INSPECTION PROCEDURE 85501

INVENTORY PROGRAM

PROGRAM APPLICABILITY: 2683

85501-01 INSPECTION OBJECTIVE

The objective of this inspection procedure is to verify that the licensee's[1] material control and accounting (MC&A) program, for a Category III uranium enrichment facility, includes a physical inventory program, for performing dynamic and static physical inventories, and appropriately reconciling static physical inventories with book inventories, in accordance with existing regulatory requirements.

85501-02 INSPECTION REQUIREMENTS

Dynamic physical inventories are required to be performed for uranium and contained U^{235} in the process (i.e., enrichment) equipment, while the process continues. A static physical inventory is required for total uranium and contained U^{235} in all natural, depleted, and enriched uranium at the facility, outside of the process equipment, at least every 370 days.

The inspector should ensure that the licensee has implemented an inventory program, that the required static and dynamic inventories are being conducted, and that the book inventory is reconciled to reflect the results of the static physical inventory. The inspector should perform the following review, observational, and determination activities, as follows:

02.01 Physical Inventory Plans and Procedures. Review procedures for preparing the licensee facility for dynamic and static physical inventories.

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[1]Hereinafter, 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."

02.02 Inventory Preparations. Review procedures for conducting dynamic and static physical inventories.

02.03 Conduct of Inventories. Review previous inventory records and the inventory schedule, and observe inventories.

02.04 Establishment of Control Limits. Review procedures and calculations for determination of the standard error of the inventory difference (SEID), procedures for and reports from reconciliation of inventory differences (IDs), and investigative reports associated with excessive IDs.

02.05 Trend Analysis. Evaluate licensee trend analysis process and results.

02.06 Inventory Reconciliation. Review licensee reconciliation activities.

02.07 Loss Detection and Reporting. Review the licensee's monitoring and assessment activities for determining the status of inventories and identifying abnormal situations.

02.08 Inventory Accuracy and Adequacy. Determine accuracy and adequacy through random sampling and examination of inventory records.

85501-03 INSPECTION GUIDANCE

General Guidance

The inventory program and its procedures must be effectively implemented. Dynamic physical inventories should be conducted at least every 65 calendar days and static inventories at least every 370 days. These inventories should confirm the quantity and location of nuclear material in the licensee's possession. The book inventory should be reconciled and adjusted to the results of a combined dynamic and static physical inventory, so as to provide a total plant material balance every 370 days. Each ID result should be reported to NRC within 60 days after the start of the physical inventory [pursuant to 10 CFR 74.17(a)]. Inventory trend analysis should be used to identify protracted theft of special nuclear material (SNM) or unauthorized production or enrichment.

To prepare for the inspection, the inspector should:

a. Review those portions of the Fundamental Nuclear Material Control (FNMC) Plan and the certificate conditions pertaining to the planned inspection activities.

b. Review the previous two MC&A inspection reports for the site.

c. Review any unresolved or followup items from the previous inspections to be addressed during the current inspection.

d. Review the contents of any communications (including information notices and bulletins), to the licensee, that were issued since the last inspection.

Specific Guidance

03.01 Physical Inventory Plans and Procedures. The inspector should verify that procedures for conducting physical inventories ensure appropriate assignment of responsibility and provide adequate guidance for inventorying source material (SM) and SNM in containers and in-process equipment. The plan and procedures should contain definitive statements that specific inventory instructions will be prepared and issued in advance of each dynamic and static inventory.

The responsibility for planning, organizing, and conducting the physical inventories should be assigned to one primary manager and an alternate who are familiar with overall operation of the facility. The inventory of each plant area should be assigned to individuals who are familiar with, but who have no direct responsibility for, the material and operations conducted in that area. As a general rule, inventories should be conducted by teams consisting of at least two people. These people should report to the inventory manager while the inventory is being conducted.

The inspector should verify the following:

a. The plan for conducting, verifying, and reconciling nuclear material inventories is documented and implemented.

b. Procedures that define responsibilities and specify criteria for conducting physical inventories, including frequency and reconciliation activities, are documented and implemented.

c. The accounting structure is able to localize IDs, and provide a system of checks and balances, in verifying the accuracy of the data.

d. The number of material balance areas (MBAs) and inventory control areas is sufficient to identify and localize IDs and their causes.

e. Procedures ensure that all nuclear material is inventoried.

f. Procedures for determining the nuclear material content of environmental wastes (e.g., stack effluents and liquid waste streams) are documented and implemented.

