

# NRC INSPECTION MANUAL

NMSS

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## INSPECTION PROCEDURE 85307

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### PROCESS MONITORING

PROGRAM APPLICABILITY: 2681

#### 85307-01 INSPECTION OBJECTIVE

Verify that process monitoring procedures ensure timely detection of the possible abrupt loss of five or more formula kilograms of SSNM from an individual unit process. The program must also include quality control tests and trend analyses for evaluating sequences of process differences.

#### 85307-02 INSPECTION REQUIREMENTS

The process monitoring systems must comply with all applicable NRC regulations and safeguards license conditions. The FNMCP contains commitments relative to process monitoring. By inspection determine whether:

02.01 Internal transfers, storage, and processing of SSNM are monitored. [74.53(a)] The licensee's process monitoring must achieve the detection capabilities described below except for 1) SSNM subject to item monitoring requirements in 10 CFR Part 74.55; 2) scrap in the form of small pieces, cuttings, chips, solutions, or in other forms that result from a manufacturing process, held in containers of 30 gallons or larger, with an SSNM content of less than 0.25 grams per liter; 3) SSNM with an estimated measurement standard deviation greater than five percent and which is either input or output material associated with a unit that processes less than five formula kilograms over a consecutive three month period; and 4) SSNM involved in research and development operations that process less than five formula kilograms during any seven consecutive day period.

02.02 A production quality control program capable of monitoring the status of material in each unit process has been established and is being maintained. The program includes a statistical test that has at least a 95 percent power of detecting an abrupt loss of five formula kilograms within three working days of a loss of Category IA material from any accessible process location and within seven days of a loss of Category IB material from any accessible process location. [74.53(b)(1)]

02.03 The production quality control program includes a quality control test whereby process differences greater than both three times the estimated standard deviation of the process difference estimator and 25 grams of SSNM are investigated. [74.53(b)(2)]

02.04 The production quality control program includes a trend analysis for monitoring and evaluating sequences of material control test results from each unit process to determine if they indicate a pattern of losses or gains that are of safeguards significance. [74.53(b)(3)]

02.05 For research and development operations exempt from the requirements of 74.53(b) as inspected in requirements 2.02-2.04 above, the licensee has:

- a. Performed material balance tests on a lot or batch basis, as appropriate, or monthly, whichever is sooner, and investigated any difference greater than 200 grams of plutonium or U-233 or 300 grams of U-235 that exceeds three times the estimated standard error of the inventory difference estimator. [74.53(c)(1)]
- b. Evaluated material balance results generated during an inventory period for indications of measurement biases or unidentified loss streams. If the cumulative inventory differences generated during an inventory period exceeded three formula kilograms of SSNM, the licensee investigated, determined the cause(s) of, and instituted corrective actions for the difference. [74.53.(c)(2)]

### 85307-03 INSPECTION GUIDANCE

#### 03.01 Regulations. 74.53

03.02 Regulatory Guides and Reports. NUREG-1280, Standard Format and Content Acceptance Criteria for the Material Control and Accounting (MC&A) Reform Amendment, Section 1, "Abrupt Loss Detection."

03.03 Criteria. The inspector ensures that the licensee has quality control and trend analysis programs in place that will provide early indications of material losses that may be indicative of a protracted (trickle) diversion or theft and a prompt detection system for significant abrupt diversions of 5 FKG or more.

Pre-inspection Activities. To prepare for the inspection, the inspector should review the specific portions of the FNMCP and the safeguards license conditions for the planned inspection activities; review the previous inspection report for the site; review any unresolved or followup items to be addressed during the inspection; and review any communications (including information notices and bulletins) with the facility since the last inspection.

Post Inspection Activities. Followup is conducted as described in Manual Chapter 92701 and the Inspection Report is generated as described in Manual Chapter 0610.

- a. For requirement 2.01, the inspector should review operations for each process unit to determine whether 1) the process monitoring tests used pertain to all the SSNM processed through the unit; 2) the tests have been conducted according

to the commitments in the NRC approved FNMCP as inspected below for requirements 02.02 and 02.03; 3) the comparison of a test result with the reference value used is adequately sensitive (i.e., provides 95 percent probability of detection) to detect an actual loss of five FKG; and 4) that anomalies resulting from the tests have been investigated. [Note: Item 4 of 03.03.01 is covered within Inspection Procedure 85313, but should be addressed as part of this inspection procedure if 85313 has not been applied within the past 60 days and is not scheduled to be applied for at least another 60 days.]

Review of Material in Process Area. The inspector should verify that all SSNM in the processing areas of the plant has been included in a process monitoring test except for those materials identified in 74.53(a). The inspector should review the process area and an inventory listing to determine whether all materials have been included in a material control test as described in the FNMCP. If the inspection identifies material that has not been included in a test and has not been described in the approved FNMCP, then the MC&A licensing unit should be notified. The inspector should review process changes to determine whether the process monitoring tests are still valid.

