications Guide to Pedestrian SNM Monitors," Los Alamos National Laboratory Report LA-11971-MS (November 1990)

Robbie Lynn York, P. E. Fehlau, "1997 Update for the Applications Guide to Vehicle SNM Monitors," Los Alamos National Laboratory Report LA-13247-MS (April 1997)

P. E. Fehlau, H. F. Atwater, and K. L. Coop, "Neutron-Chamber Detectors and Applications," Nuclear Instruments and Methods in Physics Research A299, p.29 (1990)

ASTM Standard C993-97, 2003, "Standard Guide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors," ASTM International, West Conshohocken, PA, www.astm.org.

ASTM C1112-99, 2005, "Standard Guide for Application of Radiation Monitors to the Control and Physical Security of Special Nuclear Material," ASTM International, West Conshohocken, PA, www.astm.org.

ASTM C1169-97, 2003, "Standard Guide for Laboratory Evaluation of Automatic Pedestrian SNM Monitor Performance," ASTM International, West Conshohocken, PA, www.astm.org.
ASTM C1189-02, "Standard Guide to Procedures for Calibrating Automatic Pedestrian SNM Monitors," ASTM International, West Conshohocken, PA, www.astm.org.
ASTM C1236-99, 2005, "Standard Guide for In-Plant Performance Evaluation of Automatic Vehicle SNM Monitors," ASTM International, West Conshohocken, PA, www.astm.org.
ASTM C1237-99, 2005, "Standard Guide to In-Plant Performance Evaluation of Hand-Held SNM Monitors," ASTM International, West Conshohocken, PA, www.astm.org.
"Entry-Control Systems Technology Transfer Manual," Sandia National Laboratories Report SAND87-1927 (November 1988)
"Metal Detector Guide," U.S. Department of Energy, Office of Safeguards and Security (February 22, 1990)
"Safeguards Seals Reference Guide," U.S. Department of Energy, Office of Safeguards and Security (September 1993)

Section 4: Measurements

4.1 General Information

The Measurements subtopic addresses the methods used to produce MC&A measurements and associated measurement control activities. Measurements are used to: (1) provide nuclear material values for inventories and transactions; (2) validate previously documented material values; and (3) affirm the stated presence and/or type of nuclear material. These three measurement categories are respectively termed accountability, verification, and confirmation. Specifically:

- Accountability measurements establish new accountability values or replace accountability values with more accurate measured values.
- Verification measurements validate the accounting system values or respond to an anomalous condition.
- Confirmation measurements validate the presence of nuclear material.

Confirmation and verification measurements are also used to support accountability. Assessors should determine which of the measurements are performed at the site being assessed and ensure that the measurements meet requirements for the type of measurement being performed.

Measurement programs are implemented in a graded manner based on the quantities and attractiveness of the nuclear material in an MBA. Measured values are inputs to the measurement program and are used to establish category levels that determine protection requirements. Facilities should choose the most accurate and precise measurement methods for the most attractive material with the largest nuclear material flows (the largest quantities with the greatest amount of throughput and inventory). Methods that are less accurate and less precise may be used for nuclear material flows that do not significantly impact the uncertainty of the total inventory or ID. Measured values are also used to estimate the ID that is calculated when a material balance is performed. While destructive methods are the most accurate, the relatively long time required for results, along with the scrap and waste generated, has limited their use in material balance calculations. Facilities are therefore more likely to employ nondestructive assay (NDA) methods in ID calculations, as they can be performed in less time and also enable the facility to maintain a continuously updated inventory balance of nuclear material within an MBA.

Measurement control activities ensure the effectiveness of measurement systems and the quality of measured values used for accountability purposes. Measurement control programs also provide data for estimating the precision and accuracy of measured values that are used to quantify the measurement uncertainty of nuclear material on inventory and to evaluate the significance of shipper/receiver (S/R) differences and IDs.

The diversity and complexity of DOE facilities results in measurement programs that vary from site to site. Approval for specific elements of the programs is delegated to DOE line management and is generally obtained when the site MC&A Plan is approved.

DOE Order 474.2, Change 4, *Material Control and Accountability*, identifies two Measurements objectives that a site/contractor MC&A program must meet. Measurements objectives are:

- The measurements program must provide measured values with uncertainties sufficient to detect theft or diversion of nuclear materials.
- The measurement control program must ensure the quality of measurements made for MC&A purposes.

In addition to these two objectives, Attachment 3 of the order contains 15 metrics that can be used to assist in the evaluation of the Measurements element. Section 6.3 of the DOE technical standard for MC&A (DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*) provides additional guidance on practical means of implementing an effective MC&A Measurements element. Figure 4-1 of this assessment guide summarizes the assessment activities that are most commonly performed by the MC&A topic team for each Measurements subtopic area.

4.2 Data Collection Activities

Assessors review and provide input to the site data call that EA receives from the site prior to the initiation of the assessment. The data call is frequently provided electronically to expedite review. Additional data is also requested during the conduct of the assessment.

4.2.1 Information Needed

During assessment planning and conduct, assessors interview points of contact, review available documentation, and participate in plant tours. In addition to reviewing documentation, assessors identify key MC&A, measurement, and measurement control personnel to interview to gather additional insights into the program. These personnel can be identified using the site's MC&A Plan, organizational charts, measurement and measurement control procedures, training records, or during interviews of MC&A staff. Measurement program assessments should include interviews with the following personnel:

- MC&A manager and selected staff
- NDA measurement staff and management
- Destructive analysis (DA) staff and management
- Measurement control coordinator(s) including NDA and DA
- MC&A statistician and statistical support personnel
- Metrology staff
- MC&A and measurement (if different) training coordinator.

Other personnel deemed relevant to the assessment (e.g., engineering or operations personnel) may be interviewed. A review should also be performed of the following documents.

4.2.1.1 MC&A Plan

The MC&A Plan should identify the person responsible for the measurement control program and describe how this staff member is independent from personnel performing measurements. Assessors must identify the measurement methods that the facility uses for the accountability of nuclear material. These measurement methods should be identified or referenced in the MC&A Plan. In conjunction with the measurement methods, assessors must identify the types and forms of nuclear material that are in the inventory. A description of how the measurement control program is based on the use of standards traceable to the National Institute of Standards and Technology (NIST) or New Brunswick Laboratory (NBL) should be provided in the MC&A Plan.

The MC&A Plan points to applicable operations procedures. The plan should identify or reference the methodology for estimating the accuracy and precision of each measurement method, and document precision and accuracy goals and the target values for accuracy and precision established by the site. The MC&A Plan identifies key measurement points used to localize timely detection and identification of IDs. The technical basis for the measurement programs should be documented or referenced in the plan.

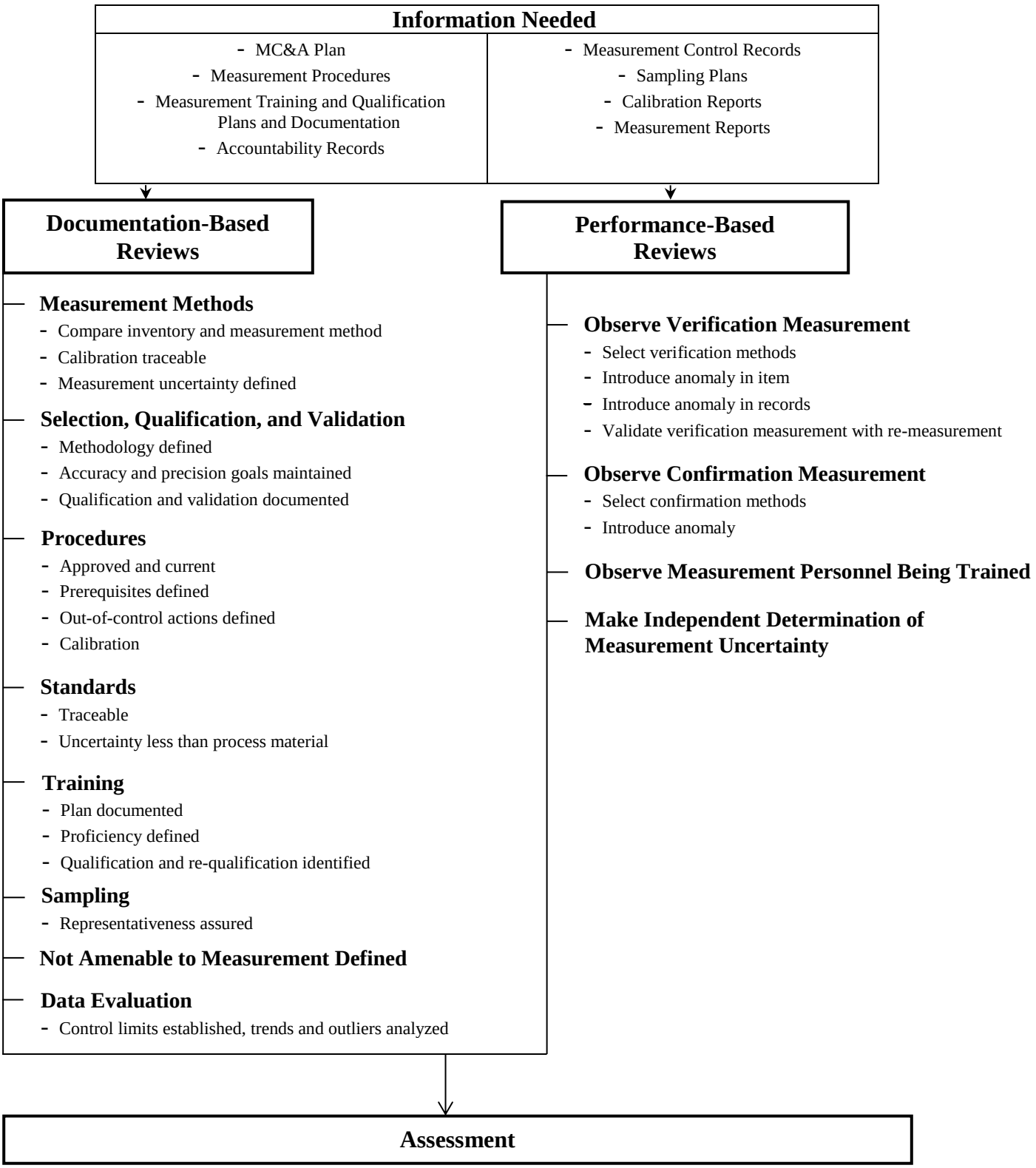

Figure 4-1. Assessing Subtopic Measurement

4.2.1.2 Measurement Procedures

The procedures that govern the use of measurement systems should be identified. Operational and measurement control procedures should be reviewed for all measurement methods. Key measurement points should be identified in either measurement or process operating procedures. Standards used for calibration and quality control checks should be listed with information about traceability to NIST or NBL.

Measurement control procedures are the primary sources of detailed information for the assessment and should identify all pertinent data including control chart requirements, measurement standards specifics, and documentation of the statistical evaluations of measurement control data. The measurement control procedures should document measurement and uncertainty methodologies and statistical terminology accepted by voluntary consensus bodies. The statistical evaluation documentation should address the quantification of biases and should state the methodology used for the evaluation of trends and outliers. The measurement control procedures should also ensure that only calibrated measurement systems, for which control has been demonstrated, are used for measurements supporting accountability.

4.2.1.3 Measurement Training and Qualification Plans and Documentation

The MC&A organization should maintain a measurement training plan documenting qualification and re-qualification requirements. Measurement personnel training and qualification can be performed and updated by MC&A personnel or a separate site organization. Regardless of who performs and records the training, assessors should review documentation demonstrating that personnel performing accountability-supporting measurements are qualified to conduct the specific methods that are used to generate measured values. Additionally, measurement training plans should identify the individuals responsible for performing measurement control functions and for personnel selecting, qualifying, and routinely validating those measurements systems.

4.2.1.4 Accountability Records

Assessors can review inventory records to identify material types being measured and measurement methods used for significant material streams. Inventory records demonstrate key measurement point locations. This review also examines whether accurate and precise methods are used for material flows with significant influence on the ID calculations. Material flows may change when processes are modified. However, even when major processing changes do not occur, changes to measurement uncertainty can gradually increase, making them no longer consistent with stated target values. The review of inventory records assists assessors in identifying potential changes to processes that may not have been detected by the MC&A system.

4.2.1.5 Measurement Control Records

Measurement control is generally monitored using control charts. These charts plot measurements of a standard, where individual measurement results are plotted on an x,y graph where the ordinate (y-axis) is the measurement result and the corresponding measurement dates are plotted on the abscissa (x-axis). Horizontal lines representing 2σ and 3σ limits for the measurement instrument may be plotted on the graph. Documentation of what investigations were performed for measurements outside 2σ and 3σ limits and the treatment of outliers should be reviewed.[1] Assessors review control charts to identify trends and validate that site trend analysis is being conducted.

[1] As will be discussed in Section 4.2.2.7, control limits are generally set at 2.0 and 3.0 standard deviations for warning and alarm respectively. However, the various sites may employ slightly different limits.

Assessors should also assess summary reports of reviews of measurement control performance. Often, measurement control committees review and summarize the results on a periodic basis. These reports can provide insight into difficulties experienced with instruments and measurement standards.

4.2.1.6 Sampling Plans

Sampling plans should be maintained by MC&A and documented for solutions and bulk sampling activities. Assessors should review background documentation of studies and validation of the sampling plan to ensure that they are current. Sampling plans and procedures should include characteristics of the sampled material, size and number of samples, mixing methodology, and estimates of sampling uncertainty.

4.2.1.7 Calibration Reports

Calibration reports provide information regarding the timeliness and validity of the calibration process.[2] Assessors should review calibration frequencies to evaluate whether these frequencies are adequate to provide control of calibration uncertainty. Training records of those performing calibrations should be checked to ensure that personnel performing calibrations are trained and qualified. Reviewing the calibration report provides specific standard identification to determine whether standards are traceable to NIST or NBL.

4.2.1.8 Measurement Reports

Individual measurement reports should be correlated with the training and qualification records of individuals performing measurements to ensure that only qualified personnel are conducting data collection, reporting, and/or review. Individual reports may also contain standards data and thus can be used to validate the use of traceable measurement standards. Assessors should evaluate the reporting process and ensure that it includes uncertainty calculations and has complied with measurement procedures.

4.2.2 Documentation-Based Reviews

Assessors should evaluate eight key areas of the measurement program for compliance with DOE requirements, based on the documents reviewed and the information provided through interviews with MC&A and operations personnel who perform measurements. Assessors should evaluate the following eight areas:

- Measurement methods
- Selection, qualification, and ongoing validation
- Procedures
- Standards
- Training
- Sampling
- Data evaluation
- Materials not amenable to measurement.

4.2.2.1 Measurement Methods

The facility should identify minimum requirements for each measurement method used for accountability. The assessors' duties include ensuring that all nuclear material on inventory is quantified by: (1) a qualified measurement method; (2) documented technical justification; or (3) accepted shippers' values; or that the

[2] Note that calibration reports may be a subset of the qualification reports (see Section 4.2.2.2) used for a method or specific instrument.

material is listed and approved as "not amenable to measurement." Methods should be identified for confirming the presence and verifying the quantity of all nuclear materials listed.

The assessor needs to identify the methodology the facility uses to minimize the measurement uncertainty's contribution to the ID control limits. When verification measurements are used for accountability, the uncertainty of the verification measurement method should be better than or equal to the original accountability measurement. The facility should have documented evidence, such as control charts, showing that the measurement method meets accuracy and precision goals under in-plant conditions. Confirmation measurements should be capable of determining the existence of an attribute of the nuclear material, and the facility should have statistically based acceptance/rejection criteria for the measurement.

Measurement methods commonly used for accountability of plutonium and uranium are presented in Table 4.1 (DA methods) and Table 4.2 (NDA methods) at the end of Section 4, Measurements. These tables briefly describe the methods, the standards typically used, applicable materials for which the method is used, potential assessment concerns, and international target values (ITVs). While ITVs are not available for the majority of NDA methods used at DOE sites, a precision and bias section is available in ASTM standards for DA as well as NDA methods. These ASTM sections do not provide target values for NDA methods but do provide useful information in evaluating uncertainty for each method. Details of these methods and uncertainty concerns vary from facility to facility since applications between facilities vary.

Note that Tables 4.1 and 4.2 show a direct correlation between the measurement method and the type of measured result, e.g., calorimetry for plutonium. In practice, calorimetry provides only a heat output and must be combined with independently determined isotopic information to calculate total plutonium. Thus, the total measurement uncertainty for a plutonium quantity determined using calorimetry contains contributions from at least two methods. Because many DA and NDA methods similarly use a combination of measurement inputs, assessors must review all measurement methods and uncertainties used in determining final results. ASTM standards may provide useful general information in evaluating uncertainty for each method, including the most typically combined methods.

Standards used for calibration should be certified, and the frequencies of calibration and of re-certification of measurement standards should be specified. The measurement calibration should be traceable to NIST or NBL standards. Where working standards are employed, the certifying criteria should be documented. The facility should have documentation that the accuracy and precision of the measurement system meet goals approved by the field element. Documentation of measurement results should provide an audit trail from the measurement to the accounting records, and should be sufficient to determine the calibration used for the measurement, the person performing the measurement, and the date and time of the measurement. To make this determination, the assessor who reviews measurement methods needs to coordinate with the assessor who reviews the accounting procedures.

The facility should require that the scales are in good working order and should specify the evaluation criteria. The scales should be recalibrated on a scheduled basis or when moved, and checked on each day of use for accuracy and linearity. The accuracy can be checked by the measurement of a single standard, but the linearity check requires that the calibration be checked over the range of items measured.

For DA methods, routine measurements must be used to estimate measurement uncertainty. Two key sources of measurement uncertainty are: (1) variability introduced by measurement personnel; and (2) sampling uncertainties. The variability introduced by measurement personnel must be quantified for all methods unless the variability has been documented to be insignificant. For sampling methods, the measurement uncertainty that results from taking a sample must be quantified. The effectiveness of a DA program depends on ensuring that only representative samples are analyzed. Prior to sampling, sufficient analyses should have been performed to identify the parameters that must be controlled to obtain a

representative sample. Most common among these parameters are the number of samples, sample size, and agitation time. The sampling program should document the parameters required to ensure representativeness and how the sampling method is periodically tested or updated. For liquid samples, it might be important, for example, to specify how much material must be drawn out of the sampling port before the sample is taken. The results from such studies form the basis for estimating the sampling method's uncertainty. To simplify the propagation of errors, the sampling uncertainty may be combined and incorporated into the estimate of uncertainty for the companion analytical method. This strategy will give a single analytical uncertainty estimate that can then be used in the propagation-of-error calculation. When combining the sampling and analytical errors this way, the analyst must remember not to use the sampling error twice when propagating errors.

4.2.2.2 Selection, Qualification, and Validation

The methodology for selecting and qualifying a measurement system for accountability use should be documented in a procedure. The procedure should give the technical basis for choosing a measurement system and should identify criteria for the qualification and periodic validation of measurement systems. Measurement results including uncertainties are reported using methodologies and statistical terminology accepted by voluntary consensus standard bodies. The methodology should require that the appropriate personnel demonstrate their ability to perform the measurements properly.

Assessors should verify that all measurement systems used for accountability have been qualified and that the qualification is documented. The qualification documentation should validate that the measurement system meets accuracy and precision goals during in-plant use. Attainment of accuracy and precision goals should be demonstrated daily for the DA of nuclear material and for at least one of each five measurements for NDA.

4.2.2.3 Procedures

Procedures provide a mechanism for ensuring that measurements are performed in a consistent manner and that the measurement results are in control. To ensure quality and repeatability, measurement procedures must be documented, controlled, and approved. Each procedure should identify prerequisites for the performance of measurements and training requirements for the individual performing measurements. The procedure should define methods for recording the results of a measurement and should ensure that only qualified measurement methods are used for accountability.

The procedure for each measurement method should include measurement control requirements for calibration and calibration checks of the measurement system. Standard checks before use, during use, and after use should be defined. The procedures should identify out-of-control results and, if results exceed alarms limits, should preclude use of the method until control is reestablished. The investigations required for results exceeding warning limits and the notification requirements for results exceeding control limits should be stated in the procedures. The procedure should define outliers, specify actions to be taken when an out-of-control situation is detected, and specify actions required to recover from an out-of-control situation.

A measurement control procedure should define the methodology for estimating the random and systematic error variance for the measurement. The methodology may be included in the MC&A Plan or in a separate procedure. Key contributors to the total measurement uncertainty of an MBA should be identified. The assessor should select key procedures that the facility uses for measurements and measurement control to ensure that they are current and comprehensive, and that they can be carried out successfully by the facility operators. Procedures can also be performance tested.

4.2.2.4 Standards

Standards are required to calibrate a measurement method and to monitor the quality of the measurement results. To evaluate the quality of the standards, assessors should review the documentation of the standards. There should be objective evidence that the standard represents the material to be measured in all attributes that affect the measured results to the extent possible. The standards should be traceable to NIST or NBL, and the nuclear material content of the standards should be certified. Working standards may also be employed but must contain certifying documentation and/or a technical justification for use. All standards used for calibration should have a smaller uncertainty than the measurement method that they are used to calibrate. Standards should be stored in a manner ensuring integrity when not in use.

4.2.2.5 Training

The requirements for training individuals to perform measurements should be stated in a measurement training plan or similar document. Assessors should determine whether the plan is documented and reviewed as required by the MC&A Plan. The training plan should state qualification and re-qualification requirements for all personnel performing accountability measurements, including offsite vendors, and should require individuals to demonstrate proficiency in the measurement techniques before performing accountability measurements. The facility should have a program to evaluate the training of measurement personnel, and the results of the evaluation should be used to continually improve the measurement and measurement control programs. Maintenance training records may be the responsibility of the facility, MC&A organization, or other organization.

Training is an essential element for ensuring the quality of measurements. Assessors should evaluate the training for measurement personnel to ensure that it addresses the measurement programs. The training should specify:

- Measurement equipment operation and storage
- Method capability and potential interferences
- Calibration and recalibration requirements
- Actions to be taken when out-of-control situations are detected
- The appropriate way to distinguish between legitimate outliers and those that occur due to an assignable cause, and documentation required in each case
- Documentation and review requirements for calculating and reporting measurement results.

Assessors should review the qualifications for measurement control personnel to determine their training requirements. Their training for measurement control should be documented and reviewed periodically. Not all facilities have personnel dedicated to measurement control, but may combine these responsibilities with other functions.

4.2.2.6 Sampling

The MC&A Plan should identify each point of bulk processing operations where an accountability sample is taken. For each point, the methodology should be qualified by a documented study that evaluates mixing and sampling techniques to ensure that the sample represents the process material. The sampling technique should be based on technical and statistical principles that are validated by the mixing and sampling study and documented in a procedure. The assessor should determine how samples are taken at key measurement

points, review the procedure for taking a representative sample, and if possible, conduct a performance test by observing a sample being taken.

4.2.2.7 Data Evaluation

The objective of all measurement control activities is to ensure quality results. One major tool used to ensure quality results is statistical analysis and trending of measurement data.

For repeated measurements on standards or process items, quality results are ensured by evaluating measured results against control limits. The limits are based on estimates of accuracy and precision. Accuracy is a measure of the variation between the measured result and the true value for the item. Precision is an estimate of the variation in the result for repeated measurement of the item. In general, the control limits are set at 2.0 standard deviations for warning and either 2.58 or 3.0 deviations for alarm limits. However, the various sites may employ slightly different limits, e.g., using 1.96σ versus 2σ for warning limits. Assessors should verify that control limits are evaluated consistently across the different measurement methods, in ID calculations, and are statistically valid.

In evaluating data, assessors should:

- Evaluate the estimates to determine whether they meet or exceed target values approved by the field element.

- Examine the basis for the estimates, determine that estimates are based on current data, and determine that a program exists to update the uncertainty.

- Plot the data on control charts that identify the relationship of an individual measurement to the population of measurements being used to identify a trend. The control chart will show the statistically established warning and alarm limits; any data exceeding limits will be readily identified.

- Evaluate the methodology that the facility uses to analyze for trends (e.g., number of points above/below the center line, number of times the center line is crossed, or trend up or down).

Repeat measurements, inter-laboratory comparisons, counting of standards, etc., are used to establish the precision and bias estimates for each measurement technique. As noted above, these values must be reviewed and updated. These values are used to assign precision and bias estimates for all items measured by the specific technique. The facility can use accuracy or bias estimates in various ways; it is important for assessors to investigate the mathematical assumptions. One technique is to correct all measurements performed between calibrations by the observed bias in measuring the standards. If the correction is made, the bias should not be included in the control limit calculation. The second approach, also a valid statistical method, is to not correct for the bias but include it in the uncertainty estimate.

For confirmation measurements, assessors should determine whether the acceptance/rejection criteria are based on a statistical evaluation of data.

If the facility identifies outliers, assessors should validate the facility's assumptions. Out-of-control results should not be routinely identified as outliers. For each outlier, the facility should investigate the measurement and document the basis for classifying the result as an outlier.

Routine measurement reports encountered during the assessment process should be evaluated in conjunction with the documented technical basis and measurement procedure to determine whether the calculations are performed in accordance with these documents.

Some facilities are adopting the Guide to the Uncertainty of Measurement (GUM) methodology to determine measurement uncertainties. GUM categorizes uncertainties as Type A and Type B uncertainties. Type A uncertainties are determined by standard statistical methods, while Type B are other uncertainties such as expert judgment, manufacturing specifications, prior experience, and other terms that may not be statistically derived. GUM uses a mathematical algorithm to quantify uncertainty components through the use of the combined uncertainties.

Because total uncertainty now contains both statistically determined contributions and Type B uncertainties that have not been determined by conventional statistics, GUM uses specific terminology with which the assessor should be aware, including: coverage factor, expanded uncertainty, and the standard deviation of the final result times a multiplier. Assessors should consult appropriate references prior to the assessment if this methodology is used.

4.2.2.8 Materials Not Amenable to Measurement

Assessors should identify the materials that are not amenable to measurement during the review of the MC&A Plan. For each material, assessors should determine the basis of the accountability value for the material and evaluate whether the basis is technically defensible. Assessors should compare the material to similar materials in the DOE complex, to ensure that safeguards goals are being attained for the materials. If other facilities measure the material, assessors must determine why the facility supports identifying the materials as "not amenable to measurement."

4.2.3 Performance-Based Reviews

Assessors should observe performance of measurement and measurement supporting activities when possible. This includes observation of (1) verification measurements, (2) confirmatory measurements, and (3) training of personnel. Assessors are also encouraged to validate measurement or uncertainty results by performing their own independent calculations using actual measured data.

4.2.3.1 Observe Verification Measurement

To evaluate the performance of measurement methods, assessors should select items for measurement, witness the normal operation of the measurement system, and review documentation of measurement results. In cases where measurement uncertainty is significant, requesting repeated measurements of the same item can be useful. Assessors can request the measurement of a calibration standard to validate the calibration of the measurement method. Additionally, assessors can use the facility training evaluation methodology to test the individuals performing measurements.

During the measurement of a selected item, assessors should determine whether procedures are followed and documentation requirements are implemented according to procedural requirements. If the item has been previously measured, assessors should compare the results to determine whether the measurement system is operating correctly. The two results should agree within the uncertainty of the measurement method.

By reviewing the documentation of measurement results, assessors can determine whether the documentation requirements are being met and can determine whether the audit trail is sufficient to determine the following:

- Person performing measurement
- Date and time of measurement
- Calibration of measurement method
- Consistency in recording measured results in accountability records.

This test can be conducted using scales and balances, tank calibrations, analytical methods, or NDA methods. Performance can be tested by asking personnel to describe the steps they would take if the results of the last measurement control test could not be located.

Assessors can also introduce an anomaly into the test by having a facility switch labels or falsify accounting information. In such cases, assessors should evaluate the facility's response to the anomalous condition.

4.2.3.2 Observe Confirmation Measurement

If the facility personnel perform confirmation measurements, assessors should witness a confirmation measurement. Confirmation measurements are relatively easy to make, so several items may be selected. Assessors should compare the results to the acceptance/rejection criteria for the confirmation measurement. If the attribute is confirmed, assessors should evaluate the measurement to determine whether the measurement provides adequate assurance that the nuclear material in the container is in agreement with accountability records.

Assessors may request a review of the standards measurement or other pre-check data used to ensure that the instrument is performing correctly. Assessors can also introduce an anomaly into the test by having a facility switch labels or falsify accounting information. In such cases, assessors should evaluate the facility's response to the anomalous condition.

4.2.3.3 Observe Measurement Personnel Being Trained

To assess the effectiveness of the training program, assessors may ask the facility to conduct a training session for a specified measurement system. Assessors should evaluate the training content and the instructor's conformance to the lesson plan. This may include observation of OJT or refresher training.

4.2.3.4 Make Independent Determination of Measurement Uncertainty

The performance of a measurement control program is difficult to evaluate. Therefore, assessors should consider performing the following tasks as part of the evaluation:

- Request a series of measurements to evaluate the random error variance or request the measurement of items by an independent method, when available. In both cases, assessors should attempt to independently determine the uncertainty of the measurement.

- When calculated, compare results to the operator-determined values for the subject measurement method. (Note: Due to the smaller sample sizes the assessor selects, the assessor must exercise caution if statistical extrapolation to an entire population is planned.)

- If the results disagree, assessors should identify the reason for the difference.

Assessment schedules may not permit this level of a performance test since the measurement of several items may be necessary to obtain valid statistical results.

Alternatively, during an initial visit, assessors could select a series of items for measurement and ask that the results be available for a subsequent assessment visit. Assessors must then determine the requirements to ensure continuity of knowledge for the measurement results.

Facilities may participate in inter-laboratory comparisons. This data provides an indication of measurement bias and, combined with estimates of precision, can be used to estimate overall measurement uncertainty.

4.3 Common Deficiencies/Potential Concerns

Through multiple assessments carried out across the various DOE sites, several common deficiencies and concerns have been observed. These may range from insufficient measurement infrastructures (e.g., inadequate standards, limited instrumentation) to wide-ranging programmatic deficits.

4.3.1 Lack of Measurement Methods and Equipment

Throughout the history of DOE and its predecessor agencies, numerous scientific and research projects have created unique materials. This variety of unique materials has led to limitations in the ability of facilities to: (1) measure materials; (2) process materials; and (3) detect and quantify the theft or diversion of nuclear material. The following are some limitations that have been observed in previous assessments:

- Facilities may have nuclear material that has been approved as "not amenable to measurement" and may have an excessive number of items in this category.
- Other materials require additional processing before they can be measured, but no method for processing has been planned or developed.
- The facility does not have the equipment to implement a measurement method, or the measurement equipment represents a significant capital expenditure.
- The facility has the equipment necessary to measure and process a material type, but has not maintained the equipment or standards necessary to re-measure the material (or process products), resulting in material that does not have an accountability value, or for which the facility cannot reproduce the measured value.
- IDs exceed control limits.
- Items are listed as "not amenable to measurement" for which measurement methods are available.
- Measurement methods lack current estimates of accuracy and precision values.

At times, limitations have been introduced subsequent to the transfer of nuclear material between facilities or sites. Issues of this kind are most often evident through unresolved S/R differences.

4.3.2 Accountability Measurement Methods Not Qualified

Many facilities have not formally qualified their accountability measurement methods as required by DOE. These facilities have not ensured that measurement methods used for accountability are capable of measuring the material in question to the desired levels of accuracy and precision, consistent with a graded safeguards approach. Causes for this deficiency include:

- Standards do not exist for the material, or standards have been destroyed while still needed to reduce the total quantity of SNM in a facility.
- The certification for existing standards has expired.
- There is a limited amount of the material, and it is not considered cost effective to qualify a measurement method.

- The material form is no longer produced, and the facility does not have standards for the calibration of the measurement.

- There is no procedure to qualify a measurement method for use by MC&A.

Using unqualified measurement methods negates the facility's ability to determine the significance of an ID. Use of unqualified measurement methods also lessens the assurance that nuclear material has not been stolen or diverted. Indications of this deficiency include IDs that exceed control limits; unresolved S/R differences; open transactions; and confirmation and verification measurements that do not meet acceptance criteria. This lack of qualified measurement methods may be detected during interviews with measurement control or IRA personnel. Accounting system checks can also assist in the detection of unqualified measurement systems. Additionally, methods that are not qualified can be detected during a review of the measurement qualification and control programs.

4.3.3 Measurement Uncertainties Not Quantified

A common problem detected during assessments is a failure to quantify or correctly calculate measurement uncertainties. Some facilities also do not use the appropriate data or methodology to estimate uncertainties. The common causes are:

- Lack of formally documented measurement control program

- Lack of statistical training by staff responsible for implementing the program

- Lack of management attention to requirements

- Lack of adequate support by knowledgeable statisticians

- Measurement responsibilities spread among varying groups at the facility, with no group comprehending the total measurement system used to obtain an accountability value

- Failure of error estimation models to consider all reasonable sources of error.

Inaccurate determinations of measurement uncertainty limit the detection capability provided by alarms for S/R difference and ID evaluations, thereby limiting the ability of the measurement system to detect the theft or diversion of nuclear material. Indications of the inaccurate determination of uncertainties include: the facility does not perform repeated measurement of standards and process materials, standards are not available for measurement systems, control limits exhibit unexpected variation, control limits vary with time, and an excessive number of IDs and S/R differences that exceed control limits.

4.3.4 Sampling Methods Not Qualified

As a measurement method, the sampling of bulk materials for the analytical or NDA determination of accountability values must be qualified in accordance with DOE requirements. In practice, however, many facilities only qualified their sampling techniques during the process startup and no longer retain documentation of qualification. As with other measurement methods, the lack of qualified sampling techniques limits the facility's ability to detect the theft or diversion of nuclear material since a potential bias could exist. When facilities cannot validate the qualification and cannot quantify the uncertainty of the sampling technique, the most common causes for this deficiency are:

- The time, cost, and loss of production inherent in performing qualification activities drives facilities to consider long-implemented sampling techniques as "grandfathered," requiring no further updating.

- Failure to identify changes in processing techniques or equipment can impact the quality of the sampling technique.

When the uncertainty of the sampling technique is not known and is not incorporated in the determination of control limits for IDs and S/R differences, the control limits do not reflect reality. The limits will be either too broad, in which case theft or diversion may not be detected, or too tight, in which case false alarms may be generated. A lack of qualified sampling techniques is identified during documentation reviews, interviews with MC&A and operations staff, and evaluation of ID and S/R difference programs (especially long-term trends).

4.3.5 Lack of Standards

In some cases, measurement methods are not qualified for specific material types because of a lack of standards. Some facilities are unable to calibrate their measurement methods because they do not have standards for calibration, or their certification for standards has expired. Additionally, during D&D activities, active standards are shipped out to reduce safety basis requirements driven by nuclear material gram quantities in a facility. The facility then cannot perform a measurement that is traceable to the national measurement system and cannot evaluate the accuracy of the measurement system. Without an estimate of the accuracy, the facility should not use measurement results for the accountability of nuclear material. Indications of a lack of standards include IDs that exceed control limits, unresolved S/R differences, and lack of current estimates of accuracy.