03.02 Inventory Preparations. The inspector should verify that pre-inventory preparations will ensure an accurate determination of material in inventory and will minimize the SEID. For those items or processes for which the nuclear material inventory is difficult to measure or quantify, the inventory of the items or the processes should be reduced to the maximum extent practical (e.g., by draindown, revaporization, or cleanout) before the inventory begins. The procedures should ensure that inventory cutoff procedures, tag procedures, and post-inventory inspections -- or

equally effective measures -- are used to ensure that all material quantities will be accounted for and not counted more than once. Sufficient information should be provided in the procedures to show that the inventory process is organized and coordinated. The details of the plan and procedures should ensure the use of uniform and consistent practices for checking and recording the SM and SNM status.

Before the inventory, the person with overall inventory responsibility should perform a preliminary inspection of the plant areas to be inventoried, review the inventory procedures and instructions with key individuals, and supervise any needed additional training of inventory personnel. The inspection of plant areas should focus on ensuring that material is measured and properly tamper-safed, packaged, labeled, stored, or otherwise prepared for inventory, and that process equipment is addressed according to previously established written procedures and instructions.

The inspector should verify the following:

a. The procedures and methodologies associated with performing static and dynamic physical inventories are documented and implemented.

b. An inventory notice and specific procedures are prepared for each dynamic inventory.

c. Cutoff times for internal and external transfers of nuclear material are specified.

d. Cutoff times for the termination of nonenrichment processing operations are specified.

e. The enrichment cascade is maintained in a steady-state operating condition for at least 24 hours before starting a dynamic inventory.

f. Process measurement data are recorded, and process samples are collected over a period of approximately 6 hours, before starting a dynamic inventory.

g. Preparations are completed to ensure that a complete feed and withdrawal system switchover to pre-inventoried containers at inventory time can be performed.

03.03. Conduct of Inventories. The inspector should review the physical inventory records and the inventory schedule to determine whether inventories are conducted at the frequency required in the FNMC plan (i.e., at least every 65 calendar days for dynamic physical inventories, and at least every 370 days for static physical inventories). The inventory should act as a check on the book inventory and on the effectiveness of the item control program. It also should enable the licensee to adjust accounts to accurately reflect the status of the SM, SNM, and cascade inventories within the facility. Static physical inventories should be conducted in conjunction with dynamic physical

inventories of in-process uranium, to provide a total site material balance.

The inspector should observe the licensee conducting the physical inventory to determine whether the physical inventory procedures provide for verifying the location and identity of all quantities of SM and SNM, and enable the licensee to adjust the accounts to accurately reflect the status of the nuclear material inventory at the facility.

The inspector should verify the following:

a. All material flows to and from the MBA are documented.

b. Physical inventories are based on measured values.

c. Direct or indirect SNM inventory measurements are made of material contained or held up in the process system.

d. Static nuclear material inventories are conducted at least every 370 calendar days, and dynamic inventories of the enrichment process system are conducted at least every 65 days.

e. The static nuclear material inventory is performed concurrently with a dynamic inventory, to provide a total plant material balance at least every 370 days.

03.04 Establishment of Control Limits. The inspector should verify the proper calculation of the SEID and of the ID control limits. Current inventory period data should be used for the estimation of the SEID. Data generated in immediately preceding material balance periods may be combined with current data, when it can be demonstrated that the data are from the same distribution. The combined data are then used to establish current-period SM and SNM values. The inspector should compare the SEID with the active inventory to determine whether the measurement systems have been sufficiently controlled.

Procedures for establishing control limits should be documented and contain a detailed description of the methodology for determining ID threshold values. The statistical methods used to evaluate the inventory data should be detailed in the FNMC Plan. Typically, they include, as appropriate, tests of individual and cumulative differences, tests of randomness, and tests of distribution. Control limits should be recalculated at a predetermined frequency and modified if required. If an ID exceeds established control limits, a licensee investigation should be conducted to determine reasons for the out-of-limit conditions and any deficiencies should be corrected.

The ID and SEID should be examined by the inspector to determine whether the estimates are traceable to the accounting and measurement control program records, and whether the estimates are generated as approved in the FNMC plan. The method used for estimating the SEID for the typical material balance must meet several requirements:

(1) All reasonable and probable sources of measurement error for the key measurement systems affecting IDs are included.

(2) The selection of the key measurements, whose variances are to be included in calculating the standard error, is justified by an analysis of the relative magnitudes of the variance components of a typical ID and their comparative effect on the SEID.

(3) Any measurement error standard deviations, not actually determined by the measurement control program, are shown to be reasonable, either by comparison with published state-of-the-art measurement performance in similar applications, or with available records of past performance data from the licensee facility.

(4) The calculation of the SEID is performed in accordance with a recognized error propagation method, as detailed in the FNMC Plan.

