

NRC INSPECTION MANUAL

NMSS

INSPECTION PROCEDURE 85402

MEASUREMENT PROGRAM

PROGRAM APPLICABILITY: 2683

85402-01 INSPECTION OBJECTIVE

The objective of this inspection procedure is to verify that the licensee's¹ material control and accounting (MC&A) program, for a Category III fuel facility or uranium enrichment facility, includes a measurement program that meets the appropriate regulatory requirements, including the stated general performance objectives, for the applicable type of facility.

85402-02 INSPECTION REQUIREMENTS

Verify that the licensee has implemented a measurement program that ensures that all quantities of special nuclear material (SNM) in the accounting records are based on measured values. The inspection activities will include the review of documents and procedures pertaining to the measurement program and the evaluation of measurements being performed. The inspector should review the following:

02.01 Key Measurement Points. Review the key measurement points for the facility, required to provide accountability data on the quantity of SNM received, transferred, processed, and stored at the facility, as described in the facility's Fundamental Nuclear Material Control (FNMC) Plan and process flow diagrams.

02.02 Measurement Techniques and Equipment. Review measurement and sampling techniques used, specific to the material types being measured.

¹Hereinafter, the term licensee subsumes the term "certificate holder," which applies in the case of the gaseous diffusion plants (GDPs). Likewise, all certificate-related requirements, including those in GDP compliance plans and corrective action commitments, are subsumed under the term "license."

02.03 Sampling Procedures and Equipment. Review sampling procedures and equipment to ensure samples are representative of the material being measured.

02.04 Verification of Measurement Capability. Evaluate performance of sampling and measurements at selected key measurement points.

85402-03 INSPECTION GUIDANCE

General Guidance

The inspector should verify that SNM values used for MC&A purposes are based on measurements and that all reportable quantities of SNM are measured. The goal of the measurement program is to provide measurements that are as precise and accurate as feasible for each material type. The inspector should verify that the measurement program includes the capability to perform quantitative determinations of the uranium and U-235 content in discrete items and bulk material. This capability must include the capability to measure the SNM content in (among others) receipt, shipment, and storage containers; process material containers; scrap and waste containers; tanks and process vessels; and material "held-up" in process systems.

To prepare for the inspection, the inspector should:

1. Review those portions of the FNMC Plan and the license conditions pertaining to the planned inspection activities.
2. Review the previous two MC&A inspection reports for the site.
3. Review any unresolved or follow-up items from the previous inspections to be addressed during the current inspection.
4. Review the content of any communications (including information notices and bulletins) to the licensee that were issued since the last inspection.

Specific Guidance

03.01 Key Measurement Points. The inspector should verify that all key SNM measurement points have been identified. These should include, as a minimum, facility receipts, shipments, and material on inventory. At each measurement point, the measurement system and the material types to be measured should be described. The description of each distinctive material type should include: (1) level of homogeneity; (2) matrix components; (3) physical state; (4) chemical and isotopic composition; and, if nondestructive assay (NDA) measurements are performed, (5) a detailed description of the material's containment.

The measurement system description should include: (1) the methods for sampling; (2) bulk-quantity (i.e., mass or volume) determination; (3) the isotopic abundance determination; (4) the uranium and U-235 assay and quantity determinations; and (4) any

other measurements used for accountability purposes. Descriptions of each measurement system should also include (1) a summary of the sampling and measurement techniques; (2) sample aliquoting and pretreatment techniques; (3) equipment used; (4) range of application; (5) standards used for calibration and measurement control; (6) measurement interferences; (7) measurement sensitivity; and (7) random and systematic error estimates.

The use of predetermined factors to estimate the quantity of SNM should be limited to those situations where timely measurements are impractical or true batch (lot) variability is less than the measurement variability. The factors must be: (1) based on measurements; (2) monitored; and (3) updated on a periodic basis, or when appropriate statistical tests indicate the need for updating.