4.3.6 Deficient Measurement Control Programs

Measurement control program deficiencies can be the cause of S/R differences and IDs exceeding control limits. These deficiencies limit the ability of the MC&A system to localize and resolve IDs. Assessment activities that should detect inadequate measurement control programs include interviews with measurement personnel and reviews of measurement data, control charts, trend analyses for measurement systems, and estimates of accuracy and precision. The facility's IRA program should identify deficiencies in the measurement control program.

Previously observed deficiencies have included:

- Measurement control programs that are inadequately implemented or nonexistent

- Failure to select, qualify, and validate measurement methods capable of providing desired levels of accuracy and precision

- Changes in the statistical support staff available for MC&A activities, adversely affecting measurement control quality

- Infrequent or non-existent monitoring of measurement system performance.

4.3.7 No Audit Trail for Measurement Uncertainties

Facilities are often unable to support their calculated measurement uncertainties because measurement control data is not documented or the documentation does not identify the type of measurement, the person performing the measurement, the material measured, or the calibration used. These types of deficiencies usually result from a lack of procedures, lack of training, or lack of management attention. In some cases, only minimal processing is conducted, and insufficient data is generated to estimate the uncertainty. Such deficiencies can result in incorrect evaluation of IDs and S/R differences, poor measurement quality, and the misuse of resources to resolve alarms.

These deficiencies are generally detected by interviewing personnel responsible for statistical analyses, reviewing the analysis of statistical data, evaluating propagation of variance calculations for IDs, reviewing the calculation of limits for S/R differences, examining the repeatability of measurement results, and auditing the measurement programs.

4.3.8 Trends and Biases Not Evaluated

Many facilities only evaluate IDs and S/R differences. These facilities determine the significance of single values and do not evaluate the long-term trends of the differences. While evaluating the single event is important, the facility must evaluate the differences over time in order to identify trends and biases that are insignificant for a single difference, but that can mask a "trickle" theft or diversion of nuclear material. The most common causes of this deficiency are the lack of knowledgeable staff to perform the analysis, lack of management attention, and failure to recognize the significance of trends and biases in detecting the loss or diversion of nuclear material. Other causes include: lack of statistical data due to changes in processing methods that impact the steady state operation of the facility; lack of data due to an inadequate statistical evaluation program; and difficulty in identifying and making corrections when trends and biases are identified.

Failure to identify and correct for trends and biases could limit the facility's assurance that a trickle theft or diversion of nuclear material would be detected. Indications of an inadequate program to identify and correct for trends and biases are IDs and S/R differences that do not fluctuate randomly, and cumulative differences that grow in a consistent direction (either positive or negative).

4.3.9 Lack of Control of Measurement Equipment

Failure to provide secure controlled locations for storage and operation of measurement equipment and standards can lead to the inability to ensure the quality of measurement results. Unsecured equipment is at risk of either accidental or intentional damage, theft, or tampering. These deficiencies usually result from reallocation of facility locations or lack of management attention.

4.4 References

Active Nondestructive Assay of Nuclear Materials, prepared by Tsahi Gozani for the U.S. NRC, NUREG/CR-0602, 1981

ANSI N15.36, Nuclear Materials – Nondestructive Assay Measurement Control and Assurance

ASTM C 1030 Standard Test Method for Determination of Plutonium Isotopic Composition by Gamma-Ray Spectrometry

ASTM C 1068-03, Standard Guide for Qualification of Measurement Methods by a Laboratory Within the Nuclear Industry

ASTM C 1108 Standard Test Method for Plutonium by Controlled-Potential Coulometry

ASTM C 1133 Test Method for Nondestructive Assay of Special Nuclear Material in Low-Density Scrap and Waste by Segmented Passive Gamma-Ray Scanning

ASTM C 1207 Test Method for Nondestructive Assay of Plutonium in Scrap and Waste by Passive Neutron Coincidence Counting

ASTM C 1221 Test Method for Nondestructive Analysis of Special Nuclear Materials in Homogeneous Solutions by Gamma-Ray Spectrometry

ASTM C 1316 Standard Test Method for Nondestructive Assay of Nuclear Material in Scrap and Waste by Passive-Active Neutron Counting Using 252Cf Shuffler

ASTM C 1380 Standard Test Method for Determination of Uranium Content and Isotopic Composition by Isotope Dilution Mass Spectrometry

ASTM C 1455 Standard Test Method for Nondestructive Assay of Special Nuclear Material Holdup Using Gamma-Ray Spectroscopic Methods

ASTM C 1458 Standard Test Method for Nondestructive Assay of Plutonium, Tritium and 241Am by Calorimetric Assay

ASTM C 1490 Standard Guide for the Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel

ASTM C 1500 Standard Test Method for Nondestructive Assay of Plutonium by Passive Neutron Multiplicity Counting

ASTM C 1514 Standard Test Method for Measurement of 235U Fraction Using Enrichment Meter Principle

ASTM C 1625 Standard Test Method for Uranium and Plutonium Concentrations and Isotopic Abundances by Thermal Ionization Mass Spectrometry

ASTM C 1592/C 1592M-09, Standard Guide for Making Quality Nondestructive Assay Measurements

ASTM C 1718 Standard Test Method for Nondestructive Assay of Radioactive Material by Tomographic Gamma Scanning

Guide to the Expression of Uncertainty in Measurement, International Standards Organization, 1993, ISBN-92-67-10188-9, http://www.bipm.org/en/publications/guides/gum.html

Handbook of Nuclear Safeguards Measurement Methods, edited by D. R. Rogers, NUREG/CR-2078, September 1983

Quantifying Uncertainty in Analytical Measurement 2nd edition (2000)
[available at http://www.measurementuncertainty.org.]

Passive Nondestructive Assay of Nuclear Materials, edited by Doug Reilly, Norbert Ensslin, and Hastings Smith, Jr., NUREG/CR-5550, March 1991

Statistical Methods for Nuclear Material Management, edited by Michael Bowen and Carl A. Bennett, NUREG/CR-4604, December 1988

Table 4-1. Plutonium and Uranium DA Measurements

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Relative Std. Unc. %[b] (Random) [Systematic] ITV[c]			MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
			Pu	U/Pu	U		
Titration/element concentration (Davies & Gray for U) [Pu, U/Pu, U]	The sample to be analyzed is put into solution, treated and titrated against a standard solution.	Standardized iron sulfate solution, NBL certified	(0.15) [0.15] **0.21**	(0.2) [0.2] **0.28**	(0.1) [0.1] **0.14**	Metal, oxide, salts Uncertainties for oxides and nitrates	Sample has several points for the introduction of errors. Duplicate samples, standard samples, operator training, and routine operator testing are critical.
Coulometry/element concentration [Pu]	A type of redox titration in which electric current is used as the titrant.	Known plutonium solution, NBL certified	(0.1) [0.1] **0.14**			Oxide, salts Uncertainties for pure compounds	Sample has several points for the introduction of errors. Duplicate samples, standard samples, operator training, and routine operator testing are critical.
Thermal Ionization Mass Spectrometry /Isotopic Assay (TIMS) [Pu]	A small sample of the material is ionized and accelerated electrostatically through a magnetic field where it is separated by mass and detected.	Certified reference material of similar isotopic composition	(0.15) [0.1] **NG**			Pu and U/Pu materials	The material analyzed must be of high chemical purity to avoid mass (e.g., Pu-238 and U-238) and ionization interference. The starting solution must be of high purity, and suitable standards must be run through the system routinely.
Isotopic Dilution Mass Spectrometry /Element (IDMS) [Pu, U]	A known amount of tracer isotope of Pu or U is added to a measured amount of sample and analyzed by mass spectrometry.	Known amount of trace isotope (Pu-242 or 244 for Pu and U-233 or 236 for U) NIST traceable sources	(0.3) [0.3] **0.42**		(0.3) [0.3] **0.42**	Metals, salts, solutions for Hot Cell conditions	The material analyzed must be of high chemical purity to avoid mass (e.g., Pu-238 and U-238) and ionization interference.

(a) NBL = New Brunswick Laboratory
NIST = National Institute of Standards and Technology

(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

(c) NG indicates that no target value is available.

Table 4-1. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Relative Std. Unc. %[b] (Random) [Systematic] ITV[c] Pu	U/Pu	U	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
X-ray Fluorescence/ Element Concentration [Pu, U]	The sample (after preparation) is irradiated by a source (usually x-rays) that stimulates the emission of characteristic x-rays of the element in proportion to the quantity present.	An internal standard is used such as yttrium (for Pu) or strontium (for U).	(2) [2] **2.8**		(2) [2] **2.8**	Solutions	Running standards and splitting samples are important to ensure the quality of the data.
Gravimetry [U]	The uranium sample is chemically converted to U_3O_8 and weighed. The U_3O_8 is not affected by loss or gain of weight that can provide erroneous mass measurements.	The procedure is standardized with standard reference materials from NIST and control of the scales.			(0.1) [0.1] **0.14**	Pure compounds	It is important that the method is calibrated with standard reference materials and that duplicates of typical samples are run routinely.

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(c) NG indicates that no target value is available.

Table 4-2. Plutonium and Uranium NDA Measurements

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Relative Std. Unc. %[b] (Random) [Systematic] ITV	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Electronic Balances and Load-cell based Weighing systems/Mass [Pu, U]	The material is accurately weighed on a precision balance or scale.	NIST traceable weight standards	(0.05) [0.05] **0.07**	Metals, oxides, compounds; packages or compounds containing SNM material (e.g., fuel elements or other containers that can be considered tamper-indicating)	The instrument must be routinely checked with standards covering the useful range and not used outside the calibrated range. Instrument performance must be documented and tracked. If the material is in a container, the values must be corrected for the tare weight. Weights must be corrected for density, purity, and chemical form as appropriate. Many factors can affect measurement uncertainty, including instrument leveling, water loss/gain, and reactions (e.g., oxidation). For use as a verification tool, the correction should be small and have a small associated uncertainty.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
High Resolution Gamma Spectrometer [Pu, U]	Precision spectrometers are used to measure the energy and intensity of the natural gamma rays emitted during the radioactive decay of SNM. The spectrometers consist of a Ge detector, signal processing electronics (amplifiers), a multichannel analyzer, and a computer for data reduction. Such measurements are often part of a verification measurement (isotopic composition measurement to be used in conjunction with calorimetry for Pu mass determination). Can be used for verification in the instance of SNM material in a known, low-density matrix of fixed geometry.	NIST traceable photon standards for energy. For photon intensity measurements (to infer SNM mass), standards are fabricated to be similar to the item(s) measured and are independently verified (measured by independent techniques).	(0.2-13) [0.3-2]	Containers of SNM materials in various forms: oxides, metals, wastes liquids	The instrument must be routinely checked for energy calibration using known sources. When used for intensity measurements, traceable standards of similar composition are needed. Instrument performance must be documented and tracked (a control chart of the measurements on the standards). If the material to be measured is in a container, the attenuation effects of the container must be considered. The detector must be properly shielded, and additional sources or samples stored to avoid interference.
Neutron Counters (signature, SNM monitors, or Shielded Neutron Assay Probe (SNAP) detectors) [Pu, Highly Enriched Uranium]	Materials that spontaneously fission emit neutrons, which can be used as an indication of their presence and quantity.	Materials of known quantity and similar nature are used as standards.	(2-10) [4-20]	Pu in various forms and matrices	The composition of the material is important because the presence of materials such as F, Li, Be, etc., will lead to (α,n) reactions that produce neutrons that cannot, in this case, be discriminated from the fission neutrons.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Photon Counters (SNM monitors) (gamma signature monitors) [Pu,U]	The photon counters use the same physical principle as the high resolution counters, but are usually self-contained and may be designed for a specific purpose. Typical instruments are designed as portal monitors to detect SNM, or as photon detectors to identify specific energies associated with a material for identification. NaI is generally used as the detector, and some units may be designed to also detect neutrons.	Typical SNM materials are generally used to calibrate the instrument. They are not traceable since only a typical spectrum is needed.	N/A	SNM materials in various forms and containers	The instruments should be tested on a routine basis, and in some cases, the instrument can be tested with a non-SNM source to confirm energy calibration. In some cases, mixtures of SNM cannot be reliably evaluated and the operator should use other techniques, including looking at the raw spectrum or using a high resolution detector.
Enrichment Meters [U]	The counters use the same physical principles as the high resolution counters and may use either a low resolution detector or a high resolution detector. The unit operates by rationing the 186 keV photon of U-235 to the higher energy continuum or to one of the U-238 photons. The ratio of the intensities is proportional to the percentage of U-235 in the sample (enrichment).	The instrument is calibrated with a series of samples of different enrichments that have been verified by independent methods. Samples are developed internally or obtained from NBL.	(0.2-2) [0.5-2]	Metals or oxides that may be in various containers	Corrections must be made for the wall thickness of the container, and the unit should be routinely calibrated and tested against standards with enrichments similar to the samples.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Measurement Error, %[b] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
High Level Neutron Coincidence Counters [Pu]	Materials that spontaneously fission emit a few neutrons in coincidence that can be measured in a neutron coincidence counter as a measure of fissionable mass (SNM). Self-multiplication from induced fissions contributes to the fission (coincidence) neutrons and is usually corrected for during the analysis. This depends on mass and composition, but occurs in relatively small masses.	Standards having SNM mass and composition similar to the material to be assayed, covering the mass range of interest and verified by independent techniques are fabricated. Some standards are available from NBL. A Cf-252 source is used to verify stable operation.	(0.5-2) [13-25]	Containers of Pu metal, oxide, carbides, fuel rods, assemblies, solutions, scrap, waste	The mass, isotopic composition, material homogeneity, size, shape, container, etc., must be similar to the standards to produce acceptable uncertainties. Data verifying the usefulness of the counter for the materials measured should be reviewed along with estimated uncertainties. Instrument performance must be documented and tracked (a control chart of the measurements on the standards). To use the counter results for verifications, the isotopic composition must be known (mass spectrometry, gamma spectrometry) since the spontaneous fission rate varies among the isotopes and is usually dominated by Pu-240 content.

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(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Neutron Multiplicity Counter	Multiplicity counting is a passive NDA technique for plutonium analyses. It uses three measured parameters: singles, doubles, and triples data is obtained. These are used to determine: Pu-240-effective mass, self-multiplication, and (α,n) reaction rate. Multiplicity counters are designed to maximize neutron counting efficiency and minimize neutron die-away time. They also have much lower electronic deadtimes, and their detection efficiencies are less dependent on neutron energy.	Standards having SNM mass and composition similar to the material to be assayed, covering the mass range of interest and verified by independent techniques are fabricated. Some standards are available from NBL. A Cf-252 source is used to verify stable operation.	(0.25-2) [7-25]	Containers of Pu metal, oxide, carbides, fuel rods, assemblies, solutions, scrap, waste	The mass, isotopic composition, material homogeneity, size, shape, container, etc., must be similar to the standards to produce acceptable uncertainties. Data verifying the usefulness of the counter for the materials measured should be reviewed, along with estimated uncertainties. Instrument performance must be documented and tracked (a control chart of the measurements on the standards). To use the counter results for verifications, the isotopic composition must be known (mass spectrometry, gamma spectrometry) since the spontaneous fission rate varies among the isotopes and is usually dominated by Pu-240 content.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Measurement Error, %[b] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Active Well Coincidence Counters, (AWCC) [U]	The AWCC irradiates the fissionable material, causing fissions that emit a few neutrons in coincidence that can be measured in a neutron coincidence counter as a measure of fissionable mass (SNM).	A series of U standards of similar composition and mass covering the range of the analysis must be fabricated. Such standards are available from NBL.	(1-10) [2-20]	U metal, oxide, scrap in various containers	The mass, isotopic composition, material homogeneity, size, shape, container, etc., must be similar to the standards to produce acceptable uncertainties. Data verifying the usefulness of the counter for the materials measured should be reviewed, along with estimated uncertainties. Instrument performance must be documented and tracked (a control chart of the measurements on the standards).

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(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Calorimetry [Pu]	Energy from the radioactive decay of isotopes is released in the form of heat that can be measured in a calorimeter. The heat released by Pu is enough to provide accurate measurements of a few grams of materials in the proper calorimeter.	A series of certified masses of plutonium with known heat output are required and should be in containers similar to those used during the measurements. The heat output is generally certified by specialists at Los Alamos National Laboratory and provides traceability to national standards.	(0.3-0.8) [0.2-0.6] for isotopics by gamma (0.3-0.4) [0.15] for isotopics by mass spec	Plutonium in all forms with known isotopic composition and enough mass to provide an acceptable uncertainty	The calibrated range of the calorimeters should be verified and routine standardization and control charts reviewed. Samples should fall into this range. If end point projection is used instead of allowing the calorimeter to come to equilibrium, the basis for the projection and test results should be reviewed.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Cf Shuffler [U, Pu]	A Cf-252 source is repeatedly shuffled in and out of the measurement cavity where the sample is placed. The neutrons from the source induce fissions in the fissionable nuclear material in the sample, and some of the fission products decay soon after production yielding neutrons. When the source is in the storage position, these delayed neutrons are measured, providing a measure of the fissionable material.	Standards produced with independently verified quantities of SNM in configurations simulating the types of items to be measured are produced.	(0.2-4) [0.6-10] [4-50] for scrap and wastes	Metals, ingots, scrap, oxides, etc., in containers up to 55-gallon drums The ability to handle large samples is an advantage of the shuffler.	The shuffler is sensitive to the matrix (neutron penetration) and material position, and the standards used in the calibration need to closely resemble the samples and be in the same type of containers.

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(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Segmented Gamma Scanner [U, Pu]	In the segmented gamma scanner, the photons from the decay of the SNM are measured with a collimated high resolution detector. The sample is rotated and translated in front of the detector to permit measurements from progressive segments of the sample. A source with photon energies close to those of the measured photons (transmission source) is also used to measure the attenuation in each segment and to correct for loss of photons from the SNM due to attenuation.	Standards should consist of independently verified materials placed in containers and matrices similar to the items to be measured.	(2-9) [0.5-20]	Metals, scrap, waste	The transmission sources typically have a short half-life and must be replaced periodically. The standards must be similar to the measured matrix, and the unit must be under periodic quality control with routine counting of standards (or control samples) and tracking of results on a control chart.
Tomographic Gamma Scanner (TGS) [U, Pu]	TGS combines high-resolution gamma spectrometry and low spatial resolution three-dimensional transmission and emission imaging techniques to accomplish assay goals. The emission data is used to solve for the radionuclide distribution on a voxel-by-voxel basis, which is then corrected for photon attenuation using the transmission map.	Standards should consist of independently verified materials placed in containers and matrices similar to the items to be measured.	(1-6) [4-15]	Scrap, waste items with low to medium density	The transmission source has a short half-life and must be replaced periodically. The standards must be similar to the measured matrix, and the unit must be under periodic quality control with routine counting of standards (or control samples) and tracking of results on a control chart.

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Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Measurement Error, %[b] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Barrel Scanner [Pu, U]	The barrel scanner is a specialized segmented gamma scanner designed to handle large samples (barrels).	Standards should consist of independently verified materials placed in containers and matrices similar to the items to be measured. Generally, the standard consists of a specially designed barrel filled with material simulating the matrix and with positions for the insertion of known sources.	(2.5) [1-30]	Generally wastes in a low-density matrix	The transmission source (usually Yb-125) has a short half-life and must be replaced periodically. The standards must be similar to the measured matrix, and the unit must be under periodic quality control with routine counting of standards (or control samples) and tracking of results on a control chart. For Pu measurements, Se-75 and Co-57 are used for the transmission measurement. Several positions must be tested to estimate the uncertainty for a range of situations.

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(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[(a)]	Measurement Error, %[(b)] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Nuclear Materials Identification System (NMIS) [U,Pu]	NMIS measures the time sequence of decay neutrons and photons from a sample and may use a decay time measured source to cause the emission of fission neutrons and photons. By looking at the time-correlated signals, the system can accurately discriminate among several nuclear materials types.	NMIS requires calibration using a known material sample similar to the material of interest. Many materials of interest have already been measured.	N/A	Weapons components, metal, waste, holdup in ducts, etc., in matrices permitting measurement of the signature radiation	This is a specialized system and must be operated by an experienced individual or someone trained by one of the users/developers of the system.
Holdup Measurement System [U,Pu]	This is a specialized gamma photon measuring system designed to measure photons emitted by SNM materials "held up" in ducts and pipes in the process system. The system consists of a detector (NaI, CdZnTe, Ge), a multi-channel analyzer, and a computer and software to analyze the data.	The system must be calibrated for the geometry and material. Software for typical geometries is available.	10-100% accuracy	Material in process piping, air ducts, etc.	The operator must properly evaluate and select the geometries and should be using the latest version of available software. Interference can occur from materials in nearby structures when the collimator or shielding is not properly set up.

(a) NBL = New Brunswick Laboratory
NIST = National Institute of Standards and Technology

(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Table 4-2. (Continued)

INSTRUMENT/ TECHNIQUE [material]	BRIEF DESCRIPTION	STANDARD[a]	Measurement Error, %[b] (Random) [Systematic]	MATERIAL TYPES MEASURED	ASSESSMENT CONCERNS
Solution Assay System for Uranium [U]	The system measures the intensity of the 186 keV gamma from U-235 in a liquid and makes a correction for attenuation using a transmission source (Yb-169). Systems performing measurements on high concentration solutions use gamma absorption (K-edge densitometry) in which the transmission of a photon near the K-edge of the material is measured and compared to transmission below the K-edge.	The system is calibrated using a series of solutions of independently known concentrations in sample containers similar to the measurement containers.	(0.2-1.0) [0.4-2.0]	Process solutions contained in a standard-geometry container	Sample uniformity is important since the system only measures the concentration in a small volume of the sample. Precipitation of solids in samples can also be a problem.
Solution Assay System for Plutonium [Pu]	Measurements on solutions use gamma absorption (K-edge densitometry) in which the transmission of a photon near the K-edge of the material is measured and compared to transmission below the K-edge. Sources of Se-75 or Co-57 are used.	The system is calibrated using a series of solutions of independently known concentrations in sample containers similar to the measurement containers.	(1.0) [0.4-2]	Process solutions contained in a standard-geometry container	Sample uniformity is important since the system only measures the concentration in a small volume of the sample. Precipitation of solids in samples can also be a problem.

(a) NBL = New Brunswick Laboratory
NIST = National Institute of Standards and Technology

(b) The quoted errors are for a 95% confidence level. Measurement errors will vary with the material, its purity, quantity, form, container, etc., and the numbers should be considered informational.

Section 5: Material Accounting

5.1 General Information

The Material Accounting subtopic addresses the various methods used to maintain records of and account for nuclear materials at a facility. The Material Accounting element of an MC&A program provides data and reports on nuclear material to support local, national, and international reporting requirements. The accounting system provides assurance that all nuclear material quantities are present in the correct amounts, provides detection of a loss of nuclear material, and estimates the amount of any loss and its location. The assessment addresses selection of MBAs, records systems, timeliness of entry, report generation, source document preparation, data submission to the NMMSS, data traceability, and transfer documentation.

The accounting system must provide for: (1) retention of key material accounting data (internal/external transactions), original source data, relevant reports, and applicable documentation; (2) TID records; (3) physical inventory listings, reconciliations, and work sheets; (4) records of IDs, other inventory adjustments, and calculations of LEIDs; and (5) reports of investigations and resolution of alarms, excessive IDs, and S/R differences on an individual and cumulative basis.

DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*, identifies two objectives that a site/contractor MC&A program must meet to provide an acceptable program.

Material Accounting Objectives.

(1) Accurate records of nuclear materials inventory are maintained and transactions and adjustments are made in a timely manner.

(2) The accounting system

(a) Provides data and reports on nuclear material sufficient to support local, national, and international commitments.

(b) Must accurately reflect the nuclear material inventory and have sufficient controls to ensure data integrity.

(c) Provides data for reporting on accountable nuclear material to NMMSS.

(d) Must use MBAs as the basis of the accounting structure with key measurement points established to localize and identify IDs.

(e) Must provide a complete audit trail for all accountable nuclear material from receipt through disposition.

Performance metrics documented in DOE Order 474.2, Change 4, Attachment 3, may be addressed in the MC&A Plan to demonstrate how the MC&A program will meet Material Accounting objectives, and can be used by assessors to assist in the evaluation of the Material Accounting subtopic. In addition to the performance metrics documented in DOE Order 474.2, Change 4, Attachment 3, guidance on meeting Material Accounting objectives is described in the DOE Technical Standard, DOE-STD-1194-2011, Section 6.4, Accounting. Figure 5-1 summarizes the assessment activities that are most commonly performed by the MC&A topic team for each Material Accounting subtopic area.

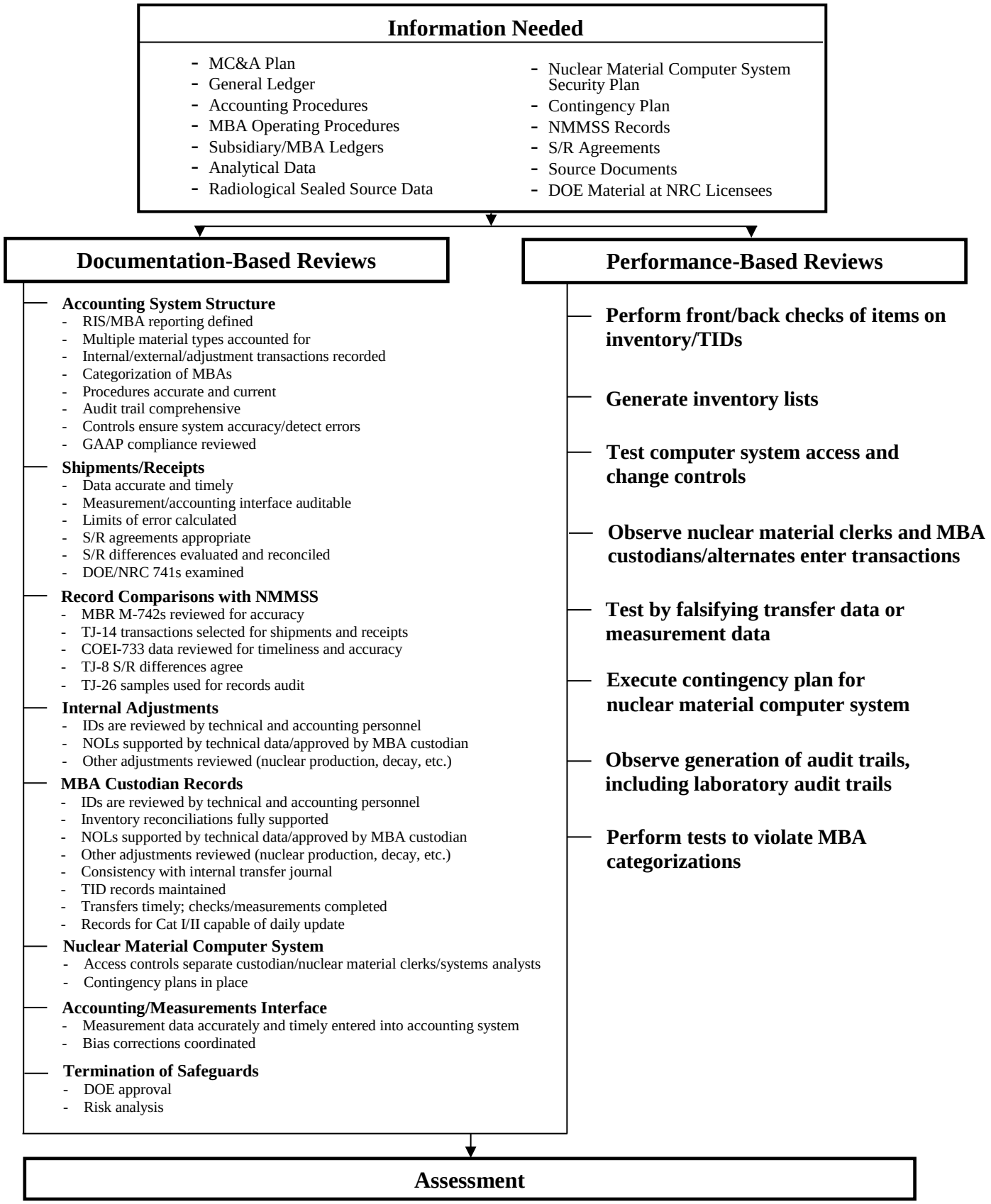

Figure 5-1. Assessing Material Accounting

5.2 Data Collection Activities

5.2.1 Information Needed

The key information needed to conduct a comprehensive review of the Material Accounting subtopic includes the MC&A Plan, general ledger, accounting procedures, MBA operating procedures, subsidiary/MBA ledgers, analytical data, accounting system computer security plan, contingency plan, NMMSS records, S/R agreements, and source documents.

In addition to reviewing documentation, assessors should identify key MC&A and management personnel to interview to gather additional insights into the program. These personnel can be identified using the site's MC&A Plan, organizational charts, procedures, training records, or other documents that describe key responsibilities. When assessing MC&A accounting system performance, assessors should include interviews with the following personnel (note that each site may use different titles):

- MC&A manager
- MC&A accounting supervisor
- MC&A accounting personnel
- MBA custodians
- MBA personnel who enter accounting data
- Computer system administrator
- Computer system analysts.

Since some of these individuals are also interviewed as part of the Program Management topic review, these interviews should be coordinated with the assessment of the administrative systems. Joint interviews are effective and minimize the impact on the facility operating staff. Standardized questions and knowledge testing can be used in addition to interviews.

5.2.1.1 MC&A Plan

Assessors should begin by reviewing the MC&A Plan, which will provide a general description of the Material Accounting function and identify individuals (by title) who are responsible for maintaining the accounting system and entering data into the accounting system. The MC&A Plan may identify sub-tier documents that will further describe the accounting system.

5.2.1.2 General Ledger

Assessors should review the general ledger, which shows the overall facility balance by RIS and material type. Ledgers may be reconciled with the physical inventory monthly, bimonthly, and/or cumulatively. The DOE accounting period for reporting to the national database is annual, with the reporting period ending September 30.

Most facility general ledgers are in the M-742 format, and the ledgers are organized by Material Type Code. EA assessments routinely focus on high enriched uranium and plutonium, but the assessor must also pay attention to significant activities in other accounts, such as plutonium-238, and separated americium and neptunium-237. Using the ledger as a basis, the assessor can determine which backup data to examine for shipments, receipts, IDs, and other accounting adjustments.

5.2.1.3 Accounting Procedures

Assessors should review accounting procedures. These accounting procedures are specific to the MC&A organization and detail how transactions are entered into the accounting system. Procedures should include details of routine inventory adjustments (e.g., decay, transmutation) and requirements for approval authority for these adjustments.

Becoming familiar with the facility terminology and records can be a difficult task in Material Accounting assessments. For example, each facility has its own set of material description codes and listing of MBAs. These site-specific documents may be included in procedures, but if not, the assessor should obtain a copy.

5.2.1.4 Operating Procedures

Assessors should review MBA operating procedures. Some facilities have MBA operating procedures that detail how each MBA maintains its records. Frequently, the MBA operating procedures will detail how all MC&A requirements are met within the MBA and contain only minor discussions of the accounting system.

5.2.1.5 Subsidiary/MBA Ledgers

Assessors should review subsidiary/MBA ledgers, if present. Although a central MC&A accounting system routinely has ledgers for all MBAs, subsidiary/MBA ledgers may be kept in some MBAs. For example, an MBA could have a standalone, PC-based accounting system that would interface with the central MC&A system, or a standards laboratory could have a records system that uses more significant digits in reporting than NMMSS requires.

5.2.1.6 Analytical Data

Assessors should review analytical data to ensure that correct nuclear material values are entered into the accounting system. Data from all laboratories that generate accountability values must be reviewed, and the flow path of the data from the laboratory through the MBA custodian to the records system must be examined. Coordination of Material Accounting and Measurements assessment tasks will minimize duplication during an assessment.

5.2.1.7 Computer System Security Plan

Assessors should review the accounting system computer system security plan, which details how data integrity is maintained. The plan describes the different levels of access (e.g., systems analyst, nuclear material accounting, nuclear material measurements, MBA custodian, laboratory personnel). Coordination between the MC&A assessor and the Computer Security topic is frequently required.

5.2.1.8 Contingency Plan

Assessors should review the contingency plan for the computerized accounting system, which describes how backup information is maintained and how frequently the backup system is tested. This plan may be incorporated into the computer security plan.

5.2.1.9 NMMSS Records

Assessors should review NMMSS records, which are the facility copies of documentation received from NMMSS. Each facility maintains these records as a means of reconciling the national accounting system with the facility accounting system. Assessors should select a time period for review and ask to have the

NMMSS and facility records available for review. Only a cursory examination may be required since this data should be routinely examined by the field element during MC&A surveys.

5.2.1.10 Shipper/Receiver Agreements

Assessors should review S/R agreements, which are facility-to-facility agreements that specify typical conditions and measurements that will be performed on planned shipments between two facilities. Both shipper and receiver facility field elements must approve the agreements. The agreements describe the measurements that will be made, timeframes for completion, and whether or not safeguards closure will be invoked. S/R agreements are proactive in nature but are not required. If such agreements exist, they will assist in facility reconciliation of any S/R differences.

5.2.1.11 DOE-Owned Material

Assessors should review the facility's documentation of DOE-owned material at NRC licensees or non-DOE/NRC sites. The facility must obtain written verification at least annually that the licensee continues to possess the materials and verify that the NMMSS records are correct for these materials.

5.2.1.12 Radioactive Sealed Sources

If requested, assessors may review facility data for radioactive sealed sources. Documentation for reporting sealed sources to DOE Headquarters and reconciliation should be reviewed. Sources that meet the reporting requirements set out in DOE Order 474.2, Change 4 (i.e., material type and accountable quantities) should be included in the MC&A accounting system, as well as being reported through the DOE Headquarters sealed source database to the NRC.

5.2.2 Documentation-Based Reviews

As shown in Figure 5-1, the documentation-based review of the accounting system can be divided into reviews of the accounting system structure, shipments/receipts, record comparisons with NMMSS, internal adjustments, MBA custodian records, the nuclear material computer system, and the accounting/measurements interface. In addition, the process for termination of safeguards should be reviewed.

The reviews performed in each of these areas are briefly summarized in the following subsections. While the major focus of the reviews will be the facility's accounting system, assessors should also verify that the field element is performing sufficiently detailed audits on the accounting system and provide this feedback to the PPM topic for input into an analysis of the field element survey program.