The inspector should verify the following:

a. Procedures for establishing ID control limits and requiring investigations when those limits are exceeded are documented and implemented.

b. Procedures for establishing ID control limits are based on variance propagation or other valid statistical techniques.

c. IDs exceeding control limits are evaluated and resolved, as detailed in the FNMC Plan.

d. Statistically based ID control limits are compared with the historical ID data to validate the completeness of the data inputs.

03.05 Trend Analysis. The licensee should perform trend analysis by applying appropriate parametric or nonparametric statistical techniques (e.g., Page's Test, Runs Test, Dietz's Test, Power One Test, MOSUM Test, or other appropriate tests) as described in the FNMC plan. The inspector should compare the trend analysis methods implemented by the licensee, with the corresponding descriptions in the FNMC plan, and determine whether the assumptions inherent in the described methods are valid for the licensee's data (e.g., some of the non-parametric methods assume that the distribution of the data is symmetric). The inspector should also determine, through review of the trend analysis methods, how measurement data not available at the time of physical inventory tests, but which are generated at a later date, are incorporated into the data analyzed for trends and patterns.

The inspector should evaluate the trend analysis assumptions and data to determine whether the methods are appropriate for the current process conditions. The inspector should be aware of changes in process operations, measurement, or accounting practices. The statistical methods used to evaluate the trend analysis assumption may be the same used to evaluate the quality of

the data, and may include tests of individual and cumulative differences, randomness, and distribution.

The inspector should evaluate the trend analysis results, to determine whether the trend analysis was performed as described in the FNMC plan, and whether significant trends were investigated and resolved. A trend should be considered significant to MC&A when the applied test indicates it to be so, and the absolute quantity involved is in excess of 5 formula kilograms of U^{235}. The inspector's evaluation of the trend analysis results would also consider other indicators of trend in the process monitoring data. Other sources of information on trends include biases identified by the measurement-control program, quantities of material recovered from scrap, and measurement values for waste and holdup cleanout. The inspector should compare the trend analysis results with these other sources for consistency.

The inspector should verify the following:

a. Trend analysis is accomplished by the licensee using appropriate statistical techniques.

b. Data and assumptions used in conducting trend analysis are appropriate for current process operating conditions.

c. Significant trends are investigated and resolved by the licensee.

03.06 Inventory Reconciliation. The inspector should verify that after completion of the inventory, the inventory records are checked for correctness, and the book records are reconciled and adjusted to the results of the inventory. The inspector should verify that the licensee's reconciliation includes both the central accounting records and the subsidiary journals.

Bias corrections should be applied to individual items whenever a bias estimate is statistically significant, exceeds 50 grams of U^{235} across all affected items, and exceeds 0.5 gram of U^{235} for a single item; otherwise, bias corrections should be applied as a correction to the ID. The emphasis of bias correction should be to obtain an unbiased value for the total plant ID quantity. Each bias correction that is greater than its uncertainty at the 95 percent confidence level should be considered to be statistically significant. All affected items and associated records should be corrected if the effect on the individual items is greater than the rounding error associated with the accounting records. Bias correction need not be considered if the measurement system bias is less than the uncertainty of the calibration or control standards for that measurement system.

For all SNM, both statistically significant and insignificant bias corrections must be applied so that the reported plant ID value is the best estimate of the true ID. In addition, bias correction information from prior periods must be maintained and accurately tracked so that it can be correctly applied to SNM listed under each term in the plant ID expression (i.e., beginning inventory,

ending inventory, additions to inventory, removals, and prior-period adjustments).

The effect of prior period adjustments should be taken into account before the significance of the current period ID is assessed. The appropriate procedure for dealing with these discrepancies is, for the purposes of ID evaluation, to modify the ID quantity by adding or subtracting a quantity of SM and SNM equivalent to the adjustment before assessing the significance of the current period ID. The adjustment to the book records must include the prior-period adjustments, to bring the accounting records into balance.

Assessment of the significance of current-period material balance results by sequential analysis of prior-period ID data requires consideration of the comparability of the sequence of IDs used for analysis and the covariances that exist between adjacent and alternate pairs. When assessing these covariances, the inspector should also consider the effects of processing SM and SNM generated in prior periods and the time since the material was generated such as might occur in a scrap-recovery process that operates in campaigns of different types of material.

The inspector should verify the following:

a. A physical inventory reconciliation is conducted after each inventory, to ensure that nuclear materials have been accounted for and that the facility's record reflects the results of the physical inventory.

b. Measured values for inventory purposes are determined in time to provide for computation and reconciliation of inventories and determination of IDs, consistent with established inventory procedures.

c. All adjustments to the records are evaluated.

d. Inventory adjustments are supported by measured values or other technically defensible bases.

e. A program for statistical reviews of inventory adjustments is documented.

f. Assessments of IDs, including statistical tests for trends and biases, are applied to both total and actual IDs on an individual and cumulative basis.

g. The investigation and reporting of IDs is consistent with approved plans.