Review of Exceptions. The inspector should verify that SSNM items in the processing areas that have been excluded by the licensee from the process monitoring tests, as allowed by 74.53(a) and which instead are subject to the requirements of 74.55, are in fact monitored. All bulk (i.e., non-item) SSNM currently within the material access area (MAA) should either have been subject to a process monitoring test within the past three working days or past seven calendar days, except for 1) SSNM exempted by 74.53(a)(2), (3) or (4); 2) SSNM existing as residual hold-up; and 3) SSNM located at a "non-accessible process location."

For scrap and/or waste that meets the conditions for exception, the inspector should determine that such materials are identified in the FNMCP and that the material actually meets the conditions for exception as specified in 74.53(a)(2). Scrap should be recovered as required by 74.59(h)(2) and the inspection of the process monitoring tests should evaluate how this scrap has been modeled. Scrap may be accounted for by the use of an average value of the process loss in the process monitoring test. The inspector should compare the quantities of scrap recovered with values estimated by the product of the  $x$  and the number of tests performed.

For low throughput operations, e.g., waste compactors and incinerators, where throughput is less than 5 FKG in 3 months and the measurement uncertainties on inputs and/or outputs are greater than five percent, material balances should be performed on a batch basis and appropriate corrections made to the originating units(s) or area cumulative balances to the extent practicable. Holdup determinations are necessary only at the time of the physical inventory (or sooner for criticality reasons), and input-output differences need only be

assessed to the extent that significant trends are investigated to identify measurement biases or an unaccounted for loss stream.

Review of Potential Substitution Materials. The inspector should review the process area for other materials that may be used for substitution. Where credible substitute material is present and uncontrolled, the material control tests must be capable of detecting diversions employing substitution. The FNMCP should identify potential substitute materials that may be present.

Assessment of the Process Monitoring Design. The inspector examines the loss detection system design to determine whether the process monitoring tests provide an indication in the event of a diversion or unexpected loss. The inspector selects various types of SSNM within each process unit (e.g. a product or flow) and estimates the indication that would occur if a diversion or unexpected loss of 5 FKG or more were to occur. The inspector then determines whether that indication would exceed the alarm limits for the process monitoring test. If the process monitoring test is a measured material balance, then the process difference should equal the hypothesized loss. If, however, the process monitoring test uses other loss detection models or nonmeasurement estimates of the quantities of SSNM, the inspector should verify the relationships between a loss and process monitoring indicator.

- b. To determine compliance with requirement 02.02, the inspector should evaluate the process monitoring procedures and instructions, audit the process monitoring records, observe the process monitoring activities, and check a random sample of process operations to confirm the descriptions in the annexes to the FNMCP. The inspector should verify the capability for timely detection of the abrupt loss of 5 FKG or more.

Evaluation of Process Monitoring Procedures. The inspector should review the procedures that the licensee has developed and is maintaining for material control tests for detecting abrupt losses of bulk material from single units or locations within the facility. The procedures should demonstrate that 1) the system is capable of detecting a goal quantity loss with at least 95 percent probability, 2) the material control tests encompass the SSNM in a definite unit or location or over a span of locations comprising a segment of the process or a single point in the process and 3) each material control test is based on a comparison of a measured value(s) of a quantity of material(s) or of a process variable with a reference value. The reference value is the expected or predicted quantity of material or value of the process variable in the absence of diversion or unexpected loss.

Audit of Process Monitoring Records. The inspector should review the records of the tests performed to determine whether the detection time goals have been met at each process unit and whether the tests have been conducted using the methods

defined in the FNMCP. The inspector should confirm that the tests for detecting abrupt losses at each accessible location will meet the 3- and 7-day detection time goals for Category IA and Category IB materials, respectively, under all routine conditions that are expected to prevail at the location. The inspector should review the date of each test in the sequence since the last inspection to determine whether the required frequency has been met.

If tests are identified that have not met the required frequency, the inspector should follow up and discuss each with the licensee. Acceptable causes might include periods when the process was shut down and cleaned out (e.g. physical inventory, holidays) and periods when material was not accessible in the process. The timeliness of abrupt loss detection at a single location is based on the interval between the time a goal quantity of SSNM becomes accessible for diversion and the completion of the material control test. The start time occurs when the quantity of SSNM is first equal to or greater than the established goal quantity. The SSNM may be treated as not accessible for diversion if access to the SSNM is physically precluded by process equipment, the chemical or physical properties of the SSNM prevent its diversion, tools required for movement of the SSNM are not available, the SSNM is so dilute that the required vessel could not escape detection, or the SSNM is under continuous surveillance by two or more individuals or an electronic or other monitoring system.

During the review of the process monitoring records, the inspector should determine whether any indicators should have been investigated. The inspector should recalculate a sampling of indicators to verify the licensee's calculations and compare the indicators with the alarm limits. The inspector should also determine the licensee's methods by which indicators that exceed alarm limits would be identified, and reported, for investigation and resolution. The inspector should make a judgement or conclusion as to whether the licensee's procedures for alarm recognition and followup actions are adequate.

Observation of Procedure Performance. After reviewing the process monitoring procedures and auditing the process monitoring records, the inspector should observe a random sample of the procedures being performed to determine that the procedures are