The inspector should verify the following:

- a. Key SNM measurement points of the MC&A system are identified, and the material flows at each measurement point are documented.
- b. All measurement systems used to determine SNM accountability values are identified and their characteristics documented.
- c. Measurement systems for performing measurements (confirmatory and verification) are provided for all SNM inventory items.
- d. Measurement methods for all SNM on inventory are developed, documented, and maintained.
- e. Direct or indirect measurement of process system holdup is made so that holdup quantities can be used in determining the inventory difference.
- f. All liquid, solid, and gaseous waste streams are measured, or monitored, for SNM content.

03.02 Measurement Techniques and Equipment. The inspector should verify proper implementation of the measurement procedures and use of the measurement equipment. Approved measurement procedures should be contained in an established and maintained manual. The review should determine whether the measurement techniques and equipment are satisfactory for the measurement application, and whether the performance is satisfactory when compared to accepted industry standards.

Three general categories of measurements are used for nuclear materials accountability: (1) bulk and process measurements; (2) NDA measurements; and (3) analytical laboratory measurements of samples. The destructive measurement of samples in an analytical laboratory generally provides accountability data regarding the uranium and U-235 concentration of feed, process, and product materials.

Bulk and process measurements are performed by the production system operator on liquids or solids in process to determine the quality, quantity, and flow rate of the process material. These measurements can include:

- a. The level, temperature, volume, mass, and/or density of liquids.
- b. The weights of containers.
- c. Measurement or monitoring of gaseous, liquid, and solid waste streams to detect and quantify releases of material.

NDA measurements may be used for the measurement of SNM content of waste materials or of material held up in the process. NDA measurements also may be made to confirm the values assigned to process material in interim storage and in other process system containers. Depending on the application, the NDA techniques may include gamma-ray counting, high-resolution gamma spectroscopy, passive neutron counting, and active neutron interrogation.

The inspector should review the precision and accuracy attained with the implemented measurement techniques and equipment versus what is achieved at other facilities for similar measurements. Each measurement procedure should include a discussion of matrix effects pertinent to the material being measured.

The inspector should verify the following:

- a. An approved measurement procedures manual is established and maintained.
- b. Measurement methods that provide clear direction to the analysts or operators, are documented.
- c. Internal audits of measurement practices ensure that documented measurement methods are followed.
- d. Procedures for the preparation, review, revision, and approval of the measurement procedures are documented and implemented.
- e. Responsibilities for the preparation, review, revision, and approval of measurement procedures are defined.
- f. Approval of measurement procedures is provided by the head of the organization performing the measurement, the MC&A manager, and the measurement control program manager.
- g. Measurement procedures are not used for accountability purposes without documented approval.
- h. Measurement methods used to provide the required levels of precision and accuracy are qualified and validated.
- i. Measurement methods for determining accountability values are selected such that the magnitude of the estimated bias and of

uncertainty components pertaining to the standard error of the inventory difference (SEID) are minimized for all measurements that are major contributors to the measurement uncertainty.

- j. Responsibilities for the selection, qualification, and validation of measurement methods are defined.
- k. For each measurement system, system specifications, kinds of material to be measured, operating environment, and level of precision and accuracy are documented.
- l. Measurement equipment and instrumentation are capable of meeting manufacturer's specifications under operating conditions.
- m. Engineering analyses and evaluations are performed for the design, installation, pre-operational tests, calibration, and operation of all measurement equipment or devices (including sampling equipment on devices) used for determining or verifying SNM accounting values.
- n. Instrumentation, sensitive to gamma-ray or neutron radiation emitted by process-related materials, is maintained and controlled to ensure that the equipment is capable of detecting specified amounts of SNM.
- o. The precision and accuracy of volume, temperature, and density measurements are determined and assured when such measurements are used for accountability purposes.
- p. The accuracy and precision of measurement methods used to verify or adjust inventory values are comparable to, or better, than the original measurement.
- q. Measurement methods are available that can confirm the presence or absence of a specific attribute of nuclear materials on inventory.
- r. The specific attribute to be measured by confirmatory measurements is documented.