5.2.2.1 Accounting System Structure

Assessment of the Material Accounting subtopic includes reviewing the account structure, records and reporting system, and accounting procedures. Facility RIS codes are the starting points for the accounting system assessment. Facilities may have more than one RIS code to accommodate transfers of waste, IAEA inspections, financial accounting, and emissions to the environment. Each RIS code must report to NMMSS by material type code. Each facility must designate an individual who is responsible for reporting data to NMMSS.

Facilities must maintain accountability data by MBA that reflects quantities of nuclear material received and shipped, adjustments to inventory, and remaining quantities on inventory. Assessors should determine whether the system is structured to allow reporting of all material types and whether it has mechanisms for recording internal, external, and adjustment transactions. The accounting system must address mixed material types (e.g., plutonium and highly enriched uranium) and multi-container packages.

A table that lists MBA, custodian, category, and a brief description of the MBA may be part of the MC&A Plan, or it may be requested as part of the account structure review. Assessors can use this table to select MBAs for additional record evaluations, or to select MBAs to tour or custodians to interview. Assessors should examine several MBA transactions by either reviewing documentation or observing personnel entering actual data.

The facility should explain how the accounting system identifies the category of each MBA and, in some cases, how the attractiveness level of each item is determined. Based on this explanation, assessors should evaluate how rollup is calculated and/or controlled. In some facilities, the computerized accounting system calculates categorization and/or rollup based on attractiveness levels and quantities of nuclear material in inventory. In other facilities, that calculation may be done by hand or through input into a separate spreadsheet file. Assessors should review the facility's methodology for appropriateness and accuracy.

Facilities may have a procedure to pre-approve internal transfers to verify that the intended receiving MBA is authorized to receive the type and quantity of material being shipped and that the MBA will not exceed its authorized category. Assessors should evaluate the effectiveness of facility procedures for rollup calculations and pre-approving internal transfers.

Assessors should evaluate documented accounting procedures, verify that they are approved by management, and determine whether they are consistent with the MC&A Plan. Organizational responsibilities should be clearly defined, and the documents should be distributed to the correct personnel (verify the currency of the documents in the field if time permits) and adequately controlled. Assessors should note the date when the procedures were last revised, how often they must be reviewed, and whether they are periodically reviewed in accordance with the facility's established timeframes. In particular, assessors should evaluate the adequacy of procedures used for reconciling the book and the physical inventories. This process should be evaluated for at least two inventory periods to ensure that procedures are followed and that the procedures are current. The procedures should specify report frequency, distribution, timeliness, and retention requirements for all accountability records, reports, and supporting documentation, specifically for process data that could be used for validating data at some future time.

The facility must maintain a record and reporting system that provides a database for tracking nuclear material inventories and for documenting nuclear material transactions. The assessment should determine whether the contractor has established an auditable records system containing sufficient information to demonstrate that all commitments in the MC&A Plan have been met and that the accounting system complies with all reporting requirements. The number and types of records assessed will vary with the reviews and audits performed by the facility and the extent of assessments and DOE field element MC&A surveys.

An acceptable records system will have sufficient redundancy to allow reconstruction of lost or missing records in a separate secure location, so that a complete knowledge of the SNM inventory is available. It is essential that appropriate safeguards be implemented to prevent loss, misplacement, or accidental destruction of the inventory and item location records. The records system should be complete and sufficiently detailed to permit auditing of all parts of the MC&A system, with records and reports readily traceable to source documents.

Audit trails must be available. For computer-based accounting systems, this is a straightforward inquiry. All transactions should be uniquely identifiable; a simple check would be to try to enter a duplicate number for a transaction. In a manual system, procedures must describe the mechanism for unique identification. Forms control is an issue in manual systems, and periodic inventories of forms, as well as physical control of used and unused forms, are important. It is essential that the facility verify that the physical control of forms is adequate.

Controls (checks and balances) are required to ensure accuracy and to detect errors (for example, mathematical errors) in records. Edit checks in computer-based accounting systems are the most common. Facility personnel should describe potential errors made by data entry personnel and how these are detected by the accounting system. The accuracy of the accounting system should be determined on a periodic basis.

Manual systems require additional review by trained personnel who understand the forms, are familiar with the data characteristics, and can perform any necessary mathematical calculations required.

Nuclear material accounting personnel should be aware of and trained in the fundamentals of generally accepted accounting principles (GAAP). While reviewing transactions, GAAP should be employed. For example:

- Separate entity should be evident from facility MBA structure.
- Matching should be demonstrated by having transactions entered and reconciled in the accounting period in which they are sent to NMMSS.
- Substance over form entries are exemplified when an ID is taken if an S/R difference was created from an RIS that is no longer in existence.
- Materiality is demonstrated when reconciling significant S/R difference of "insignificant" amounts.
- Conservatism should be evident when inventory adjustments are reviewed by accounting or management personnel.
- Continuity is demonstrated through the records retention program and through demonstrated nuclear material accounting as new contractors assume management of older facilities.
- Full disclosure is demonstrated when procedures fully document methodologies and all adjustments are thoroughly explained.
- Consistency is demonstrated when similar transactions receive similar treatment, e.g., when all IDs are consistently assigned.
- Objectivity is demonstrated when accounting adjustments are rationally examined and appropriately entered into the system.

5.2.2.2 Shipments/Receipts

Assessors should have the facility describe the mechanism for transferring nuclear material off site. Assessors should also verify that written documentation exists to support the statements and, if a shipment is planned during the assessment, observe the procedure being followed. Similarly, assessors should ask facility representatives to describe the procedure for receiving material from off site and then review the documentation. If a receipt is expected, assessors can observe unloading and unpacking.

If a central shipping/receiving facility is used, assessors should be able to determine exactly what activities are performed at the facility and review the procedures. For the most recent DOE/NRC Form 741s, assessors can review the packaging and shipping data to verify adherence to internal procedures. Assessors should also review the documentation to verify that the shipments were assessed within 24 hours of arrival and that the number of containers, serial numbers, and TIDs was verified. The total amount of SNM may

or may not be known by the shipment/receipt facility since item identification may be all that is required (e.g., assembled weapons or weapons parts).

Assessors should review the DOE/NRC Form 741 files. Most facilities maintain Form 741s by RIS codes, and it is easy to identify the most common recipients of nuclear material. These files should be reviewed to determine whether Form 741 was dispatched within 24 hours and was correctly completed (for example, whether it includes limits of error, or LEs). The backup data should be reviewed to verify that the calculation was correctly performed and that it considered systematic and random, bulk, sampling, and analytical errors. If the measurements were performed by NDA, assessors should review the method for appropriateness. Assessment of accounting systems should be coordinated with assessment activities of the Measurements topic. Assessors should verify that nuclear material in transit at the end of a reporting period is included in the receiver's inventory.

When reviewing receipt data, assessors should verify that measurements were made in a timely manner and that the receiver's measurements and LE were booked. A list of outstanding 741s that still require the receiver's measurements (an NMMSS A-E transaction) should be requested. To ascertain whether this file is complete, assessors should note the common shipper for the majority of the outstanding 741s and review the entire file for closure. Also, assessors should ask how the facility tracks open 741s. This system should be reviewed to ensure its integrity. Assessors should also ascertain how the facility ensures that material on open 741s does not enter the process until the 741 has been closed and all significant S/R differences have been resolved. If time permits, assessors can select several open 741s and request an inventory listing. If all selected items are still on inventory, it is considered evidence that the system is working. It may also be necessary to physically verify the presence of each item.

For planned shipments, assessors should review the documentation specifying the procedure to follow to determine how MC&A personnel are notified of a "final release" of shipments. Assessors should ask what mechanism is in place to ensure that the receiver is authorized to receive the planned shipment.

Assessors should review Category III and IV shipments of SNM and other nuclear materials. The facility should provide assurance that the MC&A organization is fully integrated with facility operations for preparing accountability documentation for shipments of smaller and less attractive quantities of nuclear materials.

Assessors should review the facility's documentation for determining and resolving S/R differences to determine whether the procedures allow for evaluation, investigation, reporting, closure, and follow-up of S/R differences. Material should not be entered into the process until the S/R difference is resolved (unless approved by DOE). When a significant S/R difference is determined, the notification and report must be made within 30 days. Resolution could involve one facility's values being adopted or each facility accepting its own values. Assessors should review procedures or S/R agreements. The assessor should also validate that the field elements involved must concur on all significant S/R difference resolutions.

Assessors should review the program for monitoring S/R differences to determine whether individual and cumulative trend analyses are performed and whether the methods are statistically valid. The methods must be documented. As part of this review, assessors should review LEs to determine whether they are properly calculated and whether measurement uncertainties are current and appropriate. The cumulative S/R difference for each like material type must be routinely monitored and action taken to identify and correct measurement biases when they are determined to be statistically significant.

Assessors should determine whether any alarm conditions were created since the previous assessment due to an incorrect number of items in a shipment. If so, assessors should determine whether a nuclear material alarm was indicated and what investigation and documentation were performed. All such alarms should be reviewed during the assessment.

5.2.2.3 Records Comparisons with NMMSS

The facility issues accounting reports that include nuclear material transactions, material balances, inventory adjustments, and external shipments. Assessors should review the timeliness and availability of an audit trail for the accounting records. For reports that are submitted to NMMSS, the assessment normally includes a review of the NMMSS error rates for appropriateness.

Assessors should determine and evaluate the mechanism that the facility uses to report data to NMMSS, especially the interface between the physical inventory records and the general ledger. These two functions are independent and require reconciliation. The facility should explain how this occurs and have procedures to describe the activity. Assessors should consider using the following NMMSS reports during the assessment:

- TJ-26 Statistical Sampling of Transactions
- TJ-26A Transaction Series Detail
- TJ-8 S/R Difference Report
- TJ-14 Transaction Activities
- M-742 Material Balance Report
- A-200 Ending Inventory Comparison
- A-210 Project Material Balance.

Assessors should request in advance for the facility to have these reports available (specifying RIS, timeframe, and material types) for the assessment. The reports are then compared to the facility ledger. If the field element's survey shows evidence of a strong NMMSS review and reported NMMSS error rates are low, assessors may wish to focus efforts in other areas.

5.2.2.4 Internal Adjustments

Localization of losses is an important function of the accounting structure. Assessors should determine whether localization of losses is performed on an MBA basis or whether localization of IDs by process units is obtainable. Details regarding localization of losses are verified during facility discussions and by examining the MC&A Plan and accounting records.

Assessors should review inventory adjustments to determine who is authorized to make adjustments and how adjustments are made. Adjustments must be made on an MBA basis, and the MBA custodian must approve all changes. No MBA custodian should be authorized to enter an ID without some method of peer review. (This arrangement would provide a potential vulnerability path by allowing the custodian to "re-measure" a single item and submit an ID.) It is especially important that accounting and clerical personnel are not approving ID transactions submitted by a custodian without peer review, unless they are appropriately trained, authorized, and qualified. At some facilities, MC&A personnel from an independent measurement group are required to approve all IDs.

Assessors should evaluate other inventory adjustments, such as routine tests, degradation to other materials, radioactive decay, fission and transmutation, normal operating losses (NOLs), accidental losses, and approved write-offs. The goal of this evaluation is to ensure the complete and accurate accounting of SNM with the intention of minimizing the influence of these activities on material control indicators (IDs and S/R differences). Copies of the two most recent DOE/NRC Form M-742s should be requested and significant inventory adjustments selected. The facility should be asked to provide supporting data for each of the selected adjustments.

Assessors should review the effect of prior period adjustments on the accounting system. Prior period adjustments must be taken into account before the significance of the current period ID is assessed. To modify the ID quantity, add or subtract the quantity of the adjustment before assessing the significance of the current period ID. Assessors should also review the site's methods for evaluating prior period adjustments and determine whether the evaluation of IDs for prior periods is appropriate.

Assessors should also review documentation dealing with stack, liquid waste, and other waste monitoring systems that the facility uses to determine nuclear material values. Also, associated measurement and measurement control information should be reviewed to determine whether reporting is appropriate.

Assessors should determine whether the facility has a program for evaluating IDs associated with the physical inventory-taking and whether evaluation procedures are current and approved. The program typically includes response procedures and specifies a chain of command to respond to significant IDs. This activity should be coordinated with the assessor who is reviewing physical inventories.

5.2.2.5 MBA Custodian Records

It is important that a program be established to control and account for inter- and intra-facility transfers of nuclear material. The objectives of transfer control are to document an approved procedural system that will deter or detect diversion or theft of nuclear material during transfers; to ensure that no nuclear material is transferred without the knowledge and concurrence of the custodians; to provide needed information concerning the location or disposition of material; and to provide proof and an audit trail for verifying that all requirements have been met.

Assessors should review facility documentation that specifies the requirements for authorization, documentation, tracking verification, and response to abnormal situations. Also, assessors should interview personnel who routinely perform these activities, and verify that they are familiar with and follow procedures.

For internal transfers of nuclear material, assessors should review documentation that specifies the procedure to follow. The procedures must be current, define responsibilities, and have appropriate approval.

Assessors should select one or two MBAs and review the file of internal transfers to determine whether procedures are being followed. Assessors should also determine how internal transfer checks are verified. Additionally, assessors should review material flows within and between the MBAs to determine whether appropriate documentation is generated. No marks may be made in pencil, and single line correction and initials are required for transfer error correction.

5.2.2.6 Nuclear Material Computer Systems

Assessors should review computer systems used to capture and manipulate MC&A data. This activity should be coordinated with the cyber security topic team. Assessment of accounting computer systems combines data verification and system review. The site's audit program must verify that changes to the computer software have been made in accordance with specified change controls of the software quality assurance program, and that the software quality assurance program performed the appropriate tests. Assessors should review those audits and select specific elements for testing.

Assessors should also review the software quality assurance program at the site. The cyber security topic team may test the controls that are in place to prevent or detect unauthorized access to the database and data processing systems.

It is essential that the facility establish controls limiting access to the accounting system and nuclear material accounting data. Systems assurance for computerized accounting systems is typically described in the cyber security plan and may have certain features described in a users' manual. Assessors should determine whether the system has the required access controls (for example, password or physical key control/special rooms). Assessors should consult with the cyber security team or review the foregoing plans/procedures and conduct simple performance tests (for example, log on with incorrect passwords).

A contingency plan for the accounting system is usually described in the security plan or similar document. The contingency plan must be described in writing and present a viable option. Assessors should ascertain whether records are vulnerable to a common mode failure.

5.2.2.7 Material Accounting/Measurements Interface

Assessors should review how measurement data is entered into the accounting system and by whom. The NDA laboratory could be separate from the chemistry laboratory, and data flow could be different. These data flows are extremely important to examine whether the measurement results are delayed and applied to an item after it has left its originating MBA (such as a transfer to a storage vault) since correcting transfers might be required.

It is not uncommon for an item to be transferred between MBAs with incomplete measurement information. For example, the weight or volume of material being transferred might be determined and entered into the accounting system, with the SNM concentration entered as "0." As part of the transfer procedure, one or more samples are taken and sent to the analytical laboratory for DA. The laboratory results will then be sent to one of the MBA accountants and the "0" in the accounting records replaced with the SNM concentration obtained from the laboratory. It is very important that all of the "0" values get replaced with the correct analytical results.

Data verification includes checking arithmetic accuracy when source documents contain data combinations. If the quantity of data is large, sampling plans are used to select data for verification. If data processing is computerized, data verification is limited to source documents and their entry into the computer system.

All measurement data must be funneled into the accounting system. During briefings, the facility should describe how this process is accomplished. During the assessment, assessors should validate that procedures and practices are in agreement.

5.2.2.8 Termination of Safeguards

Assessors should review procedures for terminating safeguards on nuclear materials at the facility. The facility may terminate safeguards on waste materials generated during routine activities, or on materials from D&D activities. Some facilities request DOE approval to terminate safeguards on individual batches of material, while others request approval of a process or methodology to apply to all material they wish to exempt from MC&A requirements. Assessors should review termination requests and approvals to determine whether they are appropriately documented.

Assessors should review the facility's documentation identifying materials that meet termination criteria. Assessors should also review source documents removing those materials from the accounting system. Additionally, assessors should validate that appropriate risk analyses have been performed and that terminated materials are transferred to a D&D or waste management organization.

5.2.3 Performance-Based Reviews

This section provides a brief overview of the performance tests shown in Figure 5-1. Details of these performance tests can be found in Appendix A. Since many of these performance tests compare the book inventory with the physical inventory, the reviews described below should be coordinated with the assessment of the physical inventory.

5.2.3.1 Front/Back Checks of Items on Inventory

Assessors should conduct a front check of inventory items, which consists of recording unique item identifiers observed during a facility tour/walkdown and validating that the items are correctly listed in the accounting system. Assessors should record the item identification, TID identification (if applied), MBA, material type, material description, location, gross weight, and grams of nuclear material in the container. At some facilities, a local computer terminal can be accessed to immediately validate that the accounting system properly accounts for the selected items.

A back check consists of selecting items at random from the accounting system records and going to the respective MBAs to validate that the item and its values are as stated in the accounting system.

Front and back checks should be done in several MBAs unless there is reason to believe that only a single MBA should be tested. Checking multiple MBAs will assist in differentiating generic accounting system problems from MBA-specific problems.

Assessors typically select items containing Category I or II quantities; however, if rollup is a potential issue, items containing Category III or IV quantities could be selected.

5.2.3.2 Inventory Listings

The accounting system must be able to generate book inventory listings of nuclear material by MBA. Asking the facility to generate this list and then validating the accuracy and timeliness of generating the list is a valid performance test.

This test can be done in conjunction with an emergency physical inventory. A permutation of this test would involve having a trusted agent (computer system analyst or MC&A accounting personnel) generate an extra item on the book inventory listing and evaluating the facility response. Another permutation would use the MBA custodian as a trusted agent who intentionally reports an item missing when it is not. This test would evaluate the MC&A organization's response to a missing item.

5.2.3.3 Accounting System Computer Access Control and Change Control

Assessors should identify the computer system's access/change controls and, using a trusted agent, attempt to violate them. Computer-based accounting systems typically have various levels of access controls. For example, MC&A accounting personnel may not have access to SNM; MBA custodians may not have authority to make ID adjustments; TID custodians may be prohibited from making measurement adjustments; systems personnel may not have MBA access; and laboratory personnel may not be permitted to enter SNM values for specific items. This type of performance test validates the defense-in-depth posture.

5.2.3.4 Transaction Data Entry

Assessors should observe MC&A accounting personnel and MBA custodians as they enter routine transaction data. This test can be a mechanism for validating the training program and ensuring that the

data being generated has a high degree of integrity, that performance agrees with the supporting procedures for the transaction, and that the data elements being entered ensure a comprehensive accounting system. Typical transactions include internal transfers, entry of measurement data, entry of inventory adjustment data, and entry of receiver's measurements of a recent offsite shipment.

5.2.3.5 Transfer Data or Measurement Data Errors

Defense in depth can be evaluated by attempting to input incorrect data to determine the level of oversight for data entered into the accounting system. Assessors must first ascertain when the data entry error should first be detected (and by whom) and whether the facility agrees that this is a valid test of the accounting system. For example, a 1-2 gram entry error might never be detected, a 1-2 kilogram error might be detected at the time of physical inventory, and a 10-20 kilogram error might be detected at the end of the day.

5.2.3.6 Business Contingency/Disaster Recovery Plan for Computer-Based Accounting Systems

Computer-based accounting systems must have backup and contingency plans to ensure both long-term data integrity and the capability to support the facility in an emergency. The MC&A team coordinates these tests with the cyber security team to maximize the amount of information gained. The assessor should define what successful execution of the contingency plan involves (e.g., generation of inventory listings or material balance reports (MBRs) and reconciliation with hard-copy records) and must read the contingency plan to determine the estimated timeframe for generating backup data.

5.2.3.7 Generation of Audit Trails

Computer-based accounting systems generate audit trails that record who made what changes and when the changes were made. Using a trusted agent, assessors should enter easily detectable incorrect data and determine how long it takes the system to identify the person who made the incorrect entry.

5.2.3.8 MBA Categorization

The objective of this test is to attempt to violate the category of an MBA by attempting to transfer items that would increase the category to an unauthorized level. For facilities with Category III and IV MBAs outside PAs, assessors should determine whether rollup to a Category II quantity is credible (review the SSP or VAs). For facilities with Category II MBAs that are not in MAAs, assessors should determine whether rollup to a Category I quantity is possible by reviewing the physical inventory listing and selecting items for movement that would create the anomaly. An attempt should be made to transfer the items that would violate the approved category level of the receiving MBA. (No material is actually moved.)

5.3 Common Deficiencies/Potential Concerns

5.3.1 Deficient Internal Material Transfer Practices

Common deficiencies in internal material transfer practices include failure to document nuclear material movements, deficient transfer checks, failure of the receiver to make required confirmatory measurement checks, and failure to have documented acceptance and rejection criteria for internal transfers. Deficiencies can result from one or more causes, including lack of line management MC&A expertise, MC&A personnel's lack of understanding of the chemical process operations involved in the transfer, failure of the IRA program to review this aspect of the operation, or lack of management priority to provide the required oversight. Such deficiencies reduce the effectiveness of the MC&A program and could provide an insider adversary the

opportunity for the theft or diversion of SNM. This problem is typically detected by identifying deficiencies in documentation or during interviews with MC&A personnel and MBA custodians.

5.3.2 Inadequate Shipping/Receiving System

When material is received from an offsite location, an S/R agreement should be in place and should specify the methods for safeguards closure (that is, quantitative measurements by both the shipper and receiver or safeguards closure using comparable confirmatory measurement systems). Deficiencies in this program can be caused by inadequate S/R agreements (for example, no defined acceptance and rejection criteria for the comparable confirmatory measurements) and failure of management to monitor shipments and receipts to ensure timely closure. These deficiencies result in a large number of DOE/NRC Form 741s remaining open, and failure to have accurate measured values of material on the physical inventory. Assessors can identify the problem by requesting a list of open transactions from NMMSS, by reviewing the facility's unmeasured inventory, or by reviewing the basis for the accountability values for items on the physical inventory.

5.3.3 Inadequate Accounting Procedures

Common deficiencies in accounting procedures include lack of formalized documentation of the accounting system, outdated procedures, and inconsistent procedures between accounting functions or between the MC&A accounting system and the MBA accounting activities. These deficiencies may result from insufficient staff (existing personnel who perform the functions do not have enough time to write the necessary procedures), lack of qualified staff to write the procedures, or failure of senior management to allocate sufficient resources to accomplish required tasks. These deficiencies result in numerous accounting system errors, including abnormally high NMMSS error rates, MBA custodians who are dissatisfied with the MC&A accounting system, high personnel turnover rates, and personnel who are trained by "doing" without any formalized documentation to assist them. Indications of this problem often become evident during interviews with MC&A accounting system personnel, discussions with MBA custodians, and review of the detailed accounting records.

5.3.4 Accounting Adjustments Not Approved by Knowledgeable Personnel

Accounting adjustments are not always reviewed as required, or personnel who are not trained to detect potential abnormal conditions approve a transaction. When an MBA custodian prepares accounting system adjustments and submits them to the MC&A organization for approval, personnel knowledgeable of the MBA should determine whether the adjustment is technically supported. Otherwise, an MBA custodian could transfer attractive nuclear material out of an MBA as waste, or create a large ID due to re-measurement and divert the difference. Assessors may get indications of the problem during the accounting system review of IDs and other accounting system adjustments. The accounting mechanism for entering adjustments requires approvals from MC&A accounting personnel and a knowledgeable MC&A technical oversight person. Failure to have the appropriate approvals indicates a potential problem.

5.3.5 Excessive NMMSS Error Rates

As older computer systems are upgraded, changes can lead to significantly increased errors in reporting transactions. Failure to resolve system deficiencies will result in the continuance of excessive error rates. Errors should be reviewed carefully to determine whether they are caused by a small number of transactions or by single, repeated errors appearing to be multiple errors. Excessive error rates increase the effort required for reconciliation, lengthen the time to records closure, and have the potential to misstate quantities of nuclear material reported by the national accounting system to Congress and international organizations. These rates are reviewed by examination of NMMSS and facility records.

5.3.6 No Traceability for Nuclear Material Values

All nuclear material values must be traceable to an approved measurement system. In some cases, material is very old, and it is not possible to determine whether it was originally measured by an acceptable analytical chemistry method or if the value was determined using by-difference accounting. The facility records system must be able to validate that all nuclear material is based on measured values with a specified uncertainty. At some facilities, material was received so long ago that the facility has no current standards to measure the material. In some cases, the material may have been measured, but the uncertainty data may not be available. Failure to have this information may result in a misstatement of the physical inventory quantity and uncertainty, and may lead to a lack of credibility from the international MC&A community. Without traceable values, there is no assurance that the nuclear material quantities are as stated. Measurement system traceability can be tested by selecting a random sample of inventory items and tracing the values to the original measurement systems, or, at some facilities, by reviewing data fields that show when the item was generated/received at the facility and which measurement system was used.

5.3.7 MBA Categorizations Controlled by Accounting Systems

Deficiencies arise when transfers into an MBA have the potential to increase the category of an MBA (for example, Category III to Category II or Category II to Category I). Frequently, a facility depends on the accounting system to flag potential problems and inform MC&A and operations management that a problem might exist. If no pre-transfer check is performed, a Category I quantity of SNM could be placed outside an MAA, or a Category II MBA could be established outside a PA. Assessors may get indications of these problems during tours, while watching transfers of material, or when the MBA categorization list is compared with routine facility transfers.

5.3.8 Holding Accounts Not Reviewed

Occasionally, holding accounts are not reviewed, numerous personnel are authorized to enter and alter holding account data, or untrained personnel have access to holding accounts. These conditions usually result from a failure to conduct proper reviews before establishing the holding account. This deficiency would allow the facility to place material quantities that cannot be physically inventoried into the official nuclear material accountability records system. Similarly, materials that should be included in the accountability record system could be recorded in a holding account and not included in the official nuclear material inventory. Assessors may get indications of this problem when they encounter incomplete accounting procedures that do not describe the role of holding accounts, a failure of the MC&A program to review holding accounts, or inadequate knowledge or training in the purpose and function of holding accounts.

5.3.9 Incorrect Accounting Adjustments

Errors can occur when entering and reporting inventory adjustments. Inappropriate transaction codes might be used; for example, an NOL is reported as an offsite shipment. Calculations for materials that are mixed, split, or down-blended may be inaccurate, or the material type codes used for the end products could be incorrect. When these errors occur, the MBR is incorrect, the ID can be incorrectly calculated, and reports sent to the national accounting system or other interested stakeholders will be inaccurate. Assessors can get indications of errors when examining the MBR and validating source documents for adjustments. Assessors should verify that all Form 741s for shipments and receipts are accurately reported on the MBR. Source documents for adjusting transactions should be compared to the MBR, and offsetting transactions (such as for down-blending activities) in the MBR should be reviewed for accuracy.

All discrepancies that are discovered should be brought to the attention of the facility, but the assessor must carefully evaluate discrepancies to determine whether there is a systemic weakness in the accounting system or the mistake was an isolated case of human error.

5.3.10 Cyber Security Concerns

All computer systems used for nuclear material accounting must comply with cyber security requirements, including configuration management and access controls. A facility may use a computer that is separate from the main accounting system computer (such as a laptop) as a backup for the inventory data, or for functions such as TID tracking or categorization and rollup calculations. If these systems are not properly controlled, data may be compromised or corrupted. Assessors may get indications of problems by reviewing computer security plans or procedures for use of accounting system computers. Deficiencies noted should be coordinated with the cyber security team.

5.3.11 LANMAS Not Fully Utilized

Many facilities now use the Local Area Nuclear Material Accounting System (LANMAS), a DOE provided database software designed to account for and provide all required reports of nuclear material inventories and transactions. The LANMAS software allows each facility to implement, or activate, individual modules in order to customize the database to the facility's needs. In some cases, weaknesses in the accounting program may be a result of the facility not fully utilizing the capabilities in LANMAS. Assessors may get indications of problems if reports are not being produced timely or are generated with numerous errors. Other indicators may include procedures where the facility downloads LANMAS data into other computers or software in order to manipulate the data to produce reports. The assessor should be aware that deficiencies identified in the accounting system may not be a direct result of not fully utilizing LANMAS. However, taking advantage of all LANMAS capabilities can increase efficiency in an MC&A program and ensure that data is not corrupted if transferred, as well as reduce time and resources spent manipulating data.

5.3.12 DOE-Owned Material at NRC Licensees Not Reviewed

When DOE transfers material to NRC licensees, this material must be periodically reviewed and assessed by DOE. Typically, this transferred material involves smaller quantities or non-SNM. The DOE site office should annually review the NRC site holdings and verify that the material is still present in its stated quantities.

5.3.13 DOE-Owned Material at Non-DOE/NRC Sites Not Reviewed

In rare cases, accountable nuclear material may be sent to a non-DOE or NRC site. Typically, this material involves quantities that the NRC does not account for (e.g., deuterium or lithium-6). In these cases, the facility may establish an offsite MBA. The DOE site office should periodically review this material and have written verification that the material is still at the site to which it was sent and is still required for the program.

5.3.14 Reportable Radioactive Sealed Sources Not Tracked or Reported

DOE Order 231.1B, Administrative Change 1, *Environment, Safety and Health Reporting*, defines sealed sources that must be reported to the DOE Radiological Source Registry and Tracking (RSRT) database. These sealed sources are typically controlled at the site level by either the MC&A organization or the radiological control organization. These sources should be reviewed annually and reported through the DOE RSRT database to the NRC.

5.4 References

10 CFR 835, *Occupational Radiation Protection*
36 CFR 1220, *Federal Records*
DOE Order 142.2A, Administrative Change 1, *Voluntary Offer Safeguards Agreement and Additional Protocol with the International Atomic Energy Agency*

DOE Order 200.1A, *Information Technology Management*
DOE Order 231.1B, Administrative Change 1, *Environment, Safety and Health Reporting*
DOE Order 243.1B, Administrative Change 1, *Records Management Program*
DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*
Nuclear Materials Management and Safeguards System (NMMSS) Users Guide, DOE/NNSA Office of Nuclear Materials Integration, NA-73
GAAP Guide (2013), Jan R. Williams, Joseph V Carcello, Terry L Neal, and Judith Weiss
Fundamentals of Materials Accounting for Nuclear Safeguards, compiled by K.K.S. Pillay, LANL, 1989

Section 6: Physical Inventory

6.1 General Information

The purpose of a physical inventory program is to provide timely and localized detection of unauthorized removal of accountable nuclear materials and to provide assurance that all nuclear materials are accounted for and that theft/diversion has not occurred. Physical inventories are a key element in the loss detection capability of the overall MC&A program. A comprehensive physical inventory program includes the following activities:

- Inventory planning and preparation
- Conducting the physical inventory
    - Determine the quantity of nuclear materials on hand at the time of the inventory by physically ascertaining its presence using techniques such as electronic or visual verification, sampling, weighing, and analysis.
    - Compare the nuclear materials on hand to the accounting records system (i.e., accounting system or book inventory).
- Reconciling physical and book inventories
    - Investigate and resolve differences between the physical and book inventories.

An assessment of the Physical Inventory subtopic generally focuses on SNM inventories, but inventories of other accountable nuclear materials (as defined in DOE Order 474.2, Change 4, Attachment 2, Table B) and credible SNM substitution materials may also be evaluated. Throughout this section of the Assessment Guide, nuclear material refers to SNM, other accountable nuclear materials, or SNM substitution materials unless SNM is specifically addressed. Accountable nuclear materials must be accounted for and controlled on a graded safeguards basis; therefore, physical inventories must be performed according to the strategic importance of the material (attractiveness) and the consequence of its loss (quantity). The physical inventory program must be documented in an approved MC&A Plan and must meet the Physical Inventory objectives as defined in DOE Order 474.2, Administrative Change 3:

- The physical inventory, in conjunction with other MC&A elements, assures that accountable nuclear materials are not missing.
- The physical inventory program ensures that discrepancies between the physical inventory and the accounting records system are detected and resolved.

Performance metrics, such as those documented in DOE Order 474.2, Change 4, Attachment 3, may be addressed in the MC&A Plan to demonstrate how the MC&A program will meet Physical Inventory objectives. Performance metrics can be used by assessors to assist in the evaluation of the Physical Inventory subtopic. In addition to the performance metrics documented in DOE Order 474.2, Change 4, guidance on meeting Physical Inventory objectives is described in DOE-STD-1194-2011, Section 6.5, *Physical Inventory*. Alternative performance metrics to those described in DOE Order 474.2, Change 4, may be documented in the approved MC&A Plan and are an alternate method for evaluating compliance with the Physical Inventory objectives. Performance metrics and/or DOE-STD-1194-2011 guidance may be used to assess or evaluate the Physical Inventory subtopic.

6.1.1 Physical Inventory Types

Two types of physical inventories are conducted: periodic physical inventories and special (emergency) inventories. Periodic inventories are performed on a regular, scheduled frequency, whereas special inventories are performed on an as-needed basis.

6.1.1.1 Periodic Physical Inventories

Periodic physical inventories are conducted on a frequency commensurate with the quantity and attractiveness of the nuclear materials on hand in an MBA. Both storage (non-processing) and processing MBAs may be subjected to physical inventories. The material in MBAs subjected to a physical inventory may consist of discrete items, bulk materials, holdup materials, materials in process, etc. Periodic physical inventories should be performed at the conclusion of an accounting period and should be conducted in accordance with documented plans and procedures that define responsibilities for performing the inventory and specify criteria for conducting, verifying, and reconciling inventories of nuclear material. A physical inventory program should address the following:

- Book inventory data, including item and TID identifiers, locations, and other pertinent identifying information, is field verified.
- Individual item and TID integrity are visually assessed.
- Nuclear material quantities entered in the book inventory are based on measured values.
- Holdup inventory is measured or estimated on the basis of throughput, process data, modeling, engineering estimates, or other technically defensible factors.
- Materials identified as "not amenable to measurement" may be based on the shipper's values or technically defensible values.
- Materials that are undergoing processing and/or recovery operations and are inaccessible for measurement are accounted for by use of process data, vessel level and density measurements, and calculated concentration values.
- Statistical sampling, if used for physical inventories in non-processing MBAs, is consistent with the graded safeguards concept. Parameters for the statistical sampling plans and inventory stratifications are documented in the approved MC&A Plan. Statistical sampling plans may be utilized in non-processing (storage) MBAs, where appropriate.
- Verification measurements are made on SNM items that are not tamper-indicating and on SNM items that are tamper-indicating but are not maintained under an effective materials surveillance program.
- Confirmation measurements of two material attributes are made for SNM items that are not tamper-indicating and not amenable to verification measurement.

Nuclear material quantities on the book inventory must be based on measured values or on technically defensible estimates. Nuclear material values (measured and/or estimated) are recorded in the book inventory along with item identifier, MBA, location, composition code, etc. The book inventory records should reflect what materials went into and out of an MBA during an accounting period, thereby establishing what materials should be on hand at the time of a physical inventory. Ideally, when a physical inventory is performed, all materials (discrete item or bulk) should be located and have assigned values based on quantitative verification measurements or undergo confirmation measurements to validate two independent characteristics of the item. All areas in the MBA are assessed to ensure that there are no materials present that are not reflected in the book inventory.