03.07 Loss Detection and Reporting. The inspector should evaluate monitoring and assessment activities for loss detection elements and their associated data, to determine the status of nuclear material inventories, and to identify abnormal situations. The false alarm rate and the resolution efficiency should be compared with expected normal levels. Abnormal situations indicating theft, attempted theft, or unlawful diversion of SNM should have been reported to the NRC Operations Center within 1 hour of discovery,

in accordance with 10 CFR 74.11(a). The inspector should determine that the licensee can quickly generate an inventory listing in response to an alarm situation.

The inspector should verify the following:

a. Procedures for responding to abnormal conditions are documented, and designate the individual(s) responsible for initiating and executing response actions.

b. The status of nuclear material inventories can be established in response to alarm situations.

c. Procedures for conducting special inventories are documented and implemented, when necessary.

d. Special inventory procedures address the circumstances requiring a special inventory.

e. Response to indicators of missing uranium are implemented in accordance with documented procedures.

03.08 Inventory Accuracy and Adequacy. The inspector should examine a random sample of items to: (1) ensure the existence of an adequate audit trail, (2) ensure that adjustments for reconciliation between the book inventory and the physical inventory are performed in accordance with commonly accepted accounting practices, and (3) ensure that the adjustments are traceable and capable of being audited. A random sample of items on the inventory should be selected by the inspector and located, as a check of accuracy of the inventory.

The SM and SNM quantity value on the physical inventory listing for each component in the material balance should be based on measurements. The SM and SNM content of groups of like items can be determined by averaging typical contents. Such contents are determined by measurements of representative item samples of that material at the time of the inventory, if the licensee has demonstrated that any additional uncertainty resulting from this averaging method is included in the SEID estimator. Prior measurement values may be accepted for inventory, provided they were determined by measurement systems subject to the licensee's measurement control program, and the containers were either immediately tamper-safed after the measurement or provided protection equivalent to tamper-safing. By-difference accounting is not acceptable.

The inspector should review the records of tamper-safing devices to verify that continuity of knowledge has been maintained for each item. If an item had a broken tamper-indicating device replaced, the inspector should review the methods used to protect the information on the quantities of SM and SNM contained in the item.

The inspector should verify by observation of conduct of the physical inventory that the periodic physical inventories enable the licensee to adjust accounts to accurately reflect the status of

the SM and SNM inventory within a facility. The inspector should verify the following:

a. Physical inventory records are reviewed to verify that all SM and SNM values are based on measurements.

b. Records of tamper-safing devices are reviewed to ensure that continuity of knowledge has been maintained for each item.

85404-04 REFERENCES

Regulations

10 CFR 74.33(a); 10 CFR 74.33(c)(4).

Regulatory Guides and Reports

Regulatory Guide 5.67, "Material Control and Accounting for Uranium Enrichment Facilities Authorized to Produce Special Nuclear Material of Low Strategic Significance," Sections C.6 and C.7, 1992.

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," Chapters 4 and 5, November 1991.

NUREG/CR-5890, "Material Control and Accounting Loss Detection during Transition Periods and Process Upset Conditions," March 1987.

NUREG/CR-5003, "Design of a Material Control and Accounting System to Protect Against Concealment of Diversion by Falsification and Collusion," October 1987.

NUREG/CR-5002, "Methods for Recurring Loss Tests," September 1987.

NUREG/CR-4497, "NRCPAGE Applications Manual," April 1986.

NUREG/CR-4604, "Statistical Methods for Nuclear Material Management," December 1988.

NUREG/CR-4107, "Sequential Test Procedures for Detecting Protracted Materials Losses," July 1985.

NUREG/CR-2483, "Evaluation of Simultaneous Testing Procedures for Nuclear Materials Control and Accounting," March 1982.

NUREG/CR-2466, "Statistical Sampling Plans for Prior Measurement Verification and Determination of the SNM Content of Inventories," March 1982.

NUREG/CR-1785, "Performance Evaluation of Loss Detection Schemes for Uranium Recovery Plants," November 1981.

NUREG/CR-0662, "Computational Tools for Material Control Assessment and Design of Processing Monitors: An Overview," February 1979.

B. W. Smith and P. T. Reardon, "Developing a Strategy for Licensee Investigation of an Excessive Inventory Difference," Journal of Nuclear Materials Management, July 1980.

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