03.03 Sampling Procedures and Equipment. The inspector should verify that, when samples are taken from material for analysis, the sample is representative of the parent material. In general, liquids must be thoroughly mixed and sampling lines flushed to ensure representative samples. Procedures for sampling liquids should include references to mixing and sampling studies that were made to establish mixing times and ensure adequate flushing of sample lines. Procedures for sampling solids should include multiple sampling, blending, and sub-sampling to ensure the sample represents the parent material. Procedures for sampling solids should include references to studies that were made to establish the sampling procedures.

Tests should be performed using well-characterized materials to verify the applicability of mixing and sampling procedures for SNM,

and to ensure sample validity after transport and storage. In general, tests to verify the applicability of mixing and sampling procedures need not be performed for: (1) any material that uses a standard sampling technique as recommended by an American Society for Testing and Materials guide, American National Standards Institute standard, or regulatory guide, etc., provided the sampling device is a simple manual device and historical data exist that demonstrate that the mode in which the device is being used produces an unbiased sample; or (2) any material type that contributes less than 500 grams of U-235 to the material balance.

The inspector should verify the following:

- a. The sampling procedure for each measurement method that uses sampling should be specified and documented.
- b. The estimates of variance associated with the sampling method should be documented.
- c. The provisions for retaining archived samples are documented.
- d. The number of samples and the size of the samples required for each measurement value (derived from a given method) are documented.
- e. Sampling procedures are reviewed annually or whenever changes in material type or composition occur.
- f. A prescribed sampling plan for each measurement method used for accountability purposes, based on kinds of materials, measurement requirements, and special process and operational considerations, is documented and implemented.
- g. A statistically valid sampling plan is documented and implemented (i.e., number of samples per process batch and number of analyses per sample) for each measurement method used for accountability purposes, and its basis.
- h. The basis of the sampling plan is validated through studies of the materials or items being sampled.

03.04 Verification of Measurement Capability. The inspector should independently verify the adequacy of the licensee's measurement program. Most of the effort in this area should focus on measurement systems that either contribute significantly to the SEID for the plant material balance or measure a significant portion of the inventory or transfers during an inventory period. However, each measurement system used for accountability purposes, irrespective of whether or not it is considered to be a key system, must be evaluated in some manner. The primary measurement systems would usually warrant a comprehensive review of system data as well as an evaluation using independent sampling and analysis. The remaining measurement systems may only need a simple review of data generated by the system.

The inspector may elect to observe selected measurements being performed and to submit matrix samples of known composition for

measurement. Requesting the operator to measure standards, or to re-measure material to confirm the measured value, can provide an increased degree of confidence in the measurement system.

85402-04 REFERENCES

Regulations

10 CFR 74.31(a) and 74.31(c)(2); 10 CFR 74.33(a) and 74.33(c)(2)

Regulatory Guides and Reports

NUREG-1065, Rev. 2, "Acceptable Standard Format and Content for The Fundamental Nuclear Material Control Plan Required for Low-Enriched Uranium Facilities," November 1995.

NUREG/CR-5734, "Recommendations to the U.S. Nuclear Regulatory Commission on Acceptable Standard Format and Content for the Fundamental Nuclear Material Control (FNMC) Plan Required for Low-Enriched Uranium Enrichment Facilities," Chapter 2, November 1991.

NUREG/CR-3584, "Commonly Used Nuclear Material Measurements and Their Sources of Error," January 1984.

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

NUREG/CR-0087, "Considerations for Sampling Nuclear Materials for SNM Accounting Measurements," May 1978.

NUREG/CR-0033, "Procedures for Rounding Measurement Results in Nuclear Materials Control and Accounting," March 1978.

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