It may be impractical to locate and perform verification measurements for every item at facilities with large numbers of items or with items that require significant effort to retrieve due to storage configurations. In these instances, the use of statistical sampling plans is permitted if approved by the ODFSA. Confirmation measurements may be performed in lieu of verification measurements for those items identified in the approved MC&A Plan as "not amenable to measurement."

The reconciliation of the physical and book inventories could result in discrepancies that require investigation and resolution. Reconciling the physical and book inventories may detect a loss of SNM (i.e., loss detection assessment) as indicated by an ID between the two inventories. To calculate the ID for an MBA:

$$ID = BI + A - R - EI$$

where:

ID = Inventory difference
BI = Beginning inventory (previous period physical inventory, obtained from book inventory)
A = Additions to the MBA during the period (obtained from book inventory)
R = Removals from the MBA during the period (obtained from book inventory)
EI = Ending inventory (current period physical inventory).

IDs are calculated for each SNM material type in an MBA that is subjected to periodic physical inventories. The magnitude of an ID reflects both the loss detection capability of the accounting system and the degree of assurance that SNM is in authorized locations. Loss detection capability depends upon the uncertainty associated with determining the ID. Propagation of measurement variance is the recommended method for estimating the uncertainty of the ID. Other statistically valid techniques are permitted for ID methodologies, but these techniques must be justified on a variety of parameters, such as limited data, low transfer rates, categories, significant process variations, etc. The methodology for calculating IDs must be described in the approved MC&A Plan.

An ID with an acceptably small value indicates that no loss, theft, or diversion of SNM has occurred. Statistically significant IDs are to be investigated and resolved. While it is desirable to establish an ID target value based on some goal quantity of SNM, if the ID target value is set too low, the ID will frequently exceed the limit based on measurement uncertainty alone. Therefore, it is important to establish not only a reasonable ID but also an LEID, typically two times the uncertainty or standard deviation of the ID (2σ of the ID). The LEID value is obtained by statistically propagating the measurement errors associated with all of the terms in the ID equation. In general, the quantity of SNM is determined either by performing verification measurements to validate book inventory values or by verifying TID integrity when items are tamper-indicating and have been under an effective material surveillance program. If items are protected by TIDs and were present in both the BI and the EI, the quantity of SNM present in these items cancels out of the ID calculation. When estimating the LEID, it is important that the measurement uncertainties associated with these items are not included in the LEID calculation. For these items, facility procedures may specify that the TIDs be assessed based on statistical sampling plans.

To detect protracted theft or diversion, an ID trend analysis of cumulative IDs over multiple inventory periods should be conducted on a regular, long-term basis. When simultaneous physical inventories of Category I and II MBAs are performed, the potential for an undetected sitewide ID should be addressed.

The location and presence of Category IA items should be confirmed on a routine basis. For example, inventory checks for Category IA items not in storage may be conducted weekly for physical count verification and monthly for serial number identification. Inventory checks for Category IA items in storage may require a physical count whenever the storage area is accessed, and serial number verification is performed on a monthly basis.

In addition to inventorying discrete items, physical inventories are also conducted on bulk materials. Theoretically, the physical inventory of bulk materials should be straightforward. For most processing operations, the materials are removed from the process line and measured, or the material is moved to a location where the amount of nuclear material can be determined. Solid materials are weighed and sampled; liquid solutions are placed into an accountability tank where the weight or volume is determined, and a sample is taken. The samples are analyzed for nuclear material content and isotopic composition. The quantity of material present in the tank is then calculated using tank weight/volume data and sample results.

There are some cases where the physical inventory of bulk materials is not simple. For some processes, suspending operations and consolidating materials for a physical inventory is not practical. Some facilities have obtained approval from DOE to use special inventory approaches as an alternative to a shutdown, cleanout physical inventory. These alternative inventory approaches may be called "dynamic inventory" or "perpetual inventory" and may be conducted for all required physical inventories, if approved by the local DOE office. Such alternative physical inventories are typically conducted between annual shutdown, cleanout inventories. During these inventories, sample items from the book inventory are located and measured, and the amount of material in the process is estimated and compared to the amount expected to be in the process from throughput calculations. The processing never stops, except for a "hold" on material movements while sampling is conducted.

6.1.1.2 Special Inventories

Special or emergency inventories may be conducted upon the request of the personnel identified in the approved MC&A Plan or as a result of the following situations:

- Critical assemblies are disassembled
- Change in primary MBA custodian
- Abnormal occurrences
- Change in site/facility contractor
- Missing items
- IDs exceeding established control limits (i.e., 2σ or 3σ)
- Verification that all nuclear materials are located in their stated locations following an emergency evacuation of an MBA
- Uncertainty associated with the inventory of a particular MBA
- Performance testing during management assessments, surveys, or Office of Enforcement assessments.

When assessing the physical inventory program, the assessor should conduct both documentation-based reviews and performance-based reviews. Information gathered during the planning phase and obtained during the assessment activities provides the basis by which an assessor determines whether the program meets DOE requirements and performs at a level sufficient to ensure that the Physical Inventory objectives are met. Figure 6-1 summarizes the assessment activities that are most commonly performed by the MC&A topic team for each Physical Inventory subtopic area.

6.2 Data Collection Activities

Data collection activities include interviews, document reviews, facility tours, observation of inventory-related activities, performance tests, and/or knowledge tests. The combination of these activities ensures that all data is collected and that the data collected is cross-checked for consistency.

6.2.1 Information Needed

The information required to evaluate a physical inventory program is identified in part in a standardized MC&A document request list (i.e., "data call") that has evolved over time and is based on previous assessment experiences. Prior to an onsite visit, the data call is forwarded to the site and the requested documents are reviewed by the MC&A assessment team. These documents should provide information on the inventory, help identify MC&A and Operations personnel to interview, identify additional documents to be made available to the assessors during onsite assessment activities, identify which facility tours/visits should be arranged, and identify which physical inventory-related activities and/or performance tests to observe. Once all data is collected, it is analyzed to identify program deficiencies, strengths, weaknesses, or opportunities for improvement, and leads to conclusions regarding how well the physical inventory program functions, how well the program has been implemented, and whether the program satisfies DOE Order 474.2, Change 4, Physical Inventory objectives.

6.2.1.1 Documentation

The following documents have been identified and requested in the data call sent to the site. Additional documents may be requested during onsite assessment activities.

- **Approved MC&A Plan –** describes the MBAs, inventory program, verification and confirmation inventory measurements, inventory reconciliation, and LEID methodology.

- **Approved Equivalencies/Exemptions** – describes alternative or equivalent inventory frequencies and associated compensatory detection measures. In accordance with DOE Order 470.4B, Administrative Change 1, *Safeguards and Security Program*, a security analysis and, if necessary, a vulnerability/risk assessment, will be conducted to provide assurance that the risk associated with an extended inventory period is acceptable.

- **MC&A Procedures** – the following procedures are of particular interest during a physical inventory program evaluation:

    - **TID Procedure(s)** – physical inventories are also used to demonstrate that TIDs are present in their assigned locations, applied to the item indicated in the book inventory, are intact, and that the intact TID has served its function (indicating tampering or altering).

    - **Physical Inventory and Reconciliation Procedure(s)** – details physical inventory processes (including emergency inventories), calculation of the ID and LEID, inventory reconciliation, and resolution of any anomalies.

    - **Measurement Control Procedure(s)** – ensures measurement systems generate quality accountability values.

    - **Inventory Cutoff Procedure(s) for Physical Inventories –** ensures that no material movement occurs during physical inventories or provides guidance that ensures that if material must be moved (e.g., samples transferred to an analytical laboratory), it will be included in the inventory of the appropriate MBA.

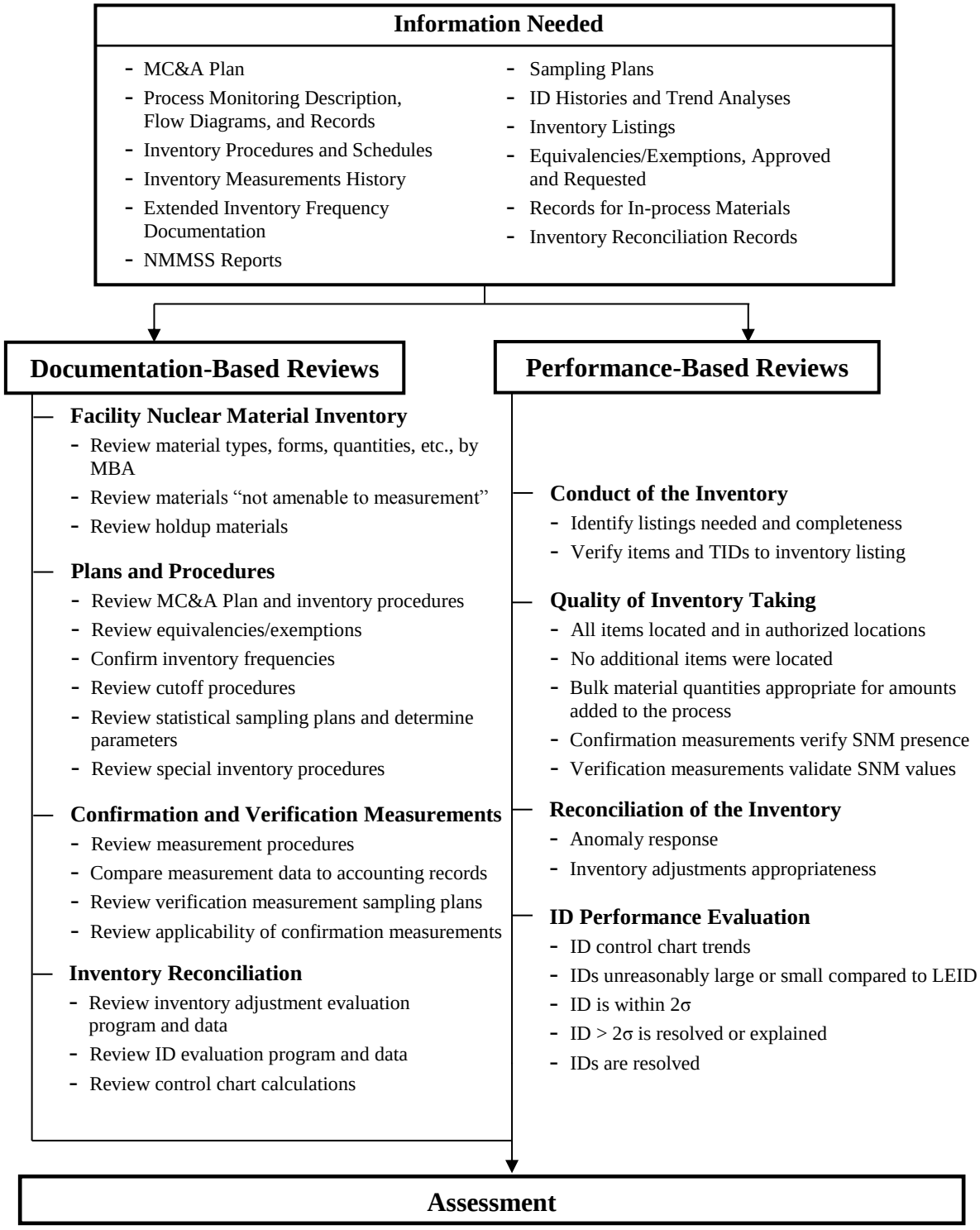

Figure 6-1. Assessing the Physical Inventory Program

- **IRA Program –** IRAs are periodically conducted to determine MC&A system effectiveness and to ensure that all elements of the MC&A program (including physical inventory) are functioning correctly and as planned.

- **Performance Testing Plan** – evaluates physical inventory effectiveness.

- **Summary Inventory Listings** – summarizes the physical inventory by material type in each MBA.

- **Physical Inventory Schedule –** documents inventory schedules by safeguards category and MBA type (i.e., processing or storage).

- **Statistical Sampling Plans –** defines the parameters for conducting a physical inventory and describes how samples are selected.

- **ID and LEID Documentation** – the following documents are of particular interest during a physical inventory program evaluation:

    - **ID and LEID Calculations** – describes the methodology used to calculate IDs and LEIDs, and documents site ID and LEID calculations.

    - **Measurement Uncertainty Contributors by Material Type by MBA** – provides overall measurement uncertainty by material type in each MBA.

    - **ID History** – validates the effectiveness of the inventory program.

    - **ID Trend Analysis** – identifies potential protracted diversions or potential long-term facility operational issues (e.g., unmeasured waste stream).

- **List of Materials "Not Amenable to Measurement" and/or Unmeasured SNM –** identifies unmeasured SNM located at the site and/or items that are not amenable to verification measurements but are subject to independent confirmatory measurements of two material attributes. This list may be included in the approved MC&A Plan.

- **NMMSS Records/Reports –** reports all IDs and LEIDs, and ensures that the facility is properly reporting data in a timely manner.

- **Records for In-process Materials Listed on Inventory –** validates holdup quantities or changes to holdup quantities used for accountability during an inventory.

6.2.1.2 Interviews

Personnel interviews can provide useful data that is not readily available from other data collection methods. Interviews are most effective in determining perceptions and individual understanding of policies, procedures, duties, and management expectations. While both formal and informal interview techniques may be employed, deliberate preparation is necessary before any interview is conducted. When evaluating the Physical Inventory subtopic, the following personnel will typically be interviewed:

- **MC&A Manager** – provides overall direction for the physical inventory program. The MC&A Manager will probably be the first contact for the assessor and will provide the assessor with the

inventory program overview and points of contact for specific discussions about the inventory process and characteristics of the MBAs.

- **Nuclear Materials Representative** – provides information on the site book inventory (i.e., accounting records system) and procedures, the site account structure, and possibly the physical inventory process. The Nuclear Materials Representative may be the inventory team lead but may also be the MC&A Manager.

- **MBA Custodians** – may also be known as MBA representatives or nuclear materials custodians. These individuals are responsible for the control of nuclear material in their MBA(s) and have specific knowledge about the nuclear materials, material locations, and the inventory procedures in their areas. They are also responsible for preparing the MBA for a physical inventory and may participate in the reconciliation process including resolution of any IDs. An MBA custodian may report to the MC&A organization or an operations organization.

- **Statistician** – provides information about the inventory populations, sampling methodologies and plans, LEID calculations, and LEID calculation assumption.

- **Accounting Clerks** – may also be known as nuclear material clerks. These individuals generally are not aware of specific locations of nuclear material but provide information on the types of material transferred into and out of the MBAs, and adjustments to the book inventory. Together, accounting clerks and MBA custodians reconcile the physical inventories to the book inventory.

- **Operations Manager** – is responsible for ensuring that facility equipment and processes are ready for a physical inventory, whereas nuclear material handlers may be the personnel to actually perform the physical inventory. The Operations Manager and the MC&A organization may have different perspectives regarding physical inventories, and interviewing the Operations Manager as well as nuclear material handlers may provide useful insight about the inventory process.

Assessment team members responsible for other topical areas (i.e., Program Management, Personnel Security, Information Security) may also interview many of these individuals. Close coordination between other assessment team members will minimize the impact of the assessment on facility operations.

6.2.2 Documentation-Based Reviews

A significant portion of any assessment involves reviewing site/facility documents to determine whether an MC&A program is being effectively implemented. A documentation-based review of a physical inventory program will focus on four basic topics: (1) facility nuclear material inventory; (2) plans and procedures; (3) confirmation and verification measurements; and (4) inventory reconciliation. Assessors should determine whether the facility meets DOE Order 474.2, Change 4, Physical Inventory objectives.

6.2.2.1 Facility Nuclear Material Inventory

The SNM inventory at the facility dictates the safeguards categorization of areas and facilities at a site. Assessors must ensure that all materials are accurately represented in the book inventory. Key considerations include:

- The assessment of the physical inventory program must interface with the assessment of the MC&A Program Management subtopic to provide the necessary information about the inventories so categorization and graded safeguards can be evaluated.

- Assessors should understand the various material types, forms, quantities, and containers that are typical for each MBA. This includes any expected or anticipated holdup and the locations where it could occur.

- Assessors must understand the boundaries for each MBA so that they can evaluate the appropriateness of material protection. The boundaries indicate where commingling of materials from different MBAs could occur.

The MC&A Plan should specify all materials that are deemed "not amenable to measurement." As a result:

- Assessors should verify materials on the "not amenable to measurement" list. The list of materials should be reasonable and should include explanations, such as high radiation levels, large critical assemblies, storage configurations with restricted access, or weapon assemblies that cannot be separated or measured.

- Assessors should review the inventory program for SNM that is not amenable to measurement to ensure that it is included in the physical inventory process. The presence of this SNM must be checked and, in lieu of verification measurements, confirmatory measurements must be made on two different SNM attributes. Caution should be used when evaluating a site that considers weight a confirmation measurement. For example, the gross weight of a metal item may be one confirmatory attribute when used in conjunction with a measurement that verifies the presence of a specific nuclear material.

- Assessors should evaluate material surveillance practices if the book inventory values for items that are not amenable to measurement are based on measured values from other sites, and/or evaluate the validity of technical estimates, including estimates of uncertainty.

- Assessors should determine whether the controls in place are appropriate for these materials and are effective in ensuring that the inventory values have not changed without inventory adjustments in the accounting records system.

- Assessors should evaluate the potential impact of SNM that is not amenable to measurement on the ID and the LEID.

Assessors should also evaluate the facility's processing areas and interview Operations personnel to determine locations for process holdup. Particular attention should be paid to this area if the estimated quantity of SNM associated with holdup is of the same order of magnitude as the ID.

- When holdup locations are determined, assessors should confirm that the holdup is included in the inventory. The basis for the quantities of holdup should be evaluated. If the holdup is measured, the quantification of its uncertainty and its contribution to the uncertainty of the ID should be validated. If the holdup is based on throughput, process data, modeling, engineering estimates, or another technical basis, the justification and supporting documentation for the values should be evaluated.

- The uncertainty for these quantification techniques should also be evaluated. Assessors should ensure that all potential holdup materials and their locations are addressed in the inventory program and that measurements are made where feasible. There may be cases where holdup cannot be measured, but the inventory program should specify how the holdup values are established and the approach should be reasonable and include supporting data.

6.2.2.2 Plans and Procedures

Assessors should review the procedures for conducting physical inventories. Since all material must be processed to a measurable form, the review should address responsibilities, notification, cutoff procedures, training, documentation, and reconciliation.

For material undergoing processing at the time of a physical inventory, assessors should review the techniques used to minimize the quantity of material in poorly measured forms and the controls in place to prevent unauthorized material movements during the inventory. Cutoff procedures are of special concern. At the time of most physical inventories, the facility specifies a cutoff time after which there are to be no movements of material until inventory activities have been completed. However, there are instances where facilities do not close all MBAs simultaneously. For example, there is some advantage to operating a scrap recovery operation for a period of time after all other MBAs have terminated operations, so that more of the inventory can be converted to a form that can be more accurately measured. In other instances, it is very costly to shut down and restart a processing operation. In such instances, any movements of material at the time of a physical inventory are strictly controlled by the MC&A organization. For these special cases, assessors should review the controls to ensure that all material movements are included. This task can be accomplished by reviewing transaction dates and times after the cutoff and checking the transfer notification documentation at the MC&A organization.

Additionally, materials selected for inventory in a processing area should have controls in place to ensure that they are not processed further until the inventory activities for these materials are complete. This may mean that items are placed "on hold" until appropriate measurements are made. If the material cannot be counted at the time of the inventory, the material should be monitored until it reaches a measurable form and then compared to its book values. Assessors should determine the impact on the ID by evaluating the measurement results for the SNM when it has been processed to a measurable form. Assessors should be aware of and account for any side streams (e.g., solid or liquid waste) resulting from the processing activities. The contribution of these materials to the uncertainty of the ID should be evaluated.

Assessors should review facility documentation to determine whether the facility performs special inventories when critical assemblies are disassembled, the operating contractor is changed, custodial responsibilities are changed, missing items are detected, IDs exceed control limits, occurrences are abnormal, or when requested by authorized facility personnel or the ODFSA. The results of IAEA inventories or special inventories should be evaluated, and if corrective actions are indicated, their implementation should be confirmed.

An inventory sampling plan is a record of how statistics are applied to inventory verification at the site. Assessors should be aware of the statistical, practical, and programmatic considerations that went into developing the plan. Statistical sampling plans for verifying the presence of items should be reviewed to confirm their validity. Assessors should determine whether the plans, when implemented, confirm that assumptions are valid, that the implementation is in accordance with the plan, and that the correct statistical inference is made.

- The inventory population(s) must be described, along with the procedures for selecting samples. As mentioned earlier, items containing SNM that is not amenable to measurement should be isolated and handled separately. Assessors should identify (for each inventory population) the minimum number of defects to be detected, the probability of detecting the minimum number of defects, and the definition of a defect. This information should be found or referenced in the MC&A Plan.

- For all materials, the confidence level for finding a minimum detectable defect must be 95 percent. The minimum detectable defect level for Category I SNM is 3 percent; for Category II it is 5 percent; and

for Category III and IV it is 10 percent. The site should include the responses to inventory anomalies and any follow-up activities. Assessors should verify that the inventory population is stratified according to item category and that separate samples are selected for the physical inventory and verification measurements.

- Assessors must be able to draw conclusions from the inventory sampling data about the state of the entire population. If the sample indicates less than the specified number of defects, the population is deemed acceptable. However, assessors should consider what the facility has defined as defects. Typically, these attributes are examined for each inventory item: (1) item identification; (2) item location; (3) item integrity; (4) quantity of nuclear material; (5) TID identifier; (6) TID integrity; and (7) label information (e.g., net weight, SNM quantity). All defects must be investigated, but the principal defects for inventory verification involve items that cannot be located and quantities recorded in the book inventory that cannot be verified by performing measurements.

- The facility's response to address these defects is important in the assessor's assessment of the inventory sampling program. However, other attribute defects may be significant because defects indicate potential weaknesses in the MC&A program. These defects should be analyzed along with the results of VAs, IRAs, performance tests, and other assessments and follow-up activities as an indicator of system performance.

Assessors should verify the category determination for each MBA to confirm that inventory frequencies are met. For Category II, III, and IV MBAs, assessors should review the shipments and receipts to ensure that the category of the MBA has not increased during the inventory period. Other areas to be addressed include:

- **Inventory checks for Category IA items:** Assessors should review documentation of daily, weekly, and monthly checks.

- **Simultaneous inventories:** For facilities with multiple MBAs with varied inventory frequencies, assessors should review inventory documentation to confirm that, at least once annually, the facility performs a complete simultaneous inventory.

- **Alternative control mechanisms:** If these mechanisms are the basis for decreased inventory frequency, the assessor should performance test them to confirm their detection capability.

If the inventory frequency deviates from that required by DOE Order 474.2, Change 4, the basis for the deviation and the required approval should be evaluated and confirmed.

6.2.2.3 Confirmation and Verification Measurements

In general, nuclear material values on the book inventory are based on measured values. However, technically justifiable estimates may also be captured in the accounting system. Assessors should confirm that the facility has established and implemented a measurement program. Assessors should also compare the book inventory to measurement values on a select sample to ensure that accounting record values are traceable to measured values.

At the time of a physical inventory, measured values for SNM are to be assured or verified. Items that are tamper-indicating or have been sealed with a TID and have been continuously under an effective material surveillance program do not need inventory measurements. Items that are not tamper-indicating or sealed with an effective TID must be measured to quantify the SNM. When a large number of these items exist,

a statistical sampling plan may be used. Justification for using a sampling plan for these materials must be provided to the ODFSA for approval. If the facility employs statistical sampling plans for measuring inventory, assessors should confirm that the sampling plans have been approved and review the inventory stratifications to ensure that the total inventory is addressed. Assumptions made in determining sample size and sampling parameters should be discussed with the appropriate statistician to validate the application of the sampling plan.

There should be separate sampling plans for the physical inventory and verification measurements. For SNM that is not amenable to measurement at the time of a physical inventory, confirmation measurements of two attributes may be substituted. The two attributes selected for confirmation shall be measured using independent methods that positively confirm the presence of SNM.

6.2.2.4 Inventory Reconciliation

Inventory reconciliation involves comparing accounting records to physical inventory results, investigating any discrepancies, and adjusting accounting records (locations and/or quantities) to reflect inventory results. Inventory reconciliations are required in MBAs by SNM material type. Any IDs resulting from inventory adjustments must be identified and reported as required.

A documented program to evaluate inventory adjustments made in the accounting records system should be established to ensure that all adjustments are supported by measured values and/or other technically justifiable basis. Inventory adjustments to SNM holdup must be justified on the basis of measurements or other factors. The program must include documented procedures for the statistical review of inventory adjustments using techniques such as tests of trends, biases, and correlation. The inventory adjustment program should be described in the MC&A Plan and should address:

- S/R differences, including a discrepancy in the number of items, a statistically significant measurement result, trending of difference data, and reporting requirements.

- IDs, including reporting of missing items, IDs that exceed control limits, and reporting requirements.

- Evaluation of other inventory adjustments, including procedures for applying radioactive decay, fission transmutation, adjustments for re-measurement of items, and reporting of abnormal situations to the ODFSA.

Assessors should review the inventory adjustment program/procedures and perform an evaluation of select adjustments. If holdup adjustments are employed, the basis of the adjustments should be confirmed by a documentation review.

As part of inventory reconciliation, assessors should also evaluate the facility's ID evaluation program. This activity should be coordinated with assessment of the Material Accounting subtopic. Procedures for establishing control limits for SNM IDs are of special concern. The basis for control limits should be reviewed to determine whether the limits are based on variance propagation using current data. If control limits aren't based on variance propagation, the basis for the control limits should be evaluated to determine whether it is justified and approved by the ODFSA. The assumptions used to set warning and alarm limits should also be reviewed to determine whether they are appropriate. The reporting of SNM IDs exceeding limits should be confirmed by documentation. Procedures for responding to missing items and investigating IDs exceeding control limits should be reviewed. Resolution of these alarms and corrective actions resulting from investigations should be confirmed. Corrective actions should be performance tested.

Assessors should review the assessment of IDs by evaluating the accuracy of the methodology used to test for trends and biases. The evaluation should address total and actual IDs on both an individual and a cumulative basis for all non-storage MBAs (i.e., processing MBAs). Inventory records, process logs (where available), or other information may also be used to detect anomalies and trigger investigations.

6.2.3 Performance-Based Reviews

In addition to documentation-based reviews, assessors must conduct performance-based reviews to evaluate whether the physical inventory program as implemented meets DOE Order 474.2, Change 4, Physical Inventory objectives. The physical inventory performance metrics documented in DOE Order 474.2, Change 4; alternative metrics documented in the approved MC&A Plan; DOE-STD-1194-2011 assessment guidance; or inventory performance tests documented in Appendix A, Performance Tests, may be used to conduct a performance-based review, which also may include personnel interviews, observation of performance in the field, special inventories, measurements, and the introduction of anomalies to test personnel response to abnormal situations. Some or all of the activities described in this section may be used by assessors to validate physical inventory program performance.

6.2.3.1 Conduct of the Inventory

A facility in compliance with DOE Order 474.2, Change 4, Physical Inventory objectives has all of the basics to ensure that the inventory of nuclear materials is correct as indicated by the accounting records and that anomalies can be detected. However, the facility must also have adequate procedures and those procedures must be followed. Having procedures does not, by itself, ensure a quality program. Assessors should determine whether procedures provide an effective means to ensure that the objectives of the physical inventory are being met. The assessor may request that the facility generate a physical inventory listing for a selected area, observe the conduct of the physical inventory, and review the reconciliation when the physical inventory is complete.

Performance tests for the accuracy of inventory records (quantity, location, description, etc.) are described in Section 5, Material Accounting. These tests primarily include front and back checks of items on the book inventory listing.

6.2.3.2 Quality of Inventory Taking

Physical inventory performance tests evaluate the facility's ability to ensure that nuclear material is accounted for and is in authorized locations. A common physical inventory performance test is to observe an actual inventory. However, a special inventory may be requested during an assessment if the assessment occurs before or after the facility's inventory frequency. The special inventory allows assessors the opportunity to observe personnel perform the inventory and to evaluate how the inventory was conducted. Special inventory performance tests could include an emergency inventory, requesting that the facility generate a statistical sample of items similar to routine inventories and then conducting the inventory, or generating a complete physical inventory listing for a specific facility location and evaluating the facility's inventory performance.

6.2.3.3 Reconciliation of the Inventory

Assessors should evaluate physical inventory reconciliation procedures. An anomaly could be introduced into the conduct of the physical inventory and the facility's response evaluated. An item could be intentionally overlooked by facility trusted agents, and the test would determine whether the reconciliation process correctly identified the item as missing. The failure of a confirmation or verification measurement could also be simulated to evaluate the facility response. All adjustments based on the physical inventory should be evaluated by reviewing the audit trail.

6.2.3.4 ID Performance Evaluation

If the IDs for several accounting periods are available, they may be plotted on a control chart. Some facilities routinely use these charts. The chart would have the successive values of the ID plotted with the 2σ and 3σ limits for the ID. If the standard deviation of the actual ID values is very small relative to the limits, there is an indication that the limits are being overestimated and as a result the ID is not being used as a valid loss indicator. Similarly, if the standard deviation of the ID is large but the limits are not exceeded as often as expected, the facility might be making unjustified adjustments in the ID or in the calculation of the LEID. A similar control chart for the cumulative ID can be used to identify biases in receipt, product, or waste stream estimates.

6.3 Common Deficiencies/Potential Concerns

Common deficiencies and/or potential concerns identified by EA during previous assessments should be reviewed prior to beginning an assessment. Information gathered during data collection activities should provide the assessor with an indication as to whether any of the deficiencies/concerns described below warrant specific investigation during the assessment.

6.3.1 Unmeasured Inventory

Some facilities have nuclear material that has not been measured; therefore, this material does not have accountability values required for inventories and transactions. This deficiency may result from lack of qualified measurement methods, lack of management attention, inadequate planning, receipt of materials for which measurements are not available or that must be processed before an accountability value is established, inventory cutoff procedures that do not provide for the completion of processing for nuclear material, or waste streams that are not identified as removals from inventory. A more subtle reason for unmeasured material can occur during facility restart when unit operations of a process are started in a sequence that allows production without an operating scrap recovery unit. Delays in scrap recovery unit operations result in scrap accumulating as unmeasured material, and the unmeasured scrap is present at the time of the physical inventory. This unmeasured scrap could affect the ID during a physical inventory.

The lack of accountability values for nuclear material on inventory results in IDs exceeding control limits, loss of control of nuclear material, and limited assurance that nuclear material has not been diverted or stolen. Typically, assessors can identify unmeasured inventory by reviewing the book inventory, S/R agreements, propagation of variance calculations for IDs, and the measurement control program. Interviews with MBA custodians and nuclear material handlers may also uncover unmeasured inventory.

6.3.2 Materials "Not Amenable to Measurement" Not Identified in MC&A Plan

Facilities may have unidentified, misidentified, or inappropriately identified SNM as "not amenable to measurement." Factors that contribute to DOE facilities having material identified as "not amenable to measurement" include:

- Failure to allocate resources for developing and procuring measurement equipment and standards
- Creating "one-of-a-kind" items, which may be very large or may remain in inventory after having been created for a specific experiment or test
- Generating large amounts of unique scrap and waste
- Changing DOE missions, which eliminates the ability to complete processing of nuclear materials
- Efforts to repackage and consolidate the nuclear material inventory.

Inappropriate use of the category "not amenable to measurement" results in limited assurance that nuclear material is accounted for and has not been diverted or stolen. Excessive misuse is identified during the review of the MC&A Plan, equivalencies/exemptions from DOE orders, and measurement systems.

6.3.3 Inventory Schedules Deficient Due to Programmatic Redirection

At some DOE facilities, schedules for physical inventories have been inordinately delayed or postponed for several reasons, including production/stabilization schedules being considered more important than conducting a physical inventory, award fee milestones being given a greater priority than an inventory, or a safety-related shutdown preventing required inventory actions. Failure to conduct an inventory within an approved schedule delays the calculation of the ID and inhibits the facility's ability to assure that SNM has not been lost, stolen, or diverted. This deficiency is detected when inventory reconciliation records, inventory schedules, and requests for equivalencies/exemptions are reviewed.

6.3.4 Warning and Alarm Limits Incorrectly Documented

Previous assessments identified a concern with facilities that have incorrectly documented warning and alarm limits. This is of concern because this practice could generate control limits that are not indicative of the detection capabilities of the MC&A system. Incorrect control limits may be established by inadequately trained staff or inappropriate statistical assumptions. Using control limits that are not based on the propagation of measurement uncertainty results in control limits for the ID that do not ensure the timely detection of theft or diversion of SNM. Limits that are too large hamper the MC&A system in detecting losses, and limits that are too small generate false alarms. The use of incorrectly documented control limits can be detected by analyzing the control limit calculations, examining the measurement systems with the greatest variance contribution, reviewing ID trend analyses, reviewing ID control charts, reviewing the measurement control program, and interviewing facility management and/or facility statisticians.

6.3.5 Deficient Verification Measurement Program

A common problem at DOE facilities is that the facilities do not verify the SNM content of inventory items that are not tamper-indicating. Verification practices may not include the evaluation of measurement results against acceptance and rejection criteria based on valid technical and statistical principles. This problem is commonly caused by a lack of management attention, inadequately trained staff, inadequate inventory procedures, failure of material surveillance programs, or failure of the TID program. The problem limits assurance that SNM is not diverted or stolen and makes the ID calculation questionable. Assessors may detect the deficiency by observing the inventory or reviewing inventory procedures or the statistical evaluation program. Assessors should determine whether these deficiencies were identified by the facility's IRA program or during a DOE field element survey.

6.3.6 Holdup Not Included in Inventory

Some facilities do not account for the variation in equipment holdup. Most processing systems in the DOE complex contain residual equipment holdup. For some processes, the holdup is a significant portion of the throughput. For physical inventories, it is important that facilities account for the nuclear material that remains in the equipment. For operating facilities, residual holdup should be included in both the beginning and ending inventory components of the ID equation. The quantity is not necessarily identical at these two points in time; the variation in the quantity contributes to the ID. Decreases in the quantity of residual holdup between beginning inventory and ending inventory may mask the diversion or theft of nuclear material, while increases may initiate an unwarranted investigation. Failure to account for the variation in process holdup can be detected by reviewing the reconciliation of physical inventory, evaluating the procedures for the holdup calculation, evaluating ID experience, investigating IDs that exceed control limits, reviewing inventory records, evaluating cleanup procedures, or interviewing Operations personnel responsible for inventory preparation.

6.3.7 Alternate Physical Inventory Frequency Not Approved or Not Appropriate

An alternate inventory frequency is allowed if documented as an equivalency/exemption that includes supporting justification that provides assurance that the risk associated with an extended inventory period is acceptable and the equivalency/exemption is approved by the ODFSA. Deficiencies could exist if the facility does not have the documented approvals or if the criteria supporting the approvals have not been met. Failure to meet the criteria could result in a degradation of safeguards since the physical inventory would not be conducted at an appropriate frequency. Indications of this deficiency typically surface during a review of approval documents or field assessment of the enhanced safeguards features.

6.3.8 Inadequate Planning for Physical Inventory

At a minimum, a comprehensive plan for conducting a physical inventory should address schedule, location, personnel assignments and responsibilities, procedures to be followed, the reconciliation process, and any post-inventory reporting and response requirements. Conducting a physical inventory with an inadequate plan may result in inaccurate inventories, delays in reconciling the book and physical inventories, incorrect post-inventory reporting and responses (positive or negative), repeat physical inventories, etc. For example, an inventory plan in a processing facility should address and communicate cutoff procedures to be followed. Failure to execute a cutoff procedure may result in incorrect accounting of nuclear material associated with the process.

6.3.9 Inadequate Conduct of Physical Inventory

A physical inventory may be incorrectly conducted due to a number of factors, such as inaccurate accounting system records; untrained, inexperienced inventory personnel; inadequate or outdated procedures; poor attitude/lack of commitment on the part of inventory personnel; environment not conducive to accurate physical inventories (i.e., poor lighting); and sabotage (deliberately performing the inventory incorrectly). Incorrectly conducting a physical inventory may result in inaccurate inventories, delays in reconciling book and physical inventories, incorrect post-inventory reporting and responses, and repeat inventories.

6.3.10 Untimely and Incomplete Physical Inventory Reconciliations

Data collected at the conclusion of a physical inventory should be compared to the book inventory (i.e., accounting system records) in accordance with site procedures. However, to identify any discrepancies between the book inventory and the results of the physical inventory, reconciliation should be performed as soon as practical after the inventory. Reconciling book and physical inventories is an important aspect of the loss detection capability at a site. Delays or incomplete reconciliations impede timely detection of the loss of nuclear material, locating any missing material, and/or identifying material that is not assigned to the location inventoried.

6.4 References

ANSI Standard 15.3, Physical Inventories of Nuclear Material

Bowen, W. M. and C. A. Bennett. 1989, *Statistical Methods for Nuclear Management*, NUREG/CR-4b

DOE Order 470.4B Administrative Change 1, *Safeguards and Security Program*

DOE Order 474.2, Change 4, *Nuclear Material Control and Accountability*

DOE-STD-1194-2011, *Nuclear Materials Control and Accountability*

Murdock, C., C. E. Crawford, D. L. Jewell, and A. R. Kubasek. 1999, *Physical Inventory Sampling*, Journal of Institute of Nuclear Materials Management, Annual Proceedings

Appraisal Process Protocols, Office of Enforcement and Oversight, Independent Oversight Program, November 2012

Section 7: Interfaces

This section discusses the input of the MC&A topic into the overall integration process, how integration within the MC&A team is accomplished, and how MC&A integrates with other topic teams during an assessment.

7.1 Integration

Integration is the process in which assessment team members work together to achieve a better understanding of the overall protection programs utilized at DOE facilities. In this context, integration includes all of the associated attributes: coordinating, cooperating, interfacing, and assimilating information. The fundamental goal of integration is to ensure that DOE facilities are provided the necessary degree of protection and that vulnerabilities are clearly identified and analyzed. Integration also results in a more effective and organized assessment effort, a refinement of assessment techniques, and a more comprehensive assessment report. Lastly, the integration effort significantly contributes to EA's ability to provide an accurate, in-depth evaluation of protection programs throughout the DOE complex.

The primary objective of a comprehensive assessment is to provide a meaningful, management-level evaluation of the overall status of safeguards and security at the assessed facility. To ensure that this objective is accomplished, the MC&A topic team and all other topic teams must work closely together throughout every phase of the assessment process, carefully integrating their efforts.

Integration is realized by exchanging information and discussing how information collected by one topic team influences protection program elements observed by other topic teams. Additionally, integration provides a means of prioritizing the efforts of the various topic teams, assigning particular items for investigation to particular teams, and mobilizing special assessment team elements to examine concerns that transcend topic boundaries.

During data collection, the various topic teams collect a massive quantity of data pertaining to their particular subject matter areas. To avoid duplication of effort, each team's assessment activities must be carefully delineated. However, even with a clear definition of activities, the boundaries between topic teams are not always neatly differentiated, and each topic team is likely to discover data of interest and significance to other teams. Such data must be shared in a timely manner, with determinations made as to which topic team will pursue identified deficiencies to a point of resolution.

Much of the required integration occurs on an informal basis. During planning and data collection, topic leads and individual topic team members share information with their counterparts from other topic teams. A formal team meeting is scheduled on a daily basis to provide a forum for exchanging information among the topic teams.

It is essential that the integration process is instilled with the fundamental understanding that the DOE protection philosophy is based on the concept of protection in depth—i.e., layers of protection applied in a manner that ensures that the failure of a single layer does not expose the protected asset. To be effective, layered protection requires the careful integration of protection layers and of the protection elements within each layer. Thus, integration ensures that DOE's security interests at a particular facility are afforded the necessary degree of protection in depth. Identifying and characterizing the priority security interests at a facility, testing and evaluating the protection system elements that are critical to the protection of these interests, and analyzing the impact of deficiencies in these critical system elements are important parts of the EA assessment process. Integration of the assessment topics ensures that the overall status of safeguards and security at the assessed facility is adequately assessed.

7.2 Interfaces with Other MC&A Subtopic Areas

The five MC&A subtopic areas (Program Management, Material Control, Measurements, Material Accounting, and Physical Inventory) comprise the overall MC&A topic. The size of the MC&A team depends upon the size of the facility and the strategic importance of the MC&A program at the site. One or two assessors could assess a facility of less strategic importance, whereas a team of five or six assessors might be required at larger facilities with multiple Category I MBAs, several MAAs, and strategic holdings of SNM.

Although coordination is ongoing throughout the assessment, planning activities define the major coordination effort required for the assessment. Facility tours are scheduled for the initial phase of data collection activities; planning activities determine which assessors will participate in which tours. The MC&A team must also plan to meet the facility's access control requirements, which are necessary for security as well as environment, safety, and health.

The following is a description of some specific coordination efforts relating to the MC&A subtopics.

7.2.1 Program Management

The effectiveness of implementation of the facility MC&A Plan and procedure directives can be determined only by a thorough review and integration of all MC&A assessors. Any training deficiencies must be analyzed to determine whether the cause is endemic to all facility programs or to a specific facility program, or whether the deficiency is a single deviation. Emergency response activities and occurrence reporting that typically occur in other subtopic areas reflect the overall administrative effectiveness of a facility program. Field assessment activities identify MBA categorization problems that must be reflected in the Program Management subtopic. Assessment activities also provide a basis for evaluating facility VAs and the effectiveness of the MC&A self-assessment program.

7.2.2 Material Control

Documentation and training activities are discussed with the Program Management subtopic assessor. Waste monitoring equipment and SNM detectors are reviewed with the Measurements subtopic assessor, and any questions concerning container location and quantity are reviewed with the Material Accounting subtopic assessor.

7.2.3 Measurements

The assessor responsible for assessing measurements routinely interfaces with accounting system personnel to ensure that data is correctly transferred to the accounting system. The error limits associated with measurements are incorporated into the LEID calculation that is part of the Physical Inventory subtopic. The results of the training and documentation reviews are discussed with the assessor of the Program Management subtopic.

7.2.4 Material Accounting

The assessor responsible for assessing accounting systems routinely interfaces with the assessors of the Physical Inventory and Measurements subtopics. The accounting records must contain all inventory data, including the calculations of the ID and its error limits. Measurements are required for physical inventory, shipments and receipts, and material transfers. Material transfer paths are discussed with Material Control personnel. Documentation deficiencies and training programs are discussed with the assessor of the Program Management subtopic.

7.2.5 Physical Inventory

This area interfaces with all other MC&A subtopics. The accounting system must identify quantities and locations, material must be properly contained and stored at measured values, and documentation requiring the above activities must be current and implemented by the facility.

7.3 Interfaces with Other Assessment Topics

Figure 7-1 summarizes areas where the MC&A team may interface with other topic teams.

7.3.1 Classified Matter Protection and Control

MC&A interfaces with the Classified Matter Protection and Control (CMPC) topic team because of the requirements for protecting information (SNM inventories may be classified), for special programs, and for accountability of classified parts (some may contain SNM/other nuclear material, and, at some facilities, MC&A may be responsible for maintaining the classified part database). In addition, most MC&A computer systems are authorized to process classified information and, as a result, the CMPC requirements for classification management, marking, and storage of records, reports, and classified media are applicable. Interface with operations security (OPSEC) and technical surveillance countermeasures (TSCM) may also be necessary.

7.3.2 Personnel Security

DOE HRPs have been implemented at some facilities, and facility personnel who routinely handle SNM are placed in this program. MC&A personnel are frequently in the HRP. MC&A can identify the individuals who should be in this program, and the Personnel Security topic team can validate their participation.

There has been an increasing trend toward using the HRP as a replacement for some standard safeguards and security program elements. Some sites have moved away from the traditional approaches to material surveillance (e.g., the two-person rule), and have begun to cite their HRP as justification for weak surveillance measures and delayed detection of theft or diversion efforts. Material Control objectives state that "The material containment and surveillance program in conjunction with other security program elements must have the capability to detect, assess, and respond to unauthorized activities and anomalous conditions/events." The lack of a fully effective material surveillance program, with or without HRP, degrades the site's ability to provide timely detection of theft or diversion efforts. This condition normally results from a management emphasis on production goals, misunderstanding of the requirements of HRP or a material surveillance program, or an effort to minimize costs. The deficiencies can be detected by observation, facility performance testing, or during interviews with personnel.

7.3.3 Physical Security Systems

The interface with the PSS topic team is particularly important, especially the close interface of the containment and surveillance program with physical security hardware and procedures. In particular, SNM and metal portal monitors are equipment systems that are routinely assessed. PSS and MC&A should agree, prior to the assessment, how this equipment will be assessed. These portal monitors are evaluated in PSS in the subtopic areas of intrusion detection and assessment, entry and search controls, and testing and maintenance.

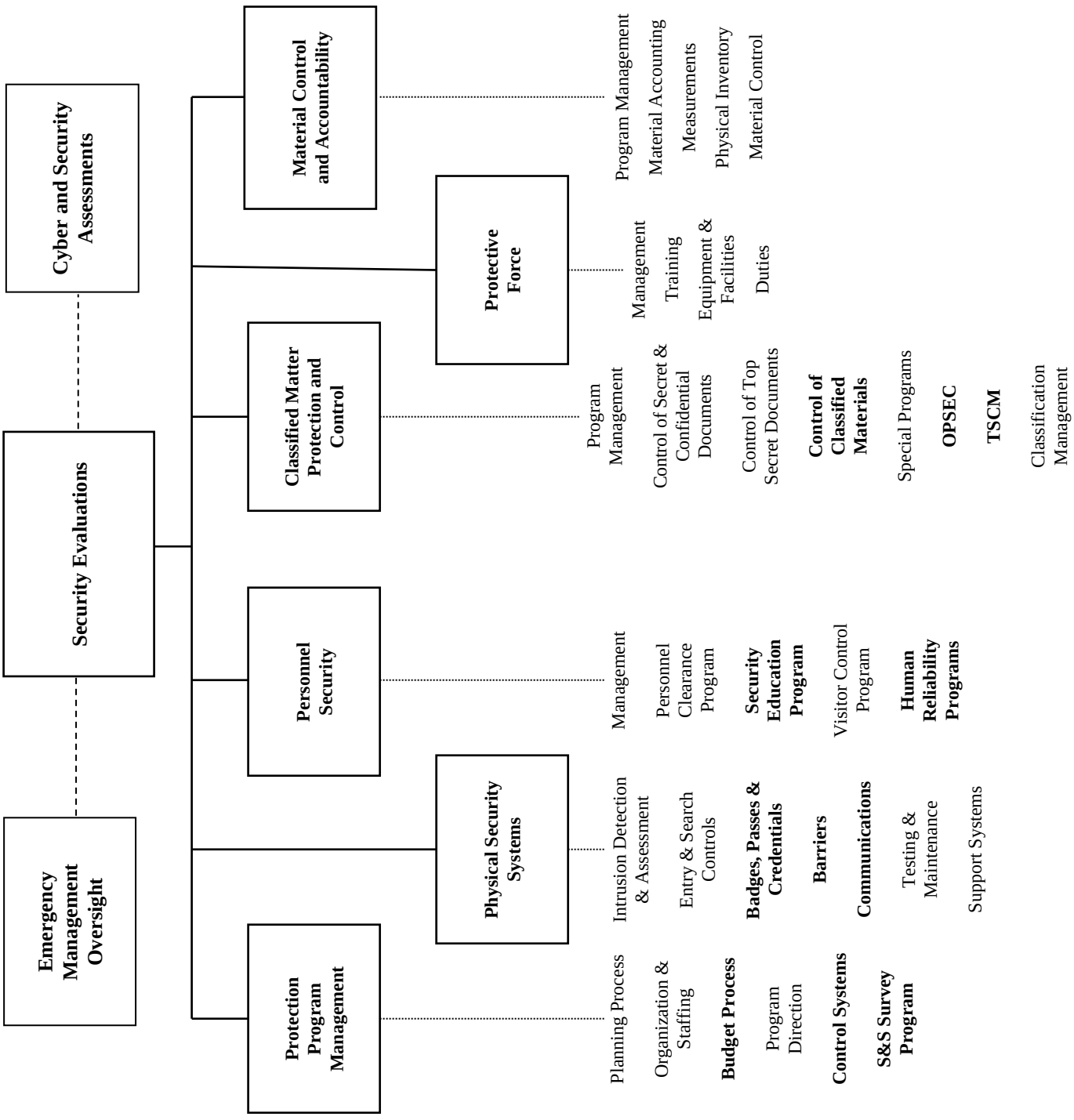

Figure 7-1. Areas of Interface Between MC&A and Other Assessment Topics (Bold)

The PSS, MC&A, and PF topic teams routinely interface in evaluating the integrated protection of SNM. During planning activities, the PSS, PF, and MC&A topic teams may schedule an integrated assessment of an MAA or vault. Since MC&A assessors routinely access facility vaults, it is common for MC&A assessors to examine certain PSS and PF protective features.

The following general guidelines are used to assist the PSS and MC&A assessors in coordinating their activities:

- Elements that are primarily MC&A functions:

  - TIDs
  - Waste monitors
  - DACs
  - Transfer authorizations
  - MBA custodial responsibilities
  - MBAs and their relationship to MAAs.

- Elements that are primarily PSS related:

  - Vault construction
  - Intrusion sensors and alarm system sensitivity and design
  - Badge systems
  - Locks.

- Elements that are applicable to both topics:

  - Material surveillance procedures
  - Combination and key controls
  - Access authorization lists
  - Portal monitors (metal and SNM detectors)
  - Material transfer operations and surveillance
  - Storage area entry procedures
  - MAA access controls
  - PA access controls
  - MAA and PA containment barriers
  - Card readers and key pads
  - Closed circuit television (CCTV) surveillance or identification systems.

As a general rule, for the elements that overlap, the PSS team should focus on the hardware aspects, whereas the MC&A team should focus on material handling and procedural aspects. For example, the PSS team should focus on card readers, CCTV, barriers, and portal monitors, whereas the MC&A team should focus on vault entry procedures, material surveillance procedures, access authorization lists, and material transfer operations. The MC&A team identifies the locations where attractive material is processed or stored. Members of PSS teams are generally not familiar with the characteristics of nuclear materials and containerization. In some instances, it may be prudent to identify these characteristics for the PSS assessors so that they may better assess that area. The MBA structure, if properly established, provides assurance that all material that should be present in the facility can be accounted for. There are occasions where SNM must be measured or processed using a piece of equipment that is not in an MBA. For such activities, temporary MBAs are established. Assurance must be provided that the SNM, when transferred into such MBAs, is not more vulnerable to theft. Diversion scenarios using waste discard streams must be similarly addressed using integrated safeguards approaches. At large, complex facilities with multiple MAAs, the MC&A and PSS teams should strongly consider focusing on the same MAAs, buildings, and processes. This shared focus would ensure that their efforts complement each other to produce a more comprehensive assessment.

7.3.4 Protective Force

During the assessment planning phase, MC&A assessors identify the extent of PF activities that interface with the MC&A topic. The PF subtopic involving duties is the most common area of overlap. At most locations, PF personnel are involved in access controls and physical checks of TIDs on facilities or containers, and respond to various types of alarms. Additionally, some sites use PF personnel as the "second person" for material surveillance programs. Specific topics of interest to MC&A assessors include:

- Training programs to qualify PF personnel to knowledgeably perform material surveillance and related duties

- Procedures for conducting routine and emergency duties, such as alarm response, SNM monitor testing and operations, and the transfer of SNM

- Standards established for the operation of equipment and disposition of anomalies.

Based on the degree of interface and its importance in the overall protection of SNM, MC&A assessors may consider conducting integrated exercises with the PF topic team. Typical examples of integrated exercises include:

- Mock shipments of SNM
- Testing of SNM and metal detector operations
- Emergency response exercises
- Review of routine duties (observations)
- Material control exercises requiring PF response
- Setup of a temporary MAA.

Also, the PF topic team may need some familiarization with the characteristics of nuclear materials and containerization so that they may better assess the PF responsibilities for the area.

7.3.5 Protection Program Management

There are four areas of PPM where MC&A and PPM must integrate: (1) planning process, (2) organization and staffing, (3) program direction, and (4) the safeguards and security survey program. As part of the planning activities, the results of the VAs performed by facility personnel, the SSP, and any deviations reported to the site office are reviewed. The PPM and MC&A topic teams interface and evaluate the MC&A content and facility impact of these documents.

During the data gathering phase, MC&A may undertake assessment activities that will provide specific input to the PPM topic. The MC&A team reviews the site office survey approach, comprehensiveness, analyses, and follow-up, and provides the results of the review to the PPM team. Facility corrective action plans are also an important part of PPM. MC&A corrective actions must be adequately tracked by the facility corrective action program, including root cause analyses and trending. In the Organization and Staffing and Program Direction subtopics, MC&A provides feedback to PPM on second- and third-tier management of the MC&A program and how these levels of management interact with senior-level management. PPM provides feedback to the MC&A team on first- and second-tier management interaction.

During data gathering, MC&A may identify management concerns to the PPM team. These concerns can serve as a data point for PPM that could lead to a systemic management deficiency. MC&A assessors may also identify key funding issues that require senior management attention. Information on building upgrades,

process improvements, and acquisition of measurement equipment is a frequent input that the MC&A team provides to the PPM team. PPM then uses these inputs in their evaluation of the overall facility PPM topic. Conversely, the PPM team may be trying to determine whether an identified deficiency is an isolated instance or a generic facility deficiency. In this case, the PPM team may ask the MC&A team to examine a specific area to see whether the deficiency exists.

MC&A provides field validation of operations/site office findings, as well as feedback from facility interviews related to the effectiveness of site office MC&A surveys. During the interpretation of results, MC&A survey assessors from the field element frequently meet with the MC&A assessor and conduct root cause analyses to determine whether findings from the EA assessment are indicative of an inadequate DOE field element survey program.

7.3.6 Classification

During their reviews, MC&A assessors encounter a variety of documents that have varying classification levels. When an MC&A assessor has a question concerning the appropriate level of classification, a derivative classifier from the appropriate assessment topic is consulted to ensure that the classification is appropriate.

7.4 Other Programs

7.4.1 Cyber Security

At most facilities, several computer systems are used to process MC&A data, including process control computer systems, MBA accounting systems, measurement systems with computer controls, and centralized MC&A computer systems for maintaining facility accounting records. During planning activities, the MC&A and cyber security assessment teams coordinate assessment activities to determine which systems may be jointly assessed. Cyber security assessments may be performed independently and at a different time than the MC&A/multi-topic assessment. Typically, the cyber security team assesses the operating system for compliance with applicable DOE orders. Assessors from the MC&A and cyber security topics may evaluate user-written software in terms of access controls, software configuration controls, and data integrity. Any findings that could result from these assessment activities are placed in the appropriate section of the assessment report and cross referenced with cyber security reports as necessary.

7.4.2 Emergency Management

MC&A may be asked to support emergency management exercises that involve the use or protection of SNM. MC&A personnel define potential targets and provide support as evaluators or controllers during performance tests.

Section 8: Analyzing Data and Interpreting Results

8.1 Introduction

Closure of an assessment requires numerous actions that are described in the EA documents *Office of Enforcement and Oversight, Independent Oversight Appraisal Process Protocols*, November 2012, and *Office of Security and Cyber Evaluations Appraisal Process Protocol*, March 2013. The primary tasks necessary to close each assessment subtopical area (e.g., MC&A) include review of data; analysis of results; determination of findings, deficiencies, and opportunities for improvement; report writing; documentation of conclusions; and integration with other topics. The protocol documents also describe final steps for closure of a comprehensive, multi-topic assessment, including preparation of the assessment report, development of policy issues, management reviews and approvals, site briefings, development and tracking of corrective actions, and coordination with DOE Headquarters and program offices.

This section provides guidelines to help MC&A assessors analyze data, assign findings, and interpret the results of the assessment. The guidelines include factors to consider while conducting an analysis. Information is also included regarding the significance of potential deficiencies, as well as suggestions for additional activities when deficiencies are identified. Assessors can refer to this section for assistance in analyzing data, interpreting results, and determining whether additional activities are needed to gather the information necessary to accurately evaluate the system and document conclusions. Examples of Conclusions sections from typical MC&A assessment reports are also provided.

8.2 Goals

The goals of assessment closure are to:

- Identify and clearly report the assessment results, including both strengths and weaknesses.
- Determine the individual and cumulative impact of assessment results on the ability of the protection program to accomplish its mission requirements.
- Report assessment results to site management.
- Produce a report that clearly and objectively represents the current status of protection programs.
- Ensure site comments to the factual accuracy review are addressed.
- Brief Headquarters management and other appropriate parties.
- Complete all routine and special tasks that may be assigned by the assessment team leader.

8.3 Integration

Data gathered and developed by one topic team often affects other topics being assessed. To take this interdependency into account, topic teams continue their integration activities until all pertinent information has been shared. This integration normally consists of a discussion of assessment results among topic teams regarding how information developed by one team influences the adequacy of the performance observed in another topic area.

Each topic team should consider information obtained through integration, along with its own data, during data analysis. When necessary, the assessor who observed the data to be integrated may prepare draft input for use by another topic team.

Integration of the results of the various assessment activities, subtopics, and elements is essential to an effective assessment effort. At a minimum, this integration process should address:

- The impact of individual components on overall system performance
- An analysis of defense-in-depth
- The impact of findings in other assessment topics.

The integrated impacts of the findings are determined by:

- Reviewing VAs to determine whether any one threat scenario is impacted by more than one finding
- Identifying a scenario that was not previously identified and that could result in undetected SNM diversion or theft
- Identifying whether items of non-compliance could result in a single-point failure.

As discussed in more detail in Section 7 of this assessment guide, assessors must be aware of the relationships and interfaces among the various elements of the MC&A system and other assessment topics. Program management is reviewed to determine whether the VAs fully incorporate MC&A activities into the analyses. Material controls are reviewed to identify access and movement/accumulation scenarios. Reviews of the physical security and PF programs address possible methods of penetrating MAA and PA boundaries and removing SNM from the MAA and PA. Material accounting programs are reviewed to identify specific SNM that could be diverted and potential diversion scenarios that could be used to conceal the diversion. Reviews of material accounting and physical inventory detection and assurance measures also address how long the diversion could remain undetected. The integration of these reviews focuses on determining whether defense-in-depth is provided by the safeguards systems and assessing whether SNM is at risk.

8.4 Analysis of Results

The continuous process of analyzing collected information reaches its culmination during the closure phase of the assessment, when all data is critically reviewed—a review that results in conclusions regarding the effectiveness of the evaluated program.

A discussion of the analysis process is contained in the appraisal process protocols. Figure 8-1 below provides a flowsheet to assist assessors in their analysis of results. Specific analyses related to MC&A are provided in Section 8.6, Interpreting Results, in this guide. Once these analyses have been completed, an overall conclusion is written for the MC&A topic.

8.4.1 Findings

Assessment findings are the primary means of identifying elements of the MC&A system that do not meet the intent of the DOE orders. Each topic team is responsible for determining which assessment results are designated as findings. Although any program element or system not in compliance with DOE policy or not meeting DOE performance standards may be identified as a finding, topic teams are expected to exercise judgment. Facts related to findings should have already been validated as part of data collection. Findings should always be worded to express the specific nature of the deficiency, clearly indicate whether the deficiency is localized or indicative of a trend, and clearly identify the organization responsible for the deficiency. Minor and non-systemic items are generally omitted. Findings are presented in a manner that identifies both the specific problem and the reference (e.g., DOE order requirement), and should be worded as closely as practical to the wording in the referenced document. However, the finding should clearly identify the nature of the deficiencies and specify whether the deficiency is limited to a particular location and/or system at the site. If findings address specific aspects of a standard, the topic team should determine whether the potential findings should be "rolled up" and reported as a single finding. This "rollup" may be appropriate if the single finding statement can clearly and completely convey the problems.

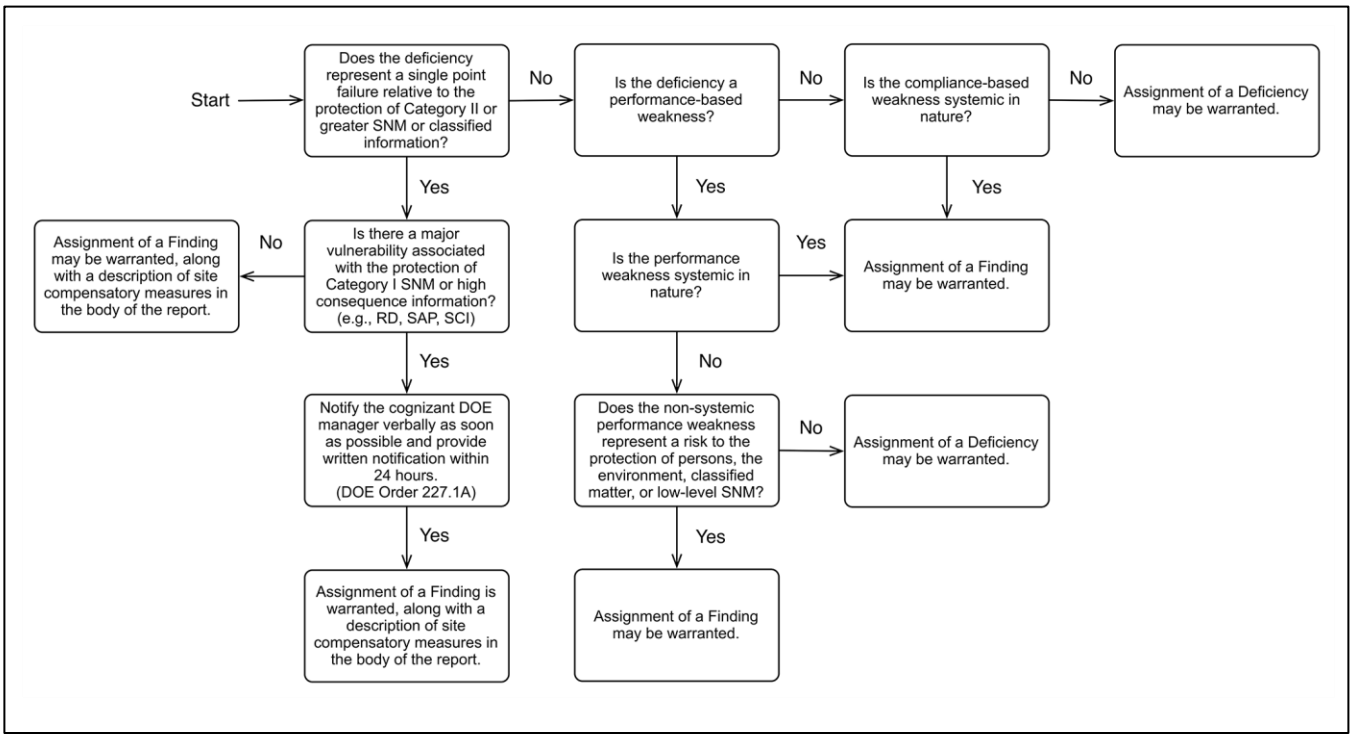

Figure 8-1. Significance Determination Process

8.4.2 Deficiencies

Deficiencies may be divided into two categories. One category, shown in Figure 8-1, reflects deficiencies that are non-systemic, compliance-based weaknesses, or non-systemic performance-based weaknesses that do not result in a significant risk to SNM. These could develop into findings if management does not take corrective action; consequently, many sites enter them into their site-specific issues management/tracking system. A second category of deficiencies occurs during the assessment when an emerging deficiency is identified. In this case, these deficiencies are communicated to site management via an Issue Paper. The format for Issue Papers is provided in the appraisal process protocols. The assessment team leader may use the Issue Paper form to:

- Document and communicate particularly complex issues to the site being evaluated
- Document weaknesses requiring time-critical mitigation and/or compensatory actions by site personnel
- Solicit a written response from line management on a time-critical issue associated with an assessment activity to aid the team's understanding of the site's perspective
- Help improve communications among the appraisal team, DOE line management, and contractors regarding, for example, a particularly contentious issue.

The purpose of this issue form is to convey to cognizant managers potentially significant information from an ongoing EA program appraisal activity and solicit feedback. EA then requests that additional information that may shed light on this deficiency (including mitigation actions, if appropriate) be provided, along with management's comments on factual accuracy. The information conveyed by this issue form is preliminary data that is not meant to communicate the entire picture of performance for a program or at a site. Consequently, this

form should be provided only to those who have a need to know the information, and used only in the context of ensuring effective communications among cognizant DOE management, the site, and EA.

8.5 Opportunities for Improvement

This discussion of opportunities for improvement is taken from the appraisal process protocols. EA assessors have a broad range of knowledge in their individual topical areas of expertise, and also have the advantage of observing methods of program implementation across the entire DOE complex. When deficiencies or inefficiencies in program implementation are identified during an EA activity, it is useful for assessors to provide insight on approaches that could be adopted by line management to improve program performance. Often, these suggestions are based on successful approaches observed at other DOE sites. Specific opportunities for improvement are identified for inclusion in EA reports; however, they are provided only in the context of recommendations for consideration by line management, not as directed action. Opportunities for improvement that correlate to findings are normally provided to offer suggested approaches that line management may consider in their corrective action plans. Additionally, opportunities for improvement may be provided for conditions or performance deficiencies that do not rise to the level of a finding.

8.6 Interpreting Results

When interpreting the results of an MC&A assessment, the assessor must consider whether there are findings, weaknesses, deficiencies, or standards that are not fully met, and the importance and impact of those conditions. Deficiencies that reduce protection and put nuclear material at risk are significant findings. It is best that the deficiencies be interpreted both individually and in concert with other deficiencies, and balanced against any strengths and mitigating factors to determine their overall impact on the MC&A program's ability to meet the required standards. This information should have already been validated during the assessment process.

Review of MC&A systems requires close coordination among MC&A assessment team members. The review of all the findings in each of the five MC&A subtopics (Program Management, Material Control, Measurements, Material Accounting, and Physical Inventory) is the first step in evaluating overall program effectiveness. Similar criteria appear several times, and it is possible for more than one member of an assessment team to evaluate facility performance in the same area, which necessitates close team coordination to preclude inconsistencies. Based on performance test results, note that criteria evaluated as satisfactory from a compliance point of view might prove to be unsatisfactory when performance is evaluated.

An important activity for all topic areas is validation with the contractor and the field element of any information that might be presented in the assessment report or that might be the basis of a finding. In a typical process, the assessor will:

- Begin the daily validations with a summary of the assessment activities performed since the last validation.
- Specifically identify any performance test conducted.
- Present each observation of the activities, and allow the field element and contractor to respond.
- Respond to any concern expressed by the field element and contractor during the validation.

Validation is intended to identify possible items overlooked by the assessor, mitigating conditions, and additional documentation needs, and to maintain the field element's and contractor's awareness of MC&A status.

The assessment activities for each subtopic are divided into performance tests and compliance reviews. Because performance tests can evaluate how several elements of the MC&A system function together, these tests tend to be a more robust assessment of acceptable performance than assessment of compliance only. The discussion below summarizes the key compliance elements of the five subtopical areas that are considered during the analysis

activities. To ensure that all major assessed elements of the MC&A topic have been addressed, this section should be reviewed prior to determining overall program effectiveness.

The following factors should be considered when analyzing the impact of an identified deficiency:

- Category and attractiveness level of the material affected.
- Whether the field element or contractor has previously identified the deficiency and initiated corrective actions. Note: Even if both have occurred and a plan is in place, the deficiency may still be the subject of a finding, depending on the effectiveness and timeliness of the actions.
- Whether the deficiency is only an isolated instance or is indicative of systemic or widespread deficiencies.
- Length of time the deficiency has existed.
- Effectiveness of other controls that protect the SNM (defense-in-depth).
- Probability of success and the degree of risk of detection or personnel injury involved in an attempt to exploit the deficiency.
- Whether the deficiency would allow an insider to defeat multiple layers of the system.

When multiple deficiencies are identified, the assessors should analyze the cumulative effect of the deficiencies on protection of SNM. The assessors should consider whether:

- A single insider's position would enable exploitation of more than one deficiency. The effectiveness of a single insider must be evaluated in conjunction with the HRP, and the results should be fully integrated with the Personnel Security topic team.
- The same material process (or repository, or transfer point) is impacted by multiple deficiencies. If it is, the degree of protection provided by the remaining controls needs to be evaluated.
- The deficiencies align such that an insider could remove SNM with little or no probability of timely detection.

8.6.1 Program Management

The Program Management subtopic deals with the management of the MC&A program, including documentation, training, IRAs, performance testing, termination of safeguards, and reporting. Program planning, policy implementation, and cost-effective MC&A program implementation are also considered. Evaluated elements include organization and management, the MC&A Plan, emergency plans, incident investigation and reporting, and administrative controls.

Effective performance in administration is indicated by proactive management, adequate funding and staffing, and sufficient management attention to support a program that meets DOE objectives. Conversely, weak administration may have an inadequate organization structure and insufficient authority to implement programs, which should prove evident throughout the program. Typically, repeated findings from previous assessments or surveys, failure to close findings in a timely manner, and other signs of inactivity are indicators of less than effective performance.

If a deficiency exists and management and the field office have been proactive by notifying the Program Office in attempting resolution, but have been hampered by fiscal, technical, or production obstacles, it may be

appropriate to direct the finding to Headquarters. The appraisal process protocols provide details for documenting and preparing issue papers and findings to Headquarters organizations.

Effective program management is characterized by current and adequate procedures, including the MC&A Plan, with DOE and other approvals as required. Outdated procedures and documents, including those that have been in draft form for extended periods of time, are characteristics of a less than effective program.

Each of the following questions should be considered when analyzing data in the MC&A Program Management subtopic:

- Does the site have an approved MC&A Plan and approved emergency plans, perform internal reviews and system assessments, and have an adequate training program? If not, identify the impact of each shortfall on the performance of the MC&A system.

- Were all of the documents requested during the assessment planning available, current, comprehensive, and appropriately approved? If not, what is the MC&A impact on facility operations?

- Is the MC&A organization independent of production responsibility? If not, what is the impact?

- Does the MC&A organization provide for custody of SNM?

- Is the MC&A performance testing program comprehensive? Are tests thorough, conducted in accordance with an approved schedule, and evaluated? Are follow-up actions completed in a timely manner?

The steps for analyzing the collected information are as follows:

- Review documentation of related assessment activities. Were any findings identified that are related to the Program Management subtopic (e.g., training)?

- Review the documentation and structure of the MC&A organization. Does MC&A administration comply with the appropriate requirements?

- Review the performance of the assessed MC&A system against existing standards. Determine the impact of any noncompliance.

Documentation. Incomplete documentation affects not only the assessment team's ability to assess an MC&A system, but also the ability of site office and contractor personnel to conduct effective field element surveys and internal assessments. The adequacy of documentation must be assessed in conjunction with the reviews of training, internal assessments, and field element surveys. If the site does not have an approved MC&A Plan that addresses the current methods for implementing MC&A at the site, then less than effective performance is indicated. Additionally, the assessment analysis of the comprehensiveness of the MC&A Plan must address the status of documented procedures, training, and assessments.

Training. In general, an evaluation of the training program is based on whether the program successfully bridges the gap between required knowledge and skills and those actually demonstrated by the individuals involved. The determination must include a review of successfully completed training in defined competency areas (both formal and OJT), as well as custodian performance as determined during performance testing activities. In addition, reviews of any problem areas related to staff performance that were revealed during other assessment activities should be investigated. If problems are identified in transfer documentation, TID applications, and measurement activities, an analysis may determine whether the problem results from an individual performance issue or a training issue.

The training program is considered inadequate if it fails to provide the necessary knowledge and skills required for successful completion of the individual's job function. Determination of adequacy requires a review of both compliance issues and performance testing to thoroughly assess the system.

Emergency Plans. Current emergency plans, approved by all appropriate levels of management, are evidence of effective performance. Performance tests of emergency plans in which personnel follow and use existing procedures are also indicative of effective performance. Outdated or inadequate plans or emergency responses in which personnel react from memory in a manner that is inconsistent with the procedure indicate less than effective performance.

Incident Investigation and Reporting. When incidents, such as an ID exceeding warning or alarm limits, occur at a facility, effective performance includes prompt response per procedure, including documentation and follow-up. Little or no documentation or inadequate closure of incidents (including follow-up and lessons learned) are symptomatic of less than effective performance.

Evaluation Programs that Monitor MC&A System Effectiveness. The MC&A system effectiveness determination must be reasonably objective and balance the deficiencies against the defense-in-depth MC&A elements. It is essential that periodic reviews and system assessments be fully documented and comprehensive, and demonstrate adequate closure by report issuance and follow-up to achieve effective performance. Staffing deficiencies that do not allow completion of an internal audit program or repeated findings and frequent extensions of commitment dates are indications of less than effective performance. Poor performance testing or the failure to conduct comprehensive performance tests is also indicative of low system effectiveness.

8.6.2 Material Control

Material control deals with the various methods used to ensure that material is appropriately maintained in authorized locations and that material movement is properly tracked and monitored. Material control involves (1) the adequacy, reliability, and logistics of detection and surveillance devices utilized by the facility; and (2) the placement and maintenance of personnel and vehicle monitors, process monitoring devices, alarm systems, and other mechanisms used to alert the facility to unauthorized activities.

Material control elements requiring evaluation include: materials access, data access, material surveillance, material containment, barriers and other access deterrents, and detection and assessment.

Material access must be controlled so that only authorized personnel have access to the material (overlaps with the PSS topic). Data access controls must provide access for authorized personnel and prevent unauthorized use (overlaps with cyber security).

It is important that the material surveillance program provide timely assurance that materials are in their authorized locations, including the detection of unauthorized material flows and transfers. Material control includes programs for MAAs (overlaps with physical protection), MBAs, material in storage, and material in use. The detection and assessment program is typically designed to detect removal of SNM from its authorized locations and to provide appropriate response when an unauthorized event is detected.

The adequacy of the material control program depends on the adequacy of the individual system elements and how effectively those elements are integrated. An effective material control program normally provides assurance that an insider cannot remove Category I or II quantities of SNM from the process or storage repository without authorization or timely detection.

A material control program that meets all DOE and site-specific objectives is performing effectively. Deficiencies in one or more elements should be analyzed both individually and cumulatively to determine their overall impact on the material control program.

A deficiency in one element (for example, TID records) allows the potential to conceal the exploitation of a deficiency in another element (for example, material surveillance). The team members assessing the containment program should coordinate findings on the documentation of containment controls with the team members addressing the Program Management subtopic.

8.6.3 Measurements

Measurement deals with the methods and systems used to determine quantities of nuclear material. Measurement and measurement control systems must provide assurance that nuclear material values are as stated and that out-of-control situations are promptly identified. It is essential that procedures describe the measurements performed and that the personnel performing nuclear material measurements be adequately trained. These elements are considered essential to an effective measurement program.

When assessment activities related to measurement and measurement control systems have been completed, the assessor may evaluate and integrate those results into the Material Accounting subtopic. Measurement and measurement control systems must provide assurance that assigned SNM values are as stated on the facility inventory records. A deficiency noted in a single measurement system must be evaluated either as an isolated problem or as indicative of an overall system problem.

An isolated problem with a measurement system is evaluated in terms of its contribution to the inventory values. Failures of measurement systems that affect significant quantities of material or artificially modify the LEID are indicative of less than effective performance. An isolated problem with a single measurement system that does not affect a significant amount of material or significantly modify the LEID would be treated as a finding in the assessment report, but would not necessarily impact the determination of overall effectiveness. Generic measurement system problems must be coordinated with the Material Accounting subtopic and with the MC&A assessment program management element.

Measurement systems that do not provide assurance that nuclear material quantities are accurately stated are indicative of less than effective performance. Failure to have a measurement control program that detects when a measurement system malfunctions is also indicative of less than effective performance. The degree to which the failure of the measurement and measurement control systems impacts the nuclear material quantity could determine the significance of findings resulting from the deficiencies.

Statistical methodologies are employed to ensure that measurement systems are in control and that the overall impact of all measurement systems on the ID is evaluated. It is essential that statistical programs be based on sound statistical theory and fully documented, especially the underlying assumptions used to determine warning and alarm limits. Failure to employ valid statistical methodologies to assess material controls could indicate less than effective performance.

8.6.4 Material Accounting

Material accounting addresses the various methods used to account for nuclear material and involves the completeness, accuracy, and timeliness of the accountability record system, and the system's capability to respond to emergency conditions. Elements requiring evaluation include the facility accounting system, material transfers, and material control indicators. By-difference accounting, excessive amounts of material not amenable to measurement, and values estimated by engineering judgment may also indicate less than effective performance.

Internal and external nuclear material transfers must be documented, and it is important that a program be implemented to provide assurance that any attempt to divert or steal nuclear material during transfer will be detected or deterred. If problems are identified in the completeness of internal transfer forms, the analysis

should consider whether the observed problems are due to the training program for custodians, the procedures, the design of forms, or other root causes.

The facility accounting system typically provides a database for tracking nuclear material, including material transfers and verification, detection, and evaluation of IDs. It is important that procedures are current, describe system operation, and provide assurance against tampering and unauthorized modification. These are essential elements for an accounting system with effective performance.

Material control indicators include documented programs for evaluating and investigating S/R differences, IDs, and other inventory adjustments. It is important that the program include timely resolution and reporting requirements. Observed deficiencies in this area are important since they could indicate that the facility does not know how much material is in the inventory.

A facility accounting system that does not reflect item identity, quantity of nuclear material, and location likely will lead to a conclusion reflecting less than effective performance. Systemic problems in the accounting system (numerous incomplete/incorrect transfers) are also indicative of less than effective performance.

8.6.5 Physical Inventory

Taking a physical inventory and reconciling the inventory records must be carefully planned, documented, and completed as stated in DOE orders and the facility MC&A Plan in order to assure effective performance. It is important that confirmation and verification programs be in place and adequately documented, with defined acceptance and rejection criteria.

When the assessment activities related to the inventory program have been completed, the assessor must evaluate and integrate those results into the Material Accounting subtopic. The inventory program must provide assurance that the records are an accurate representation of material on hand and that the assigned SNM values are based on measured values. A deficiency noted in a component of the inventory program or a defect identified during a performance test must be evaluated as either an isolated problem or indicative of the overall system.

Isolated problems associated with measured values should be evaluated to determine their impact on reports of material holdings and IDs. Significant quantities of material for which the measurement method cannot be determined from the records system audit are indicative of less than effective performance. Evaluation of impact should consider the program for confirmatory and verification measurements. Performance tests of the confirmatory and verification measurements provide evidence of whether by-difference values impact the quality of the physical inventory statement.

The training program, inventory plan, and inventory procedures are evaluated in conjunction with the program management analysis to determine whether the findings are unique to inventories or apply to the overall MC&A system. A key element of the physical inventory program is that it should include features to ensure that inventory methods are consistent from one period to the next. Such features may include training, documented procedures, process and storage area layout, and materials management practices.

A facility physical inventory program that does not provide assurance that nuclear material is as stated in the facility records is evidence of less than effective performance. The lack of assurance could be caused by a number of factors, including an incorrect frequency for taking a physical inventory, an inappropriate sampling plan for inventory items, deficient procedures that could permit nuclear material to remain unaccounted for during a physical inventory, or untimely reconciliations. The severity of the problem determines whether findings or issues may be appropriate.

8.7 Appraisal Conclusions and Reporting

After data collection, field observations, performance testing, and analyses are completed, the results of the appraisal must be documented. A typical appraisal report consists of an Introduction/Background section, analysis of results, and a conclusion. Any opportunities for improvement that were identified are also provided in the report.

The Introduction/Background section of the report describes the purpose of the appraisal, any prior issues that are of particular significance to the effort (e.g., follow-up to evaluate corrective actions for previously identified findings), the timeframe during which field activities were performed, and the means by which the appraisal data was collected (e.g., interviews, performance tests, document reviews).

The Results section of the report generally identifies specific assessment activities in each of the five MC&A subtopical areas. Those areas in which significant concerns, including issues, findings, or opportunities for improvement, were identified are detailed to provide DOE Headquarters, site management, and contractor personnel a clear picture of what was reviewed and what concerns arose. In particular, findings and issues are explicitly written to document specific weaknesses or deviations from expected performance.

The Conclusion section of the report should succinctly describe the results of the data analysis, especially as the analysis relates to the effectiveness of MC&A program performance. All conclusions described in this section must be supported by text within the Results section of the report. Language in the Conclusion section should be consistent with the observed performance of MC&A system elements. Two examples of Conclusion sections resulting from typical MC&A assessments are provided. Figure 8-2 provides a conclusion that might result when a facility's MC&A program demonstrated effective performance in all areas. Figure 8-3 is an example of an appraisal in which various weaknesses were observed. In each case, the conclusion reflects the MC&A system performance observed by EA during the appraisal.

8.8 References

Office of Cyber and Security Evaluations Appraisal Process Protocol
Office of Enforcement and Oversight, *Independent Oversight Program Appraisal Process Protocols* (November 2012)

Conclusions

Site XXX maintains a well-administered MC&A program to control and account for nuclear materials. Comprehensive documentation, including a DOE-approved MC&A Plan and detailed procedures, provides the basis for the program, which is implemented by a knowledgeable, trained MC&A staff. Embedded MC&A personnel in Category I MBAs serving as MBA custodians ensure MC&A involvement in and awareness of daily operations involving Category I quantities of SNM. Co-locating oversight personnel with MC&A staff at Site XXX facilitates effective communication and coordination among field offices and contractor personnel. Site inventory practices provide assurance of accurate and timely tracking and accounting of nuclear material at the site. The measurement program is mature and provides sufficient measurement capabilities for current operations.

Category I quantities of SNM are well protected through implementation of strong material control measures. The routine involvement of MBA custodians in nuclear material transfers, inventories, and measurement activities provides assurance that MC&A system elements are performing as intended. Material surveillance actions provide effective monitoring to deter and detect unauthorized activities involving SNM.

Various elements of the MC&A program, although effective, exhibited some deficiencies. The site uses LANMAS to maintain effective accounting of SNM, but the incorrect processing of some nuclear material transactions resulted in incorrect Material Balance Reports. Site self-assessment and performance testing programs are conducted in accordance with approved plans and schedules. Assessment and performance test results are incorporated into the site system effectiveness model determinations, but additional documentation of the basis for making adjustments to performance data would enhance the process.

Strengths noted in MC&A staff capabilities, strong field presence of MBA custodians, and effective DOE oversight mitigate the minor deficiencies observed in MC&A program management and accounting. These strengths, combined with a rigorous material control program, ensure that SNM at the site is effectively safeguarded.

Figure 8-2.
Sample MC&A Assessment Report Conclusions for a Site with Effective Performance

Conclusions

Site YYY's MC&A program is based on a graded safeguards approach consistent with the site's diverse operations and nuclear material inventories. The staff include knowledgeable, experienced MC&A personnel who control and account for nuclear materials and support implementation of MC&A program elements. An approved MC&A Plan, MBA-specific implementing plans, and detailed sitewide and facility procedures reflect current operations, although the site MC&A Plan needs to be revised to improve clarity of program implementation. DOE surveys complement contractor internal assessment activities, but, in some instances, lack sufficient depth to adequately assess MC&A system performance. The MC&A assessment program has undergone recent revision, and although all MC&A system elements are reviewed, there is no assurance that issues identified as findings are entered into the site's tracking system. Site YYY has initiated use of a model to evaluate MC&A system effectiveness, but additional effort is still needed to apply the model to all Category I areas.

The accounting system is adequate to document nuclear material transactions and maintain accountability, although the failure to review all adjustments and transfers when an MBA was restructured led to at least one accounting inaccuracy (and possibly others) that needs correction. A projected LEID was calculated prior to the initiation of Category I operations; however, failure to implement an effective process monitoring program reduced the capability to provide timely detection of potential losses of SNM, as required by DOE MC&A orders. Physical inventories of nuclear materials conducted in accordance with approved schedules provide assurance that materials are present.

Comprehensive DA and NDA measurements provide assurance that nuclear materials are accurately quantified. Measurements have been initiated that improve measurement capabilities and reduce the number of nuclear material items that are not amenable to measurement. However, a significant backlog of verification measurement and analyses still exist. Additional NDA measurements will increase the workload on the NDA organization, and analyses of data for timely inventory reconciliation will be challenging. Measurement control programs are effectively implemented and provide data that is incorporated into statistical calculations.

MC&A activities in one MBA are rigorous and use extensive material control elements to ensure material is adequately protected. The effectiveness of MC&A activities was demonstrated during a performance test, wherein personnel responded in a timely and effective manner to resolve an anomaly that was introduced into the system. However, controls observed in other MBAs are not as rigorous, and do not provide the same level of assurance.

Deficiencies identified in Site YYY's MC&A program are partially compensated for by a knowledgeable, experienced MC&A staff. However, additional attention is warranted in the areas of program management, accounting, and material control to establish a robust MC&A system that provides assurance that SNM is effectively accounted for and controlled at Site YYY.

Figure 8-3.
Sample MC&A Assessment Report Conclusions for a Site with Less Than Effective Performance

Appendix A: Performance Tests

INTRODUCTION

This appendix provides a simplified list of performance tests that may be conducted during a U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) assessment. A complete listing of current, detailed performance tests is available on the EAShare site. These scenarios presented herein are very general in nature and are to be used as guidelines for the assessor. Each scenario has an objective, brief scenario description, and general evaluation criteria. Additional details are developed during the assessment when specific facility requirements and procedures have been determined. The scenarios in this appendix do not agree one-for-one with the performance evaluation subsections of Sections 2 through 6 of this guide. The tests described here are more generic to the subtopics. An additional type of performance test, called a tabletop exercise, is described in Appendix C.

PROGRAM MANAGEMENT

Administrative (AD):1 Material Control and Accountability (MC&A) Training Effectiveness

Objective

Determine whether the MC&A training program provides assurance that personnel performing MC&A functions are trained and/or qualified.

Scenario

Prepare a 20-question written test (possibly using existing facility tests) of facility-specific questions on duties and responsibilities from facility documentation and give it to a random sample of material balance area (MBA) custodians or material handlers. The test should be pre-approved by the facility trusted agent.

Evaluation Criteria

Ninety percent of those tested scoring 70 percent or higher implies SATISFACTORY performance. Some questions can be designated as "correct answers required for passing performance." Testing organizations may vary the acceptance criteria based on their knowledge of what personnel should know.

AD:2 Emergency Response

Objective

Determine the effectiveness of material control practices and procedures employed during an alarm/evacuation.

Scenario

The MBA custodian opens an emergency exit door that is controlled by a "shadow" security police officer (SPO) and then throws out a can containing a nuclear material source. Alternatively, an evacuation of a building is staged.

Evaluation Criteria

- Is the appropriate response plan activated?
- Is proper control of material maintained according to facility plans?
- Is the SPO response to a breach of an emergency exit appropriate and according to procedure?
- Does the SPO rover locate the material or is the emergency situation resolved?
- Can the loss of material be localized?

AD:3 Emergency Response

Objective

Determine the ability of personnel to respond to and properly resolve a missing item of special nuclear material (SNM).

Scenario

State that an item of SNM is missing using various theft or hoax scenarios, or create a dummy item with a realistic history in the accounting records just prior to an inventory.

Evaluation Criteria

- Are response procedures followed?
- Can an unauthorized removal be localized?
- Does the accounting system identify the missing item?
- Does the system distinguish between a hoax and an actual missing item?

AD:4 Vulnerability Assessment (VA) Validation Checks

Objective

Determine whether the detection probabilities used by the facility are supported in the VA.

Scenario

Review the VA and select several detection probabilities. Ask the facility to produce the documentation that supports the detection probability.

Evaluation Criteria

- Does documentation exist to support the VA detection probability?
- Does performance testing data support the detection probability that was assigned?
- Does the facility have an ongoing performance testing program to support the detection probability?

AD:5 Internal Review and Assessment Program Observations

Objective

Determine whether the facility can perform an internal review by observing an actual assessment.

Scenario

Select an internal review topic and an area to be reviewed. Ask the facility to conduct an internal review. Observe the review, or have the trusted agent introduce an anomaly to determine whether the internal review is effective in detecting that anomaly.

Evaluation Criteria

- Is the reviewer knowledgeable in the area being reviewed?
- Is the topic being reviewed documented in the internal review and assessment program plan?
- Are communications between the reviewer and reviewee clear and concise?
- If there were any findings, did the reviewer effectively communicate them to the reviewee?

- If an anomaly was introduced by the assessor, was it detected?
- Were appropriate actions taken?

AD:6 Facility-Conducted Performance Test Observations

Objective

Determine whether the facility can conduct performance tests in accordance with established procedures.

Scenario

Select a performance test from an existing bank of facility performance tests. Ask the facility to conduct the test.

Evaluation Criteria

- Was the test conducted in accordance with established procedures?
- Were the pass/fail criteria clearly defined?
- If required, were corrective actions taken?
- Was the test properly controlled?
- Were the conclusions from the test accurate and properly recorded?

AD:7 Closure of Corrective Active Validation

Objective

Determine whether closed findings from the internal review and assessment program have been appropriately closed.

Scenario

From a list of closed findings from the internal review and assessment program, select several closed findings. Validate the closed findings through field assessments.

Evaluation Criteria

- Were the findings stated as closed by the facility still closed?
- Were the findings appropriate for the identified deficiencies?
- Were the closure actions still in place?
- Did the corrective action address the root cause of the deficiency?

MATERIAL CONTROL

Control (C):1 Barrier Integrity

Objective

Determine whether SPOs or individuals conducting daily administrative checks (DACs) will locate a hole in the material access area (MAA) boundary. The assessor should validate that part of the DAC is identifying breaches of barrier integrity.

Scenario

Simulate a hole in the wall of the MAA boundary.

Evaluation Criteria

- Did SPOs (or other plant personnel) identify the simulated hole?
- Were appropriate actions taken by the SPOs or personnel?

C:2 Internal Controls

Objective

Determine whether transfer authorization forms (serialized, controlled forms) can be obtained by unauthorized personnel.

Scenario

An insider, who is not authorized to receive transfer authorization forms, tries to obtain the forms.

Evaluation Criteria

- Did the person in control of the transfer forms authorize delivery to the insider?
- Did the insider obtain the transfer forms?

C:3 Internal Controls

Objective

Determine whether the combination lock for the entrance to SNM storage or a process area (or the second combination of a two-lock door) can be compromised.

Scenario

An unauthorized insider (operator, health physics, SPO, etc.) requests the combination from an authorized person for a valid reason, or surreptitiously gains access to the combination.

Evaluation Criteria

- Did the authorized person reveal the combination?
- Could the insider gain unauthorized access to the area?

C:4 Material Surveillance

Objective

Determine whether the two-person rule can be compromised.

Scenario

One of the two persons in the two-person rule asks the other person to leave to get additional supplies. This scenario can be tested in such areas as vaults, processing areas, waste assay and packaging areas, and tamper-indicating device (TID) application areas.

Evaluation Criteria

- Did the person leave the area?
- Was a second authorized person called to provide two-person coverage?

C:5 Material Transfers

Objective

Test the proper authorization signatures on transfer forms.

Scenario

Select an insider who has access to forms authorizing the transfer of SNM but is not authorized to sign the forms. The insider fills out the form, signs his/her own name, and attempts to remove a packaged nuclear material source through the MAA boundary. Alternatively, have an insider who is authorized to sign transfer forms (but is not authorized to move material) attempt to remove material from an MAA.

Evaluation Criteria

- Did the SPO at the MAA boundary check the authorizing paperwork?
- Did the SPO recognize that the signature was not authorized or that the person was not authorized to transfer material?
- Did the SPO permit the insider to leave the MAA with the material?

C:6 Material Transfers

Objective

Determine whether transfer documentation can be counterfeited.

Scenario

A transfer form is copied, signed by an authorized signature, and used to transfer nuclear material sources out of an MAA.

Evaluation Criteria

- Did the SPO allow the transfer of material?
- Did the SPO recognize the form as having been copied, and even though the signature was authorized, was the insider prevented from leaving the MAA?

C:7 Portal Detection Systems

Objective

Determine whether SNM can be removed in containers (used respirator boxes, laundry, waste boxes, toolboxes, etc.) that are being removed from an MAA.

Scenario

Place simulated SNM (sources) inside one of the items scheduled for removal by an insider. The insider then tries (under the two-person rule) to remove the SNM through the MAA boundary.

Evaluation Criteria

- Did the SNM portal monitor alarm or did the SPO monitor the containers?
- Did the SPO allow the insider to leave the MAA?
- Did the SPO respond appropriately to the alarm?
- If a TID should have been present, did the SPO question the lack of a TID?
- Was the SNM found and notification made?

C:8 Portal Detection Systems

Objective

Determine the adequacy of a portal detection system for detecting the removal of SNM.

Scenario

Observe the conduct of SNM and metal detector calibrations and tests. Conduct variations of the same tests in an attempt to defeat the detector. Use various amounts of non-ferrous metal in conjunction with SNM sources to test the combination of SNM and metal detection capability.

Evaluation Criteria

- Are the calibration sources detected by the portal detectors?
- Can shielded SNM in quantities greater than allowable limits be removed undetected?

C:9 Portal Detection Systems

Objective

Determine whether the SPO at the MAA boundary enforces post orders for other members of the security force.

Scenario

The trusted agent SPO places a nuclear material source in his/her pocket and exits the MAA boundary.

Evaluation Criteria

- Did the SPO at the MAA boundary stop the trusted agent SPO from leaving the area?
- Did the SPO at the MAA boundary require the trusted agent SPO to re-enter the portal or search the SPO with a portable detector?
- Did the search detect the nuclear material source?

C:10 Portal Detection Systems

Objective

Determine whether SNM can be piggybacked with sources to be removed from the MAA.

Scenario

An insider carries a nuclear material source in his or her pocket and a second nuclear material source in a scrap can with accompanying transfer authorization forms.

Evaluation Criteria

- After the packaged nuclear material and authorizing paperwork were checked by the SPO, was the insider asked to walk back through the portal monitor?
- After the portal alarmed again, did the SPO search the insider with a portable detector?

C:11 Portal Detection Systems

Objective

Determine whether SNM can be removed from MAA boundary exits other than the normal personnel entry point.

Scenario

Place simulated SNM (sources) inside containers that leave the MAA. An insider tries to remove the material through an MAA exit other than the primary exit.

Evaluation Criteria

- Did the SPO search the containers with portable equipment?
- Was the source detected?
- Was the SPO response to alarms appropriate?

C:12 Tamper-Indicating Devices – Use by Unauthorized Personnel

Objective

Determine whether TIDs can be obtained by unauthorized personnel.

Scenario

An insider who is not authorized to receive TIDs tries to obtain them from the TID custodian or the TID administrator.

Evaluation Criteria

- Did the custodian or administrator check the person against the authorization list?
- Did the signatures match?
- Did the insider receive any TIDs?

C:13 Tamper-Indicating Devices – Accuracy of Documentation

Objective

Determine whether TID numbers can be accurately traced to corresponding item/identification numbers/storage locations.

Scenario

Randomly select a sample of TIDs from the TID administrator for a TID custodian and trace the TID numbers with corresponding items to current status, or randomly select a sample of TIDs in use and trace their identification numbers to accounting records.

Evaluation Criteria

- Is the documentation accurate enough to provide assurance that the records reflect current status?

C:14 Tamper-Indicating Devices – Application and Removal

Objective

Determine whether TIDs are being applied and removed consistent with procedures.

Scenario

Observe the application and removal of TIDs by randomly selected persons authorized to use TIDs.

Evaluation Criteria

- Did the person follow approved procedures?
- Were the correct seal type and serial numbers used?
- Can access to the container (or location) be achieved without detecting damage to the TID?

C:15 Tamper-Indicating Devices – Resolving Discrepancies

Objective

Determine whether TID discrepancies are detected and proper resolution achieved. This test may be included with the test of DACs and physical inventories.

Scenario

Replace a TID with another without initiating changes in accounting records, or make a change in the TID number in the accounting records.

Evaluation Criteria

- Was the different number detected?
- Were records checked to verify which TID should be on the item?
- Was the item re-measured to verify the SNM content?

C:16 Daily Administrative Checks

Objective

Determine whether procedures for DACs are followed and whether the procedures are effective.

Scenario

Witness the conduct of the DAC procedures, including an abnormal situation that should be detected by normal procedures. Select a random sample of DAC records to validate DAC performance.

Evaluation Criteria

- Did the person conducting the check follow procedures?
- Was the abnormal condition detected?
- Did the records selected reflect required DAC completion?

C:17 TID Records Check

Objective

Determine whether the TID records system is accurate.

Scenario

Select a sample of TID records. The records may be from the TID custodian, the MBA custodian who applies TIDs, or the central records for TIDs. (This is a records check performance test.)

Evaluation Criteria

- Are the records current?
- Are authorized TID custodians, applicators, and witnesses the only personnel to apply/witness TIDs?
- If containers are checked relative to the TID log, do the containers have the appropriate TIDs, and conversely, do the records reflect the containers with the proper TIDs?

MEASUREMENTS

Measurements (M):1 Scales and Balances

Objective

Determine whether the scales and balances program provides data of the quality required for MC&A records.

Scenario

Select a sample of accountability weighing instruments from the MC&A organization records, and verify the frequency and currency of the calibration and the performance of daily linearity checks. Check the performance of the instrument against standards normally used or against independent weight standards that are in the normal weighing range of the instrument.

Evaluation Criteria

- Was instrument calibration current?
- Are appropriate standards being used?
- Are daily checks being performed?
- Were personnel familiar with the operating and MC&A procedures?
- Did the instruments perform to the stated specifications?

M:2 Tank Calibration Verification

Objective

Determine the performance standard error and the limits of bias of one or more key MC&A volume measurement systems.

Scenario

Select key volume measurement systems and for each require, or obtain from previous measurements made during recent weeks, duplicate measurements of at least ten volumes of process materials normally measured. Perform a statistical evaluation of the data to obtain the estimated standard error and limits of bias for each system.

Evaluation Criteria

- Were the tank calibrations current?
- Do the results of the analysis differ significantly from historical measurement control data?
- Is the observed standard error reasonable for the system?
- Were personnel familiar with the volume measurement procedure?
- Do any of the tanks have a significant bias and, if so, at what probability level? Has a bias been previously observed? Are corrections for bias being applied?

M:3 Analytical Measurements

Objective

Determine whether the measurement control data used to control the analytical method is reasonably stated.

Scenario

Using a process control standard with a standard value traceable to a national measurement base, submit two samples to operations in the morning and two in the afternoon. Request two analyses for each sample.

Evaluation Criteria

- Did the results agree within accepted control limits?
- Did the precision and accuracy of the results agree with the stated precision and accuracy of the method?

M:4 Off-Specification Measurements

Objective

Test the performance of accountability measurements and reporting procedures when measurement systems are outside system specifications.

Scenario

Select items from the inventory that are outside the performance capability or calibrated range of a measurement device. Request that the items be measured. Review the reporting and investigation of out-of-limits conditions for all accountability measurement instruments for a specific period.

Evaluation Criteria

- Were the items measured on an instrument that was beyond its operating range?
- Was the measurement flagged as being suspect due to the operating range limitation?
- Have all out-of-limits conditions been documented and investigated, with appropriate corrective actions?

M:5 Confirmatory/Verification Measurements

Objective

Determine whether the confirmatory or verification measurement program provides data of the quality required for the MC&A records.

Scenario

Select key measurement systems and measure standards or analyze items using an independent method or with an independent laboratory serving as a referee to compare standard errors and limits of bias with values reported by the facility measurement control program.

Evaluation Criteria

- Did the measurements perform to the specifications established for the system?
- Are the levels of precision and accuracy adequate to meet the material loss detection goals?
- Were acceptance/rejection criteria available for the system?
- Were personnel familiar with the operation of the system?

M:6 Confirmatory Measurement

Objective

Determine whether a confirmatory measurement system is effective and whether appropriate actions are taken if a confirmatory measurement indicates that all nuclear material is not present in an item.

Scenario

Partially shield the detector of an assay device so that it appears that some of the nuclear material is not in the item or adjust an item in such a way that the confirmatory measurement should detect the change.

Evaluation Criteria

- Did the confirmatory measurement fall outside the acceptable range?
- Was the item re-measured?
- Was supervision notified, and were the response procedures followed?

M:7 Operation of Measurement Equipment/Blind Sample for Measurement

Objective

Determine whether operators and procedures are adequate to ensure operation of nuclear material measurement equipment.

Scenario

Select a measurement system and operator. Ask the operator to operate the equipment and record measurement data, or select a sample of nuclear material to be measured and follow the material through the measurement process.

Evaluation Criteria

- Were the procedures clear?
- Were the operators trained?
- Did the equipment function as required?
- If data indicated an out-of-control condition, were appropriate corrective actions taken?
- Was data properly recorded?

M:8 Measurement of a Standard/Calibration

Objective

Determine whether the facility can successfully measure a known standard or conduct an instrument calibration.

Scenario

Select a piece of measurement equipment and ask the facility to measure a standard or calibrate the instrument. (The assessor should consider the feasibility of modifying the measurement system to obtain an unacceptable result.)

Evaluation Criteria

- Was the procedure complete, current, and followed by the operator?
- Were the measurement results evaluated correctly?
- If control limits were exceeded, were corrective actions taken?

M:9 Training Tests: Knowledge Tests

Objective

Determine whether operators are knowledgeable of measurement equipment operation.

Scenario

Prepare a knowledge examination and administer it to a group of qualified operators. (The test should be pre-approved by the facility trusted agent.)

Evaluation Criteria

- Did all personnel score greater than predetermined acceptable results?
- If unsatisfactory results were obtained, what justification was provided by the facility?

M:10 Training Tests: Training Records

Objective

Determine whether the facility training records for measurement personnel are current.

Scenario

Select the names of several operators who the facility states are qualified to perform accountability measurements. Review the training records to ensure that they are qualified.

Evaluation Criteria

- Were training qualification criteria documented?
- Were records available for all qualified personnel?
- Was each individual qualified based on the facility criteria?

M:11 Records Checks: Measurement Results/Traceability of Standards

Objective

Ensure that results of measurement data are properly recorded and that standards are traceable to the National Institute of Standards and Technology (NIST).

Scenario

Select a group of items from the inventory listing or select a group of measurement results from the laboratory. From the list, verify that the results are appropriately transcribed. The items from the inventory list should have measurements traceable to laboratory results. The measurement results should be traceable to the inventory. For each measurement system, identify the appropriate standard and request documentation of its certified value.

Evaluation Criteria

- Was data legibly recorded in the laboratory?
- For multiple analyses of the same sample, were values calculated appropriately?
- Were outliers dispositioned according to procedure?
- Was standard data traceable to NIST?
- Were reference standard sheets available?

M:12 System Not Approved for Measurement

Objective

Determine whether the facility has procedures in place to ensure that measurement systems not approved for accountability purposes are not used for accountability measurements.

Scenario

Request an accountability measurement on a measurement system that is currently not approved for accountability measurements. This can be accomplished by attempting to use a system currently out of calibration, by placing a system out of accountability early in the assessment and subsequently requesting a measurement, or by requesting an accountability measurement on an instrument outside the range/use (for example, weighing an item on a scale outside the checkweight range or requesting that an item be measured on a non-destructive assay instrument not used for that material type).

Evaluation Criteria

- Were procedures for tagging the equipment out of service for accountability purposes followed?
- Did the facility measure and report the measurement for the item?

- Was the equipment identified as "not to be used for accountability?"
- Were appropriate actions taken?

M:13 Submission of Samples: Independent Verification of Measurement Results and Duplicate Samples for Analysis

Objective

Determine the capability of the facility measurement equipment to achieve consistent measurement results.

Scenario

A sample is taken and analyzed by a different offsite laboratory or by a different laboratory within the facility, or duplicate samples are taken by the assessor and sent to the laboratory for duplicate analyses.

Evaluation Criteria

- Were sampling and analytical procedures followed?
- Were the results that were obtained within the pre-determined acceptable tolerances?
- Were any corrective actions required? If so, were they taken?

MATERIAL ACCOUNTING

Accounting (AC):1 SNM Receipt Closure

Objective

Determine whether transactions (receipts) with unmeasured values or significant shipper/receiver differences are entered into the process.

Scenario

Utilize a TJ-14, "Transaction Activity Summary By Facility," generated by the Nuclear Material Management and Safeguards System (NMMSS) to test facility records.

Evaluation Criteria

- Are receipts measured and transactions closed prior to introducing material to process?
- Are exceptions granted for those materials that do not have a measurement or for transactions not completed?

AC:2 Accountability Data Traceability

Objective

Determine whether an audit trail exists from source data to accounting records that reflects compliance with internal and DOE requirements.

Scenario

Evaluate accounting documentation related to a statistical sample of transactions detailed in an NMMSS-generated TJ-26, "Random Sample," report.

Evaluation Criteria

- Is the required documentation present and technically correct to provide assurance that the accounting system accurately reflects inventory quantities?
- Is an audit trail available for all transactions?
- Are item histories complete such that a missing or faulty record can be reconstructed or corrected, and an inventory list of all material in any MBA or storage facility can be constructed?
- Are there checks and balances that detect errors or discrepancies?

AC:3 Document Sampling

Objective

Determine whether the accounting system is in compliance with all reporting requirements.

Scenario

Randomly select a sample of accounting documents to verify accuracy and completeness and then use this sample to physically locate material. This test may be used with the tests for accountability data traceability (AC:2) and item location (AC:7).

Evaluation Criteria

- Were all records complete, accurate, and submitted in a timely manner?
- If discrepancies exist, are they a systemic problem or isolated cases?
- Does the information in the records agree with the physical inventory?

AC:4 Accounting System Failure

Objective

Determine whether the materials accounting system can function following system failures at different levels and whether the system can be recovered.

Scenario

Simulate failure of different levels of the accounting system, including online data entry points on process lines or sensors, primary accountability computers, and primary storage media.

Evaluation Criteria

- Were operations successfully restarted?
- Was there resolution of all items, operations, and measurements affected while the system was down?
- Was the system successfully restarted from backup data or systems?

AC:5 Computer Access Authorization

Objective

Determine whether facility computer access controls to the nuclear material accounting system can be violated.

Scenario

An authorized user intentionally enters incorrect passwords to the nuclear material accounting computer system.

Evaluation Criteria

- Were facility procedures for access control documented?
- Was the unauthorized entry detected?
- Was the facility response appropriate and in accordance with established procedures?

AC:6 Material Transfer Checks for MBA Categorization

Objective

Validate the facility controls to ensure that a Category II or III MBA cannot receive material that would increase the category level.

Scenario

Attempt a material transfer (using only documentation, not actual material) to a Category II or III MBA to increase the category of the MBA.

Evaluation Criteria

- Do procedures exist to prohibit an increase in category level for MBAs?
- Was the attempted transfer detected?
- Was the facility response to the attempted transfer appropriate?

AC:7 Item Identification Front and Back Checks

Objective

Determine whether the facility records accurately reflect the identity, value, and location of inventory items.

Scenario

Select a sample of items from either the inventory listing or during the field assessments. Record the item identification, location, plutonium weight, and TID. Verify the items in the field or the sample taken from the field by comparison to the accountability system records.

Evaluation Criteria

- Were items in the field successfully reconciled to the nuclear material accounting system records?

AC:8 Field Data Accounting Records Check

Objective

Determine whether the data records maintained by the MBA custodian agree with the records maintained by the nuclear material accounting system.

Scenario

Take a sample of MBA custodian records and verify the data by comparison to the central nuclear material accounting records.

Evaluation Criteria

- Were MBA custodian records reconciled to the accounting system records?

AC:9 SNM Item Listing Generation

Objective

Determine whether the facility can generate a physical inventory listing for MBAs possessing Category I SNM within 3 hours, or within 24 hours for other MBAs.

Scenario

Ask the facility to generate an inventory listing and note how long it takes to generate the listing. (This scenario can be combined with an actual physical inventory. The assessor can introduce an anomaly into the inventory list and evaluate the facility response.)

Evaluation Criteria

- Was the inventory list generated within the appropriate timeframe?
- Was the list accurate?
- How did the facility consider items in transit or data that had not been entered into the computer system?
- If an anomaly was introduced, did the facility detect it and initiate appropriate action?

AC:10 Internal Transfer Forms Falsified

Objective

Determine whether the facility can detect a falsified internal transfer.

Scenario

A facility transfer form is prepared by an unauthorized individual and processed through the accountability system.

Evaluation Criteria

- Did the facility procedure for processing transfers detect the falsified transfer?
- Was the facility response appropriate and timely?

AC:11 Audit Trail Traceability

Objective

Determine whether the nuclear material accounting system can trace changes by type of change and the individual making the change.

Scenario

Select a series of nuclear material accounting records and review their audit trails. The review can include a computer printout or may be a manual verification. Alternatively, the assessor may ask a nuclear material accounting clerk to make a series of changes to transfer records and then review the traceability of the changes.

Evaluation Criteria

- Did the audit trail provide the necessary information in a timely manner regarding the types of changes made to the accounting database?

AC:12 Personnel Data Entry Observation for Source Document and Accounting Data

Objective

Evaluate the training and procedures of facility accounting personnel by observing the entry of data into the nuclear material accounting system.

Scenario

Select individuals from the nuclear material accounting group, and select a series of nuclear material accounting transactions. Ask the individuals to enter the transactions into the accounting system while an assessor observes. Example transactions include MBA internal transfers, project changes, shipment data, receipt data, or corrections to those documents.

Evaluation Criteria

- Were nuclear material accounting procedures followed?
- Were the nuclear material accounting personnel knowledgeable of the transactions?
- Were the procedures sufficiently clear to allow the nuclear material accounting personnel to enter the transactions?

PHYSICAL INVENTORY

Inventory (I):1 Inventory Effectiveness

Objective

Determine whether inventory procedures are implemented to provide a determination of the material on inventory.

Scenario

Witness the conduct of a physical inventory of an MBA to determine whether procedures are correctly followed and the inventory is effectively performed.

Evaluation Criteria

- Was all nuclear material located during the physical inventory?
- Did all nuclear material have an associated measured value?
- Did the inventory procedure include measures to ensure the quality of the inventory-taking activities?
- Was the inventory difference (ID) within established control limits?

I:2 No-Notice Emergency Inventory

Objective

Determine whether the emergency inventory program ensures that all material is inventoried and inventoried only once. (This test does not address inventory verification measurements, audits of records for transcription mistakes, or other activities to reconcile the results of the physical inventory to the book records.)

Scenario

Select an MBA or part of an MBA to inventory within the allocated timeframe available for the assessment. Initiate the inventory by either simulating a request from the site office or in response to another test, such as the DAC test. Coordinate with appropriate material control tests for evaluation of emergency response.

Evaluation Criteria

- Were all items stated to be in the area actually present, and were no other items present?
- Were the correct procedures followed when anomalies were found?
- Were confirmation measurements within limits?
- Was the inventory completed within the timeframe expected for the area?

I:3 SNM Location

Objective

Determine whether inventory items are in their stated locations and whether inventory records accurately reflect the physical inventory.

Scenario

Choose a random sample of SNM items from the accounting records and make a physical check of their locations and inventory characteristics, or randomly select items from the physical inventory and verify their accountability information in the accounting records.

Evaluation Criteria

- Did the information in the accounting records about each selected item agree with the information listed on the item?
- Was the location of the item correct?

I:4 Item Location

Objective

Determine whether an item location anomaly can be resolved properly.

Scenario

Move an item to a different location without changing the records just prior to an inventory (may be included as a test of DACs).

Evaluation Criteria

- Did the system identify the item?
- Were reconciliation procedures followed?

I:5 SNM Verification

Objective

Determine whether items in the inventory have the correct SNM values and whether the inventory is correctly stated.

Scenario

Randomly select items from the inventory for re-measurement using an accepted verification measurement method.

Evaluation Criteria

- Were all selected items found?
- Were proper calibration checks performed on the measurement system prior to operation?
- Were the measurement results for the items within the documented acceptance/rejection criteria?
- Were proper steps followed to resolve any anomalies?
- If discrepancies were found, were they appropriately reconciled and the inventory tested further?

I:6 Variables Test of Unsealed Items – Verification Measurement

Objective

Determine whether any partial removal of SNM from items in the inventory has occurred such that a goal quantity of SNM is diverted. The removals may be classified as:

- Partial removal from a small number of items
- Partial removal from a small number of items where the removed SNM is replaced by non-SNM material or SNM of a lower attractiveness level
- Partial removal from all items
- Partial removal from all items where the removed SNM is replaced by non-SNM material or SNM of a lower attractiveness level.

Scenario

Obtain an inventory listing for an MBA, and select a goal quantity to be detected and a non-detection probability. Stratify the inventory and select a random sample. Check items for proper locations and data, and measure the items using an accepted measurement system.

Evaluation Criteria

- Were all selected items found?
- Were proper calibration checks performed on the measurement system prior to operation?
- Were the measurement results for the items within the documented acceptance/rejection criteria?
- Were proper steps followed to resolve any anomalies?
- If discrepancies were found, were they appropriately reconciled and was the inventory tested further?

I:7 Attributes Test of Sealed Items – Confirmatory Measurement

Objective

Determine whether inventory quantities are correctly stated by item and in total – i.e., whether the inventory is free of gross defects that total a stated goal quantity of SNM. A gross defect is defined as a difference between the stated and measured contents of an item that could not be normally attributed to measurement error.

Scenario

Obtain an inventory listing for an MBA, and select a goal quantity to be detected and a non-detection probability. Stratify the inventory and select a random sample. Check items for proper locations and data, and measure the items using an accepted measurement system.

Evaluation Criteria

- Were all selected items found?
- Was the TID integrity verified for each item?

- Were proper calibration checks performed on the measurement system prior to operation?
- Were the measurement results for the items within the documented acceptance/rejection criteria?
- Were proper steps followed to resolve any anomalies?
- If discrepancies were found, were they appropriately reconciled and was the inventory tested further?

I:8 Physical Inventory Anomaly Recognition

Objective

Determine whether the facility can resolve an anomaly that occurs during a physical inventory.

Scenario

Introduce an anomaly during a physical inventory. (The anomaly can be an extra item, a missing item, or a broken TID.)

Evaluation Criteria

- Was the physical inventory anomaly detected within the pre-determined timeframe?
- Were appropriate notifications made and corrective actions taken?
- Were procedures adequate to respond to the situation?

I:9 Reconciliation Verification

Objective

Determine whether the facility can reconcile a physical inventory.

Scenario

Conduct a records check of physical inventories that were completed previously. Alternatively, have the facility conduct a physical inventory and observe the inventory reconciliation through calculation of the ID. An anomaly can be introduced during the reconciliation as a means of verifying the facility's ability to reconcile properly. An item can be intentionally missed, an extra item can be inventoried, a value can be modified, or statistical sampling plans can be altered.

Evaluation Criteria

- Was the reconciliation completed in a timely manner?
- Were anomalies detected during the reconciliation?
- Were reconciliation procedures clear?
- Were appropriate corrective actions taken?
- Was the ID properly calculated?
- Was the ID properly reported and recorded in the nuclear material accounting records and to NMMSS?

I:10 Propagation of Variance Verification

Objective

Determine whether the limit of error of inventory difference (LEID) is properly calculated.

Scenario

Review the records for the LEID calculation. Trace variance data to original source data. Verify that covariances are properly accounted for.

Evaluation Criteria

- Was the LEID reported as stated?
- Were the major contributors to the LEID identified?
- Were the variances based on current data?
- Were covariances between measurements and between inventory terms properly accounted for?

I:11 Statistical Sample Generation

Objective

Determine whether the facility can generate a sample for the physical inventory in accordance with its procedures.

Scenario

Given the facility statistical sampling parameters, ask the facility to generate a sample inventory list. Alternatively, introduce an anomaly into the system (e.g., modify the statistical sampling parameters) and determine whether the facility can detect it.

Evaluation Criteria

- Was the list generated in a timely manner?
- Were procedures adequate to produce the statistical sample?
- If an anomaly was introduced, was it detected in a timely manner?
- Were appropriate corrective actions taken?

Appendix B: Statistical Sampling

INTRODUCTION

This appendix is used by material control and accountability (MC&A) assessors as a reference to support statistical calculations that may be required during a facility assessment. It is organized as follows:

Overview: A brief introduction to the application of statistical sampling during a facility assessment
Sampling Strategies: Considerations in using statistical sampling during an assessment
Formula for Variables Sampling: A simple formula for sample size determination
Table B-1: Confidence Intervals for Small Sample Sizes (Clopper-Pearson)
Table B-2: Ninety Percent Two-Sided Confidence Intervals for the Proportion of Defects

OVERVIEW

The first decision that must be made is determining whether or not a statistical sample is appropriate in testing a particular MC&A element. A statistical sampling plan provides an objective mechanism for evaluating specific criteria, but is not always warranted. Assessments are audits specifically chartered to evaluate the compliance of the facility. A single instance of non-compliance must be reported. Whether or not the single instance can be extrapolated to the entire facility must be based on additional investigation by assessors.

Statistical sampling plans can be used to assist in determining facility compliance. Assessors choose the appropriate statistical parameters, select the sample size, and determine the criteria for acceptance and rejection. Assessors then select the sample, conduct or have the test conducted, evaluate the results, and draw conclusions based on the results. The most difficult aspect of this process is determining valid acceptance and rejection criteria that are fair to both the facility and the assessment process and that can be completed during the assessment period.

Most sampling plans chosen in the assessment process are based on an acceptance number of zero—that is, no defects are acceptable. No defects are acceptable for two reasons:

(1) These plans provide a minimum sample size.

(2) The criteria being studied are of a critical nature, and in some cases, one defect is intolerable. As stated in Bowen and Bennett, *Statistical Methods for Nuclear Materials Management*:

> "The use of a zero acceptance number has considerable merit in audit and inspection applications. In many cases, the emphasis may properly be placed on uncovering errors, if they exist, rather than on attempting to discriminate between the acceptable and rejectable quality levels. In financial auditing, sampling plans of this type are called 'discovery sampling plans,' which is suggestive of their emphasis on finding errors rather than testing a hypothesis."

It should be noted that when a statistical sample is chosen and a failure is found, the single failure may not be indicative of an unsatisfactory rating. Similarly, if no defects are found, a satisfactory rating is not assured. The assessor must use judgment in evaluating the results of any test chosen. As can be seen from the Clopper-Pearson method for determining confidence levels from small samples (see Table B-1), the overall system probability of success is very broad when inferences are drawn from small samples. Thus, while a problem may be indicated, concluding that the overall system is defective based **solely** on the results of the sample may not be correct. Similarly, the absence of a problem may not mean that none exist, because a small sample has a low overall power of detection.

SAMPLING STRATEGIES

Assessors use statistical sampling plans to select elements of the site's MC&A system for testing. Some assessment activities where statistical sampling plans may be used include:

- Knowledge interviews/tests of facility personnel
- Tamper-indicating devices
- Portal monitors (special nuclear material and metal)
- Inventory verification
- Nuclear materials records audits.

Selection of a sampling plan and its attributes depends on the status of site compliance and the testing performed during internal assessments and site office surveys. If the site has compliance deficiencies (for example, lack of documentation), statistical sampling plans may be inappropriate because of the difficulties in identifying the population to test and developing mathematical models. If, by contrast, the element being tested by assessors has already been tested during internal assessments or site office surveys, then assessors would use limited sampling plans to verify that the internal assessments or site office testing was valid. A third situation that may occur is that the MC&A system is well characterized and fully operational but the site office has not implemented testing using statistical sampling. In this case, assessors may use statistical sampling to test randomly selected components with the intention of demonstrating the assurance provided by the site's program.

As previously discussed, focus areas are not always selected at random. This selection process is consistent with U.S. Department of Energy management's interest in the existence of deficiencies, rather than projections based on statistical sampling. If the identified deficiencies indicate potential vulnerabilities, the deficiencies would be interpreted in the context of the Site Safeguards and Security Plan. However, each assessment should use some random selection to ensure that all elements of the MC&A system have a non-zero probability of being assessed. Whether non-random sampling is used depends on assessment goals (e.g., identifying weaknesses or quantifying effectiveness).

FORMULA FOR VARIABLES SAMPLING

The generalized formula for calculating the sample size required from a population where zero is the acceptable acceptance number is:

$$N = N_0 * (1 - B^{Xg/M})$$

Where:

- N = Sample size
- N_0 = Number in total population
- B = Non-detection probability (probability of missing a defect)
- X = Average item weight
- g = Fractional defect detectable
  (e.g., $g = 1$ for attribute sample where item is classified as acceptable or unacceptable)
- M = Goal quantity for detection

Example:

$N_0 = 1000$
$B = 0.2$
$X = 400$ grams
$g = 1$
$M = 2{,}000$ grams
$N = 1000 * (1\text{-}0.2(400*1/2000)) \cong 1000 * (1\text{-}0.72) \cong 1000 * 0.28 \cong 280$ items

The two tables that follow are to be used as reference material during the assessment.

Table B-1. Confidence Intervals for Small Sample Sizes (Clopper-Pearson)

Sample Size	System Successes	≥90%	≥95%	≥99%
1	0	.000 < P < .950	.000 < P < .975	.000 < P < .995
2	0	.000 < P < .776	.000 < P < .842	.000 < P < .929
2	1	.025 < P < .975	.013 < P < .987	.002 < P < .998
3	0	.000 < P < .632	.000 < P < .708	.000 < P < .829
3	1	.017 < P < .865	.008 < P < .906	.002 < P < .959
4	0	.000 < P < .527	.000 < P < .602	.000 < P < .734
4	1	.013 < P < .751	.006 < P < .806	.001 < P < .889

Table B-2 shows 90 percent two-sided confidence intervals for the proportions of defects in a population for various sample sizes. This table was extracted from "Methodology for Sampling Classified Documents and Material Accountability Subsystems," June 1991.

Table B-2. Ninety Percent Two-Sided Confidence Intervals for the Proportion of Defects

Number of Defects	Sample Size			
	100	**125**	**150**	**175**
0	(.00000, .02951)	(.00000, .02368)	(.00000, .01977)	(.00000, .01697)
1	(.00051, .04656)	(.00041, .03739)	(.00034, .03123)	(.00029, .02682)
2	(.00357, .06162)	(.00285, .04951)	(.00237, .04138)	(.00203, .03554)
3	(.00823, .07571)	(.00657, .06086)	(.00547, .05088)	(.00469, .04371)
4	(.01378, .08920)	(.01100, .07173)	(.00916, .05998)	(.00784, .05154)
5	(.01991, .10225)	(.01589, .08226)	(.01322, .06881)	(.01132, .05913)
6	(.02645, .11499)	(.02111, .09254)	(.01756, .07742)	(.01503, .06654)
7	(.03331, .12746)	(.02657, .10261)	(.02210, .08586)	(.01892, .07382)
8	(.04043, .13972)	(.03224, .11251)	(.02681, .09417)	(.02295, .08097)
9	(.04776, .15180)	(.03807, .12228)	(.03165, .10236)	(.02709, .08803)
10	(.05526, .16372)	(.04404, .13192)	(.03661, .11046)	(.03133, .09500)
	200	**225**	**250**	**275**
0	(.00000, .01487)	(.00000, .01323)	(.00000, .01191)	(.00000, .01083)
1	(.00026, .02350)	(.00023, .02091)	(.00021, .01883)	(.00019, .01713)
2	(.00178, .03114)	(.00158, .02772)	(.00142, .02497)	(.00129, .02272)
3	(.00410, .03831)	(.00364, .03410)	(.00328, .03072)	(.00298, .02795)
4	(.00686, .04518)	(.00609, .04022)	(.00548, .03624)	(.00498, .03297)
5	(.00990, .05184)	(.00880, .04615)	(.00791, .04159)	(.00719, .03785)
6	(.01314, .05835)	(.01168, .05195)	(.01050, .04682)	(.00954, .04261)
7	(.01654, .06473)	(.01469, .05764)	(.01321, .05195)	(.01201, .04728)
8	(.02006, .07101)	(.01781, .06324)	(.01602, .05700)	(.01456, .05188)
9	(.02367, .07721)	(.02102, .06876)	(.01891, .06198)	(.01718, .05641)
10	(.02737, .08334)	(.02431, .07422)	(.02186, .06690)	(.01986, .06090)

Table B-2. (Continued)

Number of Defects	Sample Size			
	300	**325**	**350**	**375**
0	(.00000, .00994)	(.00000, .00918)	(.00000, .00852)	(.00000, .00796)
1	(.00017, .01571)	(.00016, .01451)	(.00015, .01348)	(.00014, .01259)
2	(.00119, .02084)	(.00109, .01924)	(.00102, .01788)	(.00095, .01669)
3	(.00273, .02564)	(.00252, .02368)	(.00234, .02200)	(.00218, .02055)
4	(.00457, .03025)	(.00421, .02794)	(.00391, .02596)	(.00365, .02424)
5	(.00659, .03472)	(.00608, .03207)	(.00565, .02980)	(.00527, .02783)
6	(.00874, .03909)	(.00807, .03611)	(.00749, .03355)	(.00699, .03133)
7	(.01100, .04338)	(.01015, .04007)	(.00942, .03724)	(.00879, .03477)
8	(.01334, .04760)	(.01231, .04398)	(.01142, .04086)	(.01066, .03816)
9	(.01574, .05177)	(.01452, .04783)	(.01348, .04444)	(.01258, .04151)
10	(.01819, .05588)	(.01679, .05163)	(.01558, .04798)	(.01454, .04481)
	400	**425**	**450**	**475**
0	(.00000, .00746)	(.00000, .00702)	(.00000, .00664)	(.00000, .00629)
1	(.00013, .01180)	(.00012, .01111)	(.00011, .01050)	(.00011, .00995)
2	(.00089, .01566)	(.00084, .01474)	(.00079, .01392)	(.00075, .01319)
3	(.00205, .01927)	(.00193, .01814)	(.00182, .01714)	(.00172, .01624)
4	(.00342, .02274)	(.00322, .02141)	(.00304, .02022)	(.00288, .01917)
5	(.00494, .02610)	(.00465, .02458)	(.00439, .02322)	(.00416, .02201)
6	(.00655, .02939)	(.00617, .02767)	(.00582, .02615)	(.00551, .02478)
7	(.00824, .03262)	(.00776, .03071)	(.00732, .02902)	(.00694, .02750)
8	(.00999, .03580)	(.00940, .03371)	(.00888, .03185)	(.00841, .03018)
9	(.01179, .03893)	(.01109, .03666)	(.01047, .03464)	(.00992, .03283)
10	(.01362, .04204)	(.01282, .03958)	(.01210, .03740)	(.01147, .03545)
	500			
0	(.00000, .00597)			
1	(.00010, .00945)			
2	(.00071, .01254)			
3	(.00164, .01543)			
4	(.00274, .01821)			
5	(.00395, .02091)			
6	(.00524, .02355)			
7	(.00659, .02613)			
8	(.00799, .02868)			
9	(.00942, .03120)			
10	(.01089, .03369)			

Appendix C: Tabletop Exercises

INTRODUCTION

This appendix provides a simplified list of potential tabletop exercises and two examples that can be conducted during a U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) assessment. Each example includes an objective, narrative, site staff needed, questions to be answered, master scenario event list, and draft cue cards. Additional details are developed during the assessment when specific facility requirements and procedures have been determined.

OVERVIEW

The first decision that must be made is determining whether or not tabletop exercises are appropriate for testing particular material control and accountability (MC&A) elements. The major advantages of tabletops often include:

- The ability to simulate activities that could take several days or weeks to perform (e.g., complete inventory or detailed measurement results)
- The ability to performance-test activities that take place in high radiation areas or in areas with excessive contamination
- The ability to test several people or groups of people in shorter periods of time, such as material balance area (MBA) custodians or material handlers
- An additional means of evaluating site MC&A performance
- An opportunity to train site personnel
- A means of identifying opportunities for improvement, thus allowing MC&A site personnel to begin to conduct their own tabletops and improve existing MC&A systems.

The purpose of the tabletop exercise is to collect data on the site's ability to resolve a hypothetical MC&A scenario and properly respond to any associated safeguards and security complications. This technique is used to determine the quality and completeness of response actions by involved personnel; the comprehensiveness of procedures and references used in performing response actions; and, if necessary, the availability of instrumentation, equipment, analytical tools, and other facility-related equipment. General instructions for participants are captured in Table C-1.

The performance tests documented in Appendix A can be accompanied by a tabletop exercise, such as those listed in Table C-2. From this list, two tests were selected and further refined to create two example tabletop exercises. Exhibit A is a blank tabletop scenario development form for use in generating additional tabletop exercises.

Table C-1. General Participant Instructions for Tabletop Exercises

1. You will be presented with a hypothetical scenario. During presentation of the scenario, utilize appropriate procedures, forms, and other documentation; describe your actions; and issue orders as though the balance of response forces were available.

2. Do not perform response activities, such as notifications. Simulate communications with other outside organizations by communicating with the controller, who will play the part of any person you may wish to contact.

3. The controller may have only a general knowledge of your facilities, design, procedures, and organization. Ask for additional information or clarification if you do not understand the information being presented.

4. To avoid confusion, not every indication or piece of information associated with the event scenario will be presented. Rather, only the substantive items necessary for response decision-making will be provided.

5. Do not be concerned about the realism or probability of events postulated in the hypothetical scenario. There are no tricks in the scenario. The auditor is simply trying to exercise the MC&A program.

6. Since some activities are time sensitive, the auditor will be observing clock times associated with some of your decision-making activities. Please state these important decisions in a timely manner.

7. Upon completion of the tabletop, please turn in any materials, notes, chronologies, etc.

8. Some time jumps/compressions may be interjected to maintain the flow of the ongoing scenario.

9. Explain to the controller what you are doing, but do not try to report what other MC&A participants might do.

10. You are encouraged to refer to your procedures to answer questions.

11. If non-participants have input, it can be provided quietly to a participant, but not interjected directly into the scenario.

Thank you for your participation.

Table C-2. Tabletop Exercise Candidates

Re-measure an item; test the performance of accountability measurements and reporting procedures when measurements are outside system specifications. (M:4)
Determine book shipper's values. (AC:1)
Examine internal transfers. (AC:10)
Determine the effectiveness of material control practices and procedures employed during an alarm/evacuation. (AD:3)
Determine the ability of personnel to respond to and properly resolve a missing special nuclear material item. (AD:2)
Determine whether inventory items are in their stated locations and whether inventory records accurately reflect the physical inventory; (I:3) talk through the scenario when an item is not in its assigned location or when an item to be transferred is not in its assigned location. (I:4)
Validate the facility controls to ensure that a Category II or III MBA cannot receive material that would increase the category level. (AC:6)
Determine whether the confirmatory or verification measurement program provides data of the quality required for the MC&A records. (M:5)
After locating a breach in the material access area boundary, determine whether security police officers or individuals conducting a daily administrative check (DAC) take the appropriate actions; the assessor should validate that part of the DAC is to identify breaches of barrier integrity. (C:1)
Examine the integration of material surveillance with the protective force and physical security systems.
Examine tamper-indicating device (TID) anomalies. (C:15)
Classify an MC&A anomaly. (DOE O 231.1B, Administrative Change 1, *Occurrence Reporting and Processing of Operations Information*)

Example A Tabletop Scenario: ITEM RE-MEASUREMENT

Objective: Given that an item has been re-measured and found to be outside limits, does the facility initiate the proper actions to resolve the measurement differences?

Narrative: An item has been re-measured. The result is significantly different from the original value. The facility rechecks the numbers, researches the results, and ensures that the measurement conducted is valid. The facility determines that an inventory difference (ID) should be booked. The facility should also determine when the item was first measured, what process area it was first generated in, and what the ID was during the inventory period when the item was first generated.

Site staff needed: Measurement personnel, MC&A person/manager, MBA custodian, and possibly a statistician and a technical MC&A individual.

Questions:

1. Does the facility recognize that the re-measurement is significantly different from its original value? (How was this determined?)

2. Does the facility take the appropriate actions when the difference is identified (i.e., research the item, examine the measurement system to ensure it is in control, collect TID history, re-measure the item)?

3. Did the facility evaluate the impact of the re-measured result and the associated ID on the ID for the inventory period when the item was first measured? Does this impact make the ID for the first measured value inventory period significant? If it was significant, was DOE notified?

4. Were other similar items examined to determine whether there is additional facility impact?

Master Scenario Event List

Scenario Input (Verbal or Text Message)	Expected Outcome
Cue 1: Select an item for measurement. (We must know what the original value is and its uncertainty; what the new value is and its uncertainty; what the combined uncertainty is; what the ID and limit of error of the ID were when the item was generated; the TID history; what kind of item it is; and how the item will be measured.)	Determine how the item will be re-measured. Describe the measurement procedure, discussing calibration of method, control limits, measurement control, etc.
Cue 2: Measurement result is outside the warning limit (WL)/alarm limit (AL).	Recheck numbers; recheck calibration and re-measure.
Cue 3: Re-measurement remains outside WL/AL limits.	Notify MC&A. Perform a historical check of the item. Check the TID history. Is the TID the original?
Cue 4: MC&A has researched the item and finds no historical reason why the measured value has changed. (If an item from a production lot is selected, then other items in that lot should be reviewed prior to the end of the tabletop.)	Determine that an ID should be booked. Book the ID. Review the ID for the inventory period when the item was generated to see if it would have exceeded limits in the prior period. Check whether other similar items exist that should be evaluated. (Measurement results of additional items should confirm book value.)
Cue 5: Previous ID period is evaluated and found to exceed WL and AL.	Notify DOE.

Draft Cue Cards

1. You have just been asked to re-measure item 123 at the request of EA. The item had an original value of y_{old}. What actions do you take?

2. The new value is y_{new}.

3. The uncertainty of y_{old} is $y_{olduncertain}$ and of y_{new} it is $y_{newuncertain}$. What actions do you take now?

4. The historical research has been completed. The TID has not been changed, and no unusual events were discovered during your research.

5. You have evaluated the impact of the ID from the period when the item was first generated. This evaluation indicated that, based on the difference observed, the ID for the inventory period now exceeds its WL/AL. What actions do you take?

Example B Tabletop Scenario: BOOK SHIPPER'S VALUES

Objective: Determine whether the site takes the appropriate actions when a shipment is received from off site, receipt measurements are made, and a significant shipper/receiver difference occurs.

Narrative: A DOE/Nuclear Regulatory Commission Form 741 and associated backup data are prepared. The 741 is presented to the site, and a receipt procedure is requested. Raw receiver's data is then presented to the site. The site states that receipt measurements are made, and the receipt measurement data and uncertainties are presented. A significant difference is identified and resolved by the site.

Site staff needed: Accounting clerk, MC&A manager, receipt personnel, and measurement personnel.

Master Scenario Event List

Scenario Input (Verbal or Text Message)	Expected Outcome
Cue 1: Complete Form 741 with shipper's values and associated backup data.	Explain initial receipt activities at warehouse. Review shipper/receiver agreements, if any.
Cue 2: Check raw receiver's data and receipt documentation; piece-count, TIDs, values etc. all agree. Data should be equivalent to what the site uses. Identify the internal transfer mechanism that the site uses.	Validate the data. No problems exist in observed/weight difference. Receive internal transaction for receipt into warehouse.
Cue 3: When will accountability measurements be performed?	How will 741 be closed? (A-E transactions)
Cue 4: Receivers measure values; two of the items agree in value, and one item will be outside limits. A significant shipper/receiver difference exists.	Determine whether the difference is significant. Discuss reconciliation process.

Draft Cue Cards

1. "Here's a 741 and associated shipper's backup data. What actions are taken for this receipt at your facility?"
2. Present the site with receiver's initial raw data receipt check information (gross weight, TID check result, number of items, etc.).
3. Describe your plan to close this 741.
4. Present receiver's measured values with uncertainties. ("What actions will you take?")

Exhibit A: BLANK TABLETOP SCENARIO DEVELOPMENT FORM

Tabletop Scenario:

Objective:

Narrative:

Site staff needed:

Questions:

Master Scenario Event List

Scenario Input (Verbal or Text Message)	Expected Outcome
Cue 1:	
Cue 2:	
Cue 3:	
Cue 4:	
Cue 5:	

Draft Cue Cards

1.

2.

3.

Appendix D: Assessing Sites with Only Category III and IV Material Balance Areas

With the downsizing of the U.S. Department of Energy (DOE) complex, an increase in the number of sites that contain only Category III and/or IV quantities of accountable nuclear materials is anticipated. Assessments of the material control and accountability (MC&A) programs at these sites have specific considerations based on changing missions and the graded safeguards approach documented in the site MC&A Plan. Along with being assessed less frequently, most program elements with Category III and IV quantities will require less time to assess than if they contained Category I or II quantities. Areas where significant changes have occurred since the last assessment, including issues raised in recent site office surveys, and the system for controlling rollup could merit increased focus.

The following table provides focus areas for assessing sites with only Category III and IV material balance areas, and includes requirements from DOE Orders 474.2, Change 4, *Nuclear Material Control and Accountability*, and 473.3A, *Protection Program Operations*. Additional guidance can be found in DOE-STD-1194-2011, Table 6.2-5, Nuclear Control Measures for Category III SNM, and Table 6.2-6, Nuclear Material Control Measures for Category IV Nuclear Materials.

Focus Areas for Assessing Facilities with Only Category III and Category IV Material Balance Areas

Activity	Category III	Category IV
Site Office Guidance	Review for clarity and specificity of requirements.	
Site Office Survey	Review to ensure that surveys are comprehensive and include major MC&A components. Deficiencies are identified and graded.	
Design Basis Threat/Graded Security Posture (DBT/GSP)	Ensure that the site has adequately addressed the concerns of the DBT/GSP, including assignment of the correct threat level and the capabilities of the insider and outsider.	
MC&A Plan	A comprehensive MC&A Plan must be approved by DOE line management and must specify how accountable materials are going to be accounted for and controlled on a graded safeguards basis.	
Rollup Analysis	Ensure that the MC&A program monitors against rollup outside appropriate security areas.	
Site Security Plan	Ensure that control and surveillance requirements are met in the MC&A Plan.	
SNM Categorization	Table C, DOE Order 474.2, Change 4, Graded Safeguards Table, should be followed.	
Accountability Values	Shipper's values can be accepted when approved by DOE line management.	
Accounting System	Ensure data is accurate and timely to confirm that a planned move will not exceed the approved category level.	

Activity	Category III	Category IV
Measurements	Ensure measured values with uncertainties are able to support detection of theft and diversion.	
In Use or Processing Security Area	Ensure that an access-controlled security area is provided within the Limited Area and that it has approved security procedures.	Ensure that a property protection area is provided and that it has approved security procedures.
Storage Security Area	The Limited Area should include a locked security container or room under intrusion detection, or an eight-hour patrol.	The property protection area should include a locked area and procedures that are documented in the Site Security Plan.
Physical Inventory Frequency	Frequency should be at least every two years.	
Safeguards Termination	Termination must be attractiveness E based on valid measurements, and materials must not be comingled.	

Appendix E: Interview Questions

INTRODUCTION

This appendix includes typical questions that assessors can ask when interviewing material balance area (MBA) custodians, tamper-indicating device (TID) administrators, material control and accountability (MC&A) managers, facility managers, and others during routine assessment interviews.

MBA Custodian Interview Questions

1. For what MBA(s) are you the custodian?
2. What line organization do you work for?
3. How long have you been an MBA custodian? Same MBA?
4. What is the function of this MBA?
5. What kinds of nuclear materials are contained in the MBA?
6. What is the category of the MBA?
7. For Category I MBA:
   - Containment features?
   - Access procedures?
   - Surveillance procedures?
   - Daily administration check procedure?
8. Do you have procedures for this MBA? Where are they maintained?
9. Do you assist in preparing the procedures?
10. Do you have access to any procedures other than your MBA procedure?
11. Do you have an inventory listing of nuclear materials in your MBA?
12. Do you assist in taking the physical inventory?
13. In the event an item has not been located during a physical inventory in your facility, do you know what the applicable procedures are? Do you know what the appropriate reporting protocols are?
14. When was the last inventory conducted of your MBA?
15. What kind of training have you received?
16. Do you get refresher training? How?
17. Are TIDs used in your MBA? Applicator? Witness?
18. What is the frequency of activity in your MBA?
19. How are transactions involving your MBA recorded in the MC&A accounting records? Transfers and receipts? TID removals and application? Measurement results?
20. When was the last self-assessment conducted of your MBA?
21. Are you the custodian for other MBAs?
22. Who is your alternate?
23. What was your job before you became an MBA custodian?
24. If there was one thing you would want to change about your job, what would it be?

TID Administrator Interview Questions

1. How long have you been the TID administrator?
2. Who is your alternate?
3. What kind of training have you received?
4. Do you get refresher training? How? How often?
5. Do you have procedures detailing your responsibilities as TID administrator?
6. Do you assist in preparing the procedures?
7. What types of TIDs are used at your facility?
8. How many TIDs are typically used monthly or annually? Are you comfortable performing these activities?
9. What's the process you use to order new TIDs?
10. Do you have certification from the TID vendor(s) that TIDs being procured are unique to your facility and will not be reproduced for others?
11. Where do you store unused TIDs?
12. Who has access to your storage area?
13. How do you issue your TIDs to TID custodians?
14. How do you verify that TID custodians are authorized to receive TIDs from you?
15. How are TID application or removal activities recorded?
16. What happens to the application and removal records (forms)?
17. Do you validate that only authorized personnel apply or remove TIDs?
18. What happens if an unauthorized person applies a TID?
19. How are application or removal transactions involving your TIDs recorded into the MC&A accounting records?
20. What happens to TIDs that are removed or voided?
21. Do you have an inventory listing of TIDs in your control?
22. How often do you take an inventory of your TIDs?
23. When did you conduct the last inventory of your TIDs?
24. Who do you report the inventory results to?
25. How do you handle discrepancies in the TID inventory?
26. If there was one thing you would want to change about your TID administrator job, what would it be?

TID Custodian Interview Questions

1. For what group, area, or MBA are you the TID custodian?
2. What line organization do you work for?
3. How long have you been a TID custodian?
4. Do you have other job duties besides TID custodian?
5. Who is your alternate?
6. What kind of training have you received?
7. Do you get refresher training? How? How often?
8. What types of activities occur in your area or MBA?
9. What types of TIDs are used in this area?
10. How many TIDs are typically used monthly?
11. Do you have procedures detailing your responsibilities as TID custodian?
12. Do you assist in preparing the procedures?
13. Where do you store unused TIDs?
14. Who has access to your storage area?
15. Who is your TID administrator?
16. How do you receive your supply of TIDs from the TID administrator?
17. How do you keep track of TIDs received from the TID administrator?
18. How do you issue your TIDs to applicators?
19. How do you verify that applicators are authorized to receive TIDs from you?
20. How are TID application or removal activities recorded?
21. What happens to the application and removal records (forms)?
22. Do you validate that only authorized personnel apply or remove TIDs?
23. What happens if an unauthorized person applies a TID?
24. How are application or removal transactions involving your TIDs recorded into the MC&A accounting records?
25. What happens to TIDs that are removed or voided?
26. Do you have an inventory listing of TIDs in your control?
27. How often do you take an inventory of your TIDs?
28. When did you conduct the last inventory of your TIDs?
29. Who do you report the inventory results to?
30. How do you handle discrepancies in the TID inventory?
31. If there was one thing you would want to change about your TID custodian job, what would it be?

Facility Manager Interview Questions

1. How much interaction do you have with the MC&A Manager and MC&A personnel?
2. How involved are you with the implementation of the MC&A program?
3. Have you received any MC&A training? If so, what training?
4. How many MBAs are in your facility? What are their category levels?
5. Do you assign MBA custodians for the MBAs? Are they approved by MC&A?
6. Have you had any incidents involving MC&A-related issues, e.g., inventory differences, missing items, missing/broken TIDs, shipper/receiver issues?
7. Describe your involvement in the physical inventory process from cleanout through reconciliation.
8. Are you involved in item adjustments that may occur during an inventory period?
9. Do you have any suggestions to improve the MC&A program?

Appendix F: MC&A Assessment Objectives

INTRODUCTION

The following matrix was established using performance metrics described in Attachment 3 of U.S. Department of Energy (DOE) Order 474.2, Change 4, *Nuclear Material Control and Accountability*. However, the metrics have been grouped according to specific assessment objectives that may be used by an assessor to evaluate the performance of selected elements of a facility's Material Control and Accountability (MC&A) program. Typical assessment methodology used to evaluate each assessment objective is also provided.

Assessment objectives are sorted by each MC&A subtopic and designated according to the following nomenclature:

IO-P Program Management
IO-C Material Control
IO-M Measurements
IO-A Material Accounting
IO-I Physical Inventory

These metrics should be supplemented by any alternative metrics included in a facility's approved MC&A Plan, and by other performance criteria, such as those documented in the DOE Technical Standard for MC&A, DOE-STD-1194-2011, *Nuclear Materials Control and Accountability.*

Assessment Objective	Program Management Metrics	Assessment Methodology
IO-P-1 Ensure that site management provides sufficient focus and resources to adequately safeguard nuclear material.	1.a. The program management element of Material Control and Accountability (MC&A) focuses on the scope and effectiveness of management relative to program planning, policy implementation, and program review to assure that a graded, cost-effective MC&A program is implemented. 1.h. Management structure and assignment of duties and authorities are clearly defined. 1.i. Persons responsible for each MC&A function have sufficient authority to effectively implement their responsibilities. An individual does not have sole authority to oversee, evaluate performance, or audit information for which he/she is responsible. 1.j. The MC&A program is sufficiently independent of operations to ensure that accounting data and reports provided by operation organizations are complete and correct. 1.l. The level of resources and personnel necessary to maintain an effective MC&A program are identified, and are available to implement and maintain the program.	• Review the Site Security Plan (SSP), MC&A Plan, facility-level policies and procedures, and other high-level program documents. • Review facility and MC&A organizational charts to ensure key positions are identified. • Assess MC&A staffing levels. • Interview MC&A and program managers to evaluate the facility's commitment to a strong MC&A program.
IO-P-2 Ensure that special nuclear material (SNM) quantities and categories are accurately characterized and appropriate levels of protection are provided.	1.b. The graded safeguards concept is used to provide the greatest relative amount of control and accountability for the types and quantities of SNM that can be most effectively used in a nuclear explosive device. (SEE MATERIAL CONTROL.) 1.u. Characterization of MC&A in the SSP is accurate and validated. 1.v. MC&A personnel validate key Vulnerability Assessment (VA) parameters affecting MC&A implementation. (SEE MATERIAL CONTROL.)	• Evaluate the site's protection strategies (as described in the SSP and MC&A Plan) to ensure that they are appropriate based on SNM attractiveness and categories. • Review material balance area (MBA) category levels and SNM quantities. • Evaluate controls to ensure that approved category levels are not exceeded. • Determine whether site MC&A personnel participated in development of the VA, including evaluation of any assumptions that were made.

Assessment Objective	Program Management Metrics	Assessment Methodology
IO-P-3 Ensure that the MC&A program is adequately documented and approved by DOE.	1.c. Plans/procedures are established that define operations for all MC&A program elements and include the utilization of resources during implementation. The MC&A Plan provides the safeguards authorization basis for the site/facility operator. 1.e. The MC&A Plan includes descriptions of all MC&A program elements. 1.g. The MC&A Plan describes the program objectives and how the objectives will be met. During review of the MC&A Plan, DOE line management evaluates the effectiveness of program implementation in meeting the stated objectives by requesting and then reviewing performance tests. 1.d. Configuration management of the MC&A Plan and associated procedures is maintained, and the MC&A Plan reflects current operating conditions. 1.x. Changes to site operations are evaluated for impact to MC&A programs prior to implementation. 1.z. The MC&A system provides a complete audit trail for all nuclear materials from receipt through disposition. Records are maintained in compliance with DOE standards. (SEE MATERIAL ACCOUNTING.)	• Review the MC&A Plan, implementing procedures, the SSP, training plans, and other MC&A documents to ensure that DOE order requirements are appropriately addressed by site programs. • Ensure that DOE has approved the current MC&A Plan. • Determine whether DOE compiled performance testing data prior to approving the MC&A Plan. • Ensure that documents, including those used by field personnel, are current and have received appropriate review/approval by the MC&A organization. • Review document revision processes to ensure that revisions are appropriately controlled and requirements are not reduced without appropriate justification. • Review changes to processes and operations since the previous assessment, and ensure that MC&A impacts have been evaluated.
IO-P-4 Ensure that personnel are trained and qualified to perform MC&A-related activities.	1.k. Requirements for MC&A training are established to meet Department requirements and ensure that personnel with MC&A functions are trained and knowledgeable of their duties and responsibilities.	• Review site and Departmental training program documentation, including qualification criteria, lesson plans, and training records. • Ensure that MC&A training addresses key requirements, has appropriate MC&A approvals, and is current for personnel performing key activities, including MBA custodians, tamper-indicating device (TID) appliers, measurement technicians, and material handlers. • Conduct custodian interviews to assess knowledge of MC&A program objectives and requirements. • Observe performance of MC&A duties by measurements personnel, TID appliers, accounting personnel, and other key MC&A positions to evaluate competency and compliance with approved procedures.

Assessment Objective	Program Management Metrics	Assessment Methodology
IO-P-5 Ensure that the effectiveness of the MC&A system is periodically verified.	1.m. Performance goals are established for each defined program element that, when met, clearly demonstrate that program objectives are met. 1.o. The overall MC&A system effectiveness is evaluated using a methodology that considers each MC&A program element, its importance to overall system effectiveness and performance, and its interaction with other program elements. 1.p. The effectiveness of each program element and the overall system is determined at a defined frequency, and evaluation of effectiveness uses objective performance criteria such as risk assessments, performance testing results, and an evaluation of practice versus procedure. 1.q. Internal review and assessment and performance testing programs are defined that have elements of schedule, comprehensiveness, conduct, evaluation, reporting, and follow-up. Performance testing of essential elements is addressed. Essential elements are defined at each site based upon mission, operations, and material.	• Review documentation of the site's MC&A system effectiveness model. • Determine whether the site has a comprehensive performance testing program that demonstrates the effectiveness of particular program elements. • Evaluate whether testing is performed at frequencies specified in MC&A program documentation. • Evaluate performance test results to identify possible problem areas and site responses to deficiencies. • Review internal assessments, self-assessments, incident reports, and other data that reflect the performance of the MC&A system. • Review the site's corrective action program and the status of responses to issues identified during performance tests, audits, surveys, etc. • Review DOE site office survey reports. • Conduct performance tests.
IO-P-6 Ensure that systems are established to maintain accountability of SNM.	1.f. Key measurement points are established during design of facilities or process systems, or changes to process lines, and documented in project documentation. Key measurement points are included in operational (process and transfer) procedures. (SEE MEASUREMENT AND MEASUREMENT CONTROL.) 1.y. The MC&A program includes a provision for maintaining MC&A systems in fully operational status when needed, and includes documentation of maintenance, calibration, and recalibration.	• Review measurement systems and internal/external transfer controls. • Evaluate shipper/receiver (S/R) difference data, inventory difference (ID) data, process monitoring, and other indicators of control of SNM as it is handled/processed at the site. • Review measurement control processes and data, including calibration records. • Review the actions the site takes when systems are determined to be out of control.

Assessment Objective	Program Management Metrics	Assessment Methodology
IO-P-7 Ensure that detection systems are in place to respond to and report potential losses of SNM.	1.n. The responsibility of each program element in deterring the loss or misuse of nuclear material is defined. 1.r. The MC&A program contains a formal process for responding to material loss indicators, anomalous conditions, and degradation of system performance. 1.s. The MC&A program responds appropriately to off-normal events both during normal operating conditions and during performance tests. 1.t. Potential or actual incidents or events of MC&A concern are appropriately reported. 1.w. Deficiencies or anomalies identified in the MC&A program are reported to all affected organizations. (SEE MATERIAL CONTROL.)	• Evaluate the MC&A Plan and procedure documents to determine how material loss indicators are assessed. • Review the development and application of control limits for IDs, S/R differences, unit processes, and measurements to determine whether an appropriate statistical methodology is being used. • Evaluate the history of MC&A incidents, including those occurring during both routine and emergency conditions. • Review reporting history to ensure that DOE was notified, if appropriate. • Conduct tabletop exercise(s) to evaluate MC&A responses to anomalous conditions.

Assessment Objective	Material Control Metrics	Assessment Methodology
IO-C-1 MBAs are defined, personnel responsibilities are defined, and internal controls are implemented.	2.a. MBAs are established so that an MBA does not cross a material access area (MAA) boundary unless alternative measures are described in the MC&A Plan, and the responsibility for all additions, removals, and inventory of nuclear materials is vested in an individual, the MBA custodian. 2.b. Inter-MBA transfers of nuclear materials must be independently checked to ensure that the transfer is authorized and that the material being transferred agrees with the accounting data. 2.c. An MBA custodian, unless alternative measures are described in the MC&A Plan, must not be responsible for multiple MBAs when transfers of nuclear material occur between those MBAs (i.e., a single custodian must not serve as both shipper and receiver for material transfers for the same nuclear material). 2.h. Access to nuclear materials is limited to authorized individuals and authorized actions.	• Identify the location, boundaries, and category designation of each MBA. • Determine whether the facility's MBA structure is capable of localizing IDs. • Ensure that procedures specify administrative controls, material flows, material transfer procedures, and measurement requirements for material crossing MBA boundaries. • Review the equipment and procedures used to control access to material in MBAs. • Interview or test custodians and alternates to determine whether they are knowledgeable of the procedures, process, and requirements. • Compare the list of personnel authorized to ship or receive with the signatures on the actual transfer forms. • Examine how access to nuclear materials, accountability data, and items or equipment vital to the MC&A program is controlled. • Examine access authorization lists, entry controls, personnel identification and verification systems, and access logs. • Ensure that excess materials are not stored in processing areas but in appropriate storage repositories equipped with mechanisms to limit access to authorized individuals. • Observe entry/opening of MC&A storage areas.

Assessment Objective	Material Control Metrics	Assessment Methodology
IO-C-2 Ensure that systems are in place to detect the loss or diversion of SNM in a timely manner.	2.d. The site/facility operator can demonstrate that a loss of a Category I quantity will be detected within sufficient time to allow effective reporting and execution of response measures, with 95 percent probability unless otherwise specified in the SSP. (For example, the SSP may describe other measures in place to mitigate the lack of detection capability.) 2.e. Losses must be localized to a specified area. The site/facility operator defines loss detection capability, including the probability of detecting the theft of a specified quantity within a specified timeframe, and justifies this approach in the SSP. 2.f. Control measures are in place for nuclear material in use and in storage that deter, detect, assess, and report loss or misuse. The control measures include defining the required communications. 2.j. Process differences and item losses or gains that exceed identified thresholds are detected and resolved.	• Review the assumptions in the SSP related to the MC&A role in loss detection. • Review the MC&A Plans and procedures related to loss detection and assessment. • Review resolution of any significant IDs within the last two to three years. • Review the disposition of any instances of Category I material being found in an unauthorized location. • Review the resolution of any process or item monitoring alarms that involved Category I quantities. • Conduct performance tests/tabletops to evaluate response to anomalous conditions. • Examine resolution of container quantities of Category I material that were identified with compromised TIDs. • Review the facility's TID program and determine whether the program contains all of the elements specified in the order. • Coordinate and integrate with the Office of Enterprise Assessments (EA) systems team for checking portal monitors and vault alarms. • Review the disposition of any unlocked Category I storage areas and determine whether appropriate MC&A actions were taken in a timely manner. • Review the process monitoring methodology and validate implementation. • Examine how process limits are determined. • Review how alarm situations are identified and resolved. • Review and evaluate the effectiveness of waste monitoring equipment. • Validate that all waste streams are monitored. • Observe daily administrative check (DAC) practices in selected MBAs to verify compliance with procedures.

Assessment Objective	Material Control Metrics	Assessment Methodology
IO-C-3 Ensure that category limits are observed.	2.g. For Category II, III, and IV MBAs, the MC&A program routinely monitors the movement of SNM to prevent rollup from occurring outside appropriate security areas. (SEE PROGRAM MANAGEMENT.)	• Evaluate the effectiveness of facility procedures for rollup calculations and pre-approving internal transfers. • Performance-test the effectiveness of procedures by attempting a transfer that would violate the category of an MBA. • Examine whether a Category II MBA outside of an MAA can roll up to a Category I MBA.
IO-C-4 Ensure that a graded approach is in place for SNM use, storage, and protection.	2.i. The Graded Safeguards Table (Attachment 2, Table C) is used to categorize nuclear materials and their locations. (SEE PROGRAM MANAGEMENT.)	• Select MBAs, review accounting records, and validate material categorization.
IO-C-5 Ensure that the termination of safeguards is properly applied to designated material.	2.k. The mechanism for termination of safeguards is documented and implemented. 2.l. Controls on nuclear material located within an MBA are only terminated when approved by DOE line management. 2.m. Nuclear materials for which safeguards have been terminated are not collocated with accountable nuclear materials, and are written off the books by a transfer to a waste reporting identification system (RIS). The waste organization RIS is under the control of a waste management or decontamination and decommissioning organization where the material is accounted for and protected in accordance with DOE waste management regulations. 2.n. Until DOE line management has approved termination of safeguards for a facility, the MC&A program is maintained at a level commensurate with the category and attractiveness of the material deemed to have been present.	• Review the material categorization of material listed as terminated for safeguards. • Examine the termination-of-safeguards documentation for the necessary reviews and approvals. • Examine the storage areas for termination-of-safeguards items to ensure that accountable nuclear material is not collocated with terminated materials.
IO-C-6 Ensure that a comprehensive TID program is established and implemented.	2.o. When a facility uses TIDs for MC&A purposes, they are procured, stored, distributed, and applied according to a documented program.	• Conduct front/back checks. • Observe and verify: storage, application, removal, destruction, and issue controls. • Test response to TID violation. • Review acquisition and procurement.

Assessment Objective	Material Control Metrics	Assessment Methodology
IO-C-7 Ensure that transfer and shipments of SNM include appropriate controls and documentation.	2.p. When shipping nuclear material, an accountability value is established or a previously established accountability value is confirmed if the material has been contained in a vault under effective material surveillance measures. 2.q. For external transfers, the shipper obtains written verification and maintains documentation that the intended receiver is authorized to accept the material before it is transferred. 2.r. S/R differences that involve item losses or gains or exceed identified thresholds are detected and resolved.	• Review how accountable values are assigned to materials being shipped or transferred. • Review verification that the receiver is authorized for offsite shipments. • Examine the evaluation of S/R differences.
IO-C-8 Ensure that controls are in place to prevent unauthorized removal of SNM in waste streams.	2.s. Waste streams are monitored using methods capable of detecting diversion of SNM. (SEE MEASUREMENTS AND MEASUREMENT CONTROL.)	• Review calibration data for monitoring equipment. • Verify that calibration checks are performed as required. • Validate that standards used for calibration are appropriate for the material stream being monitored.

Assessment Objective	Measurements Metrics	Assessment Methodology
IO-M-1 Ensure that the technical basis of measurements and measurement uncertainty are qualified, validated, documented, and approved by DOE.	3.a. The quantity of all nuclear material types present on inventory is determined using identified measurement systems, measurement services, technically justified values, or accepted shipper's values when approved by DOE line management. 3.b. Measurements and measurement uncertainties are determined and reported for each measured value using methodologies and statistical terminology accepted by voluntary consensus standards bodies. Other methodologies are only used with sufficient justification and approved in the MC&A Plan. 3.g. Measurement methods are qualified, formally documented, periodically validated, and approved in the MC&A Plan. 3.i. Capability exists to confirm type and quantity of nuclear material present. For each type of nuclear material at the site, measurement methods are identified that are capable of confirming the presence of nuclear materials and verifying nuclear material quantities. Nuclear materials not amenable to verification measurement must be identified and documented in the MC&A Plan. 3.o. The technical basis for the measurement and measurement control program is documented, and the documentation is either included or referenced in the MC&A Plan.	• Review the MC&A Plan, measurement procedures, training records, qualification, and validation reports. • Verity that measurement methods used for accountability purposes are qualified and the qualification is documented. • Ensure that measurements are periodically validated and results are reviewed for timeliness and accuracy. • Observe training. • Review the measurement training plan to ensure that training includes performance of the measurement method(s). • Review Not Amenable To Measurement list and justifications. • Ensure that accuracy and precision goals focus on measurement methods used for the most attractive and largest material flows. • Observe verification and confirmation (if used) measurements.
IO-M-2 Ensure that the sources of significant measurement uncertainty, including sampling errors are identified and used to estimate random and systematic errors.	3.c. Sources of measurement error that are key contributors to the total measurement limit of error for a material balance period are identified and used to estimate systematic and random errors. 3.h. Potential sources of sampling error for bulk measurements are identified, and samples are representative of the materials being sampled. If sampling is required to establish accountability measurements, the program describes how the representativeness/homogeneity is determined and periodically tested or updated.	• Review limit of error of inventory difference (LEID) and shipper/receiver (S/R) calculations. • Review inventory reports for key measurement methods to be further evaluated for uncertainty analysis, audit trail, and sampling studies for bulk samples. • Ensure that repeat measurements, inter-comparisons, and standards are used to establish precision and bias estimates for each measurement method. • Review certification of standards. • Ensure that standard uncertainty is less than the target value.

Assessment Objective	Measurements Metrics	Assessment Methodology
IO-M-3 Ensure that a statistically based measurement control system is implemented.	3.d. The proper functioning of measurement systems is checked against standards before use in accordance with approved procedures. 3.m. A methodology exists for ensuring that measurement systems are in control when accountability measurements are made, and evidence exists that accounting values are established only when measurement systems are in control. 3.n. A statistical control system exists that includes establishing control limits, determining out-of-control conditions, returning control to out-of-control measurement systems, and analyzing trends and outliers.	• Review control charts for documentation of situations and trends representing out of control and return to control. • Determine whether limits, including confirmation measurement acceptance/rejection criteria, are based on statistical evaluation of data.
IO-M-4 Ensure that key measurement points are established and included in operations procedures.	3.e. Key measurement points are established during construction of or changes to process lines, and documented in project documentation. Key measurement points are included in operational (process and transfer) procedures. (SEE PROGRAM MANAGEMENT.)	• Evaluate processing and transfer MBAs for measurements made.
IO-M-5 Ensure that uncertainties are appropriate and routinely verified to be consistent with approved target values.	3.f. The site/facility operator demonstrates that uncertainties remain applicable and are consistent with target values established by the site. 3.l. The measurement program identifies target values for each MC&A measurement method, referencing national and international sources as applicable, and defines the methodology, including frequency, by which uncertainties are compared to the target values and performance is assessed.	• Independently verify random and systematic errors with site data and compare to target values. • Conduct performance tests on verification measurements and ensure that uncertainty meets target values.
IO-M-6 Ensure that measurement systems, including traceable standards, are calibrated and re-calibrated on a defined frequency.	3.j. Measurements are traceable to the National Institute of Standards and Technology or New Brunswick Laboratory standards. 3.k. Measurement systems are calibrated on a defined frequency, including the frequency and methodology for recertifying the measurement standards.	• Review instrument calibration and re-calibration procedures and results. • Review records of standards procurement, traceability, and performance, ensuring that standard uncertainty is well characterized. • Determine whether standard re-certifications are performed within the allowed period of time.

Assessment Objective	Material Accounting Metrics	Assessment Methodology
IO-A-1 Ensure that accurate records of nuclear materials are maintained, and transactions and adjustments are made.	4.a. Shipments, receipts, transfers, changes in physical form, chemical/isotopic composition, location, and adjustments of the site nuclear material inventory are approved and accurately recorded, and entered into the accounting system within a site-specific defined timeframe. 4.e. Accounting system data is sufficiently accurate and timely to confirm that a planned movement of nuclear materials would not exceed the approved category level. (SEE MATERIAL CONTROL.) 4.f. Inventory adjustments are calculated and evaluated according to a defined methodology. 4.g. The accounting system provides continuity of knowledge for nuclear materials from receipt through disposition by maintaining an audit trail that includes documentation of transfers, adjustments, measurement results with measurement method, the identity of individuals making changes to the accounting system, and the date and time such changes are made. Entries are fully supported by source documentation. 4.h. Accounting and source records for physical inventory listings include item identification, material type, form, quantity with uncertainty, attractiveness, location, gross weight, net weight, isotope, element concentration, and enrichment for nuclear materials in all MBAs, as appropriate for the types and quantities of material held at the site. 4.i. The accuracy of the accounting system is determined annually using a statistically valid methodology and provides 95 percent confidence that there are no more than 1 percent errors. 4.m. Accounting information is sufficient for calculating S/R differences and IDs, evaluating their significance, and investigating and resolving significant differences.	• Examine procedures for approval and input of transactions into the accounting system. • Examine procedures for review and approval of adjustments to the inventory (normal operating loss, decay, etc.). • Review source documents for data adequacy and approvals. • Examine inventory adjustment records for supporting technical data and appropriate approvals. • Review records to ensure that transactions are input within approved timelines. • Observe nuclear material clerks and MBA custodians/alternates entering transactions. • Review transfer data for timeliness of input and for documentation that transfer checks and measurements are completed. • Review data from measurement systems to verify that data is entered into the accounting system accurately and in a timely manner. • Examine source documents for completeness and accuracy of data. • Observe generation of audit trails, including laboratory audit trails. • Conduct performance tests that simulate violation of MBA categorizations. • If input to the accounting system, review TID data for accuracy. • Review any performance testing conducted on the accounting system. • Perform front/back checks of items on inventory/TIDs. • Examine procedures that technical and accounting personnel use for calculating and reviewing S/R differences and IDs. • Examine records of S/R and ID calculations and reviews. • Examine inventory reconciliation records for supporting documentation and approvals. • Review Generally Accepted Accounting Principles compliance.

Assessment Objective	Material Accounting Metrics	Assessment Methodology
IO-A-2 Ensure that account structures are established and maintained.	4.b. At least one RIS is established for the site with an assigned nuclear material representative who is responsible for reporting data to the Nuclear Materials Management and Safeguards System (NMMSS). 4.c. Each site has established a set of MBAs. All accountable quantities of nuclear material at the site are assigned to an MBA unless safeguards have been terminated in accordance with safeguards termination requirements. 4.d. Each MBA has an assigned MBA custodian and defined key measurement points for transfers and inventory that facilitate localization of the ID.	• Review RISs assigned to the facility and validate that the nuclear material representative is current in NMMSS records. • Examine the MBA chart of accounts and/or structure. Ensure that authorized locations are addressed in the MBA structure. • Review attractiveness level determinations for MBAs. • Review procedures/process for assigning MBA custodians. • Examine key measurement points for MBAs. • Review holding accounts for authorized use and authorized data.
IO-A-3 Ensure the quality, integrity, and capability of the accountability system.	4.j. To meet emergency and special needs, the accounting system is capable of generating a book inventory listing for SNM within three hours and for all accountable nuclear materials within 24 hours. 4.k. Data integrity is assured by backing up accountability data at a specified frequency and periodically testing the disaster recovery capability. 4.l. The accounting system provides detection capability for data falsification and unauthorized access to the accounting system and source documents.	• Generate SNM inventory lists. • Review the computer security plan. • Examine procedures/plans documenting access controls, separation of duties, and authorities for the computer system. • Test computer system access control and change controls. • Test detection capability by falsifying transfer data or measurement data. • Test/execute a contingency plan for the nuclear material computer system.

Assessment Objective	Material Accounting Metrics	Assessment Methodology
IO-A-4 Ensure appropriate reporting to NMMSS.	4.n. Data fields used in the nuclear material accounting system are consistent with Table A and B of DOE Order 474.2, Change 4, and provide information sufficient to comply with national and international reporting objectives. Instructions for reporting are contained in the NMMSS User Guide. 4.o. Nuclear material in transit at the end of a reporting period is included in the receiver's inventory. 4.p. The inventory report or material balance report (MBR) is submitted electronically at least annually to NMMSS, and no later than 15 calendar days after the last day of the month. In lieu of submitting an MBR, the nuclear material representative requests an MBR (DOE/Nuclear Regulatory Commission [NRC] Form 742) from NMMSS. 4.q. Reconciliation of facility data with NMMSS data, including reconciling transaction submission to NMMSS after submission of September 30 inventory data, is completed no later than November 15. 4.r. The nuclear materials are accounted for using the units specified in Table A and B of DOE Order 474.2, Change 4.	• Review NMMSS error rates. • Review the method of reporting to NMMSS. • Compare records with NMMSS. o MBR Form M742s reviewed for accuracy o TJ-14 transactions selected for shipments and receipts o Composition of Ending Inventory 733 data reviewed for timeliness and accuracy o TJ-8 S/R differences agree o TJ-26 samples used for records audit. • Review DOE/NRC Form 741s, including any open offsite shipment 741s.

Assessment Objective	Physical Inventory Metrics	Assessment Methodology
IO-I-1 Ensure that physical inventories are conducted at defined frequencies.	5.a. Unless an alternative inventory frequency is documented with supporting justification based on the effectiveness and timeliness of process and item monitoring, access controls, and material surveillance measures, the frequency for SNM inventories is: (1) Every 60 days (calendar days) for Category I and II process MBAs (2) Every six months for Category I and II non-processing MBAs (3) Every two years (24 months) for Category III or IV MBAs. 5.b. Inventory of other accountable nuclear materials (in Table B) is conducted biennially at the RIS-level unless otherwise specified by DOE line management. 5.o. Potential substitution materials for SNM located in a Category I or II MBA are inventoried at the same frequency as the SNM. 5.n. Simultaneous inventories of Category I and II MBAs must address the potential for an undetected sitewide ID.	• Review the frequency of physical inventory for each MBA as defined in the MC&A Plan. • Review the supporting justification if alternative frequencies are defined. • Review the accounting records to determine whether these frequencies are being met. • Review material forms to determine whether substitution materials are collocated with Category I and II quantities of SNM. If so, ensure that these materials are inventoried at the same frequency. • Review physical inventory data for multiple Category I and II MBAs to verify that the dates are identical or within a reasonable timeframe.
IO-I-2 Ensure that the sampling approaches used to conduct physical inventories are statistically valid.	5.c. If statistical sampling is used to inventory areas involving activities other than processing to determine that items identified in the accounting records are present, the sampling plans specify the population, confidence level, minimum detectable defect, definition of a defect, and action to be taken if a defect is encountered.	• Review the statistical sampling parameters used to identify appropriate sample size and inventory stratification, and ensure their validity. • Review the detailed procedures that specify how sampling plans are selected. • Review the physical inventory results to ensure that the specified parameters are met.

Assessment Objective	Physical Inventory Metrics	Assessment Methodology
IO-I-3 Ensure that the physical inventory process is timely and comprehensive.	5.d. The inventory process is comprehensive and includes planning, preparation, conduct, and reconciliation. 5.e. Nuclear material accounting records are appropriately adjusted to reflect actual locations and quantities determined by the physical inventory. All nuclear materials are assigned to the proper accounts. 5.g. The inventory program ensures that item integrity has not been compromised. 5.i. Inventory reconciliation is complete within 30 days from initiating the inventory taking, following receipt of all inventory information, measurement data, and sample analyses.	• Review the physical inventory procedures to ensure that planning, site preparation, and conduct are clearly identified for each MBA. • Review the MC&A accounting procedures to ensure that they address timely reconciliation of the physical inventory. • Review the results of the physical inventory to ensure that reconciliation is completed in the timeframe required by the MC&A Plan and that the ID data is submitted to NMMSS. • Ensure that TID integrity is reviewed as part of the physical inventory process. • Performance-test by conducting a physical inventory. If possible, include an anomaly in the process.
IO-I-4 Ensure that the physical inventory is based on measured values.	5.f. Measured values for SNM are assured or verified at the time of the physical inventory, unless technically defensible estimates are required for incomplete processing of items. 5.h. The inventory program includes measurement of holdup or a determination that holdup quantities have not changed since the previous measurement. 5.p. Category I and II items that are not tamper-indicating and are not in a storage MBA are measured at the time of inventory, unless other methods of inventory verification are approved and documented in the MC&A Plan for a specific item or type of item.	• Review data from previous physical inventories and trace the values back to the analytical or non-destructive assay laboratory. • Review holdup measurements to ensure that geometric assumptions are valid. • Review physical inventory items that are not tamper-indicating to ensure that measured values are used for these items.
IO-I-5 Ensure that the site has the capability to conduct emergency physical inventories.	5.j. Emergency or special inventories are conducted as needed to support detection of loss of nuclear material during emergency conditions and changes in custodial responsibilities, and as otherwise directed by DOE. (SEE PROGRAM MANAGEMENT.)	• Review the MC&A Plan to ensure that it identifies emergency situations that may require a physical inventory. • Review procedures for conducting emergency physical inventories. • Performance-test by conducting an emergency special inventory in a specified area.

Assessment Objective	Physical Inventory Metrics	Assessment Methodology
IO-I-6 Ensure that IDs are evaluated and investigated.	5.k. ID is determined for nuclear material types by MBA. 5.l. The uncertainty of the ID is calculated, and statistically significant IDs are investigated and resolved. 5.m. Protracted theft or diversion is detected by analyses of cumulative IDs over multiple inventory periods.	• Review the methodology for calculating ID uncertainty, and validate that uncertainties are current and calculated correctly. • Review the MBA cumulative physical inventory data for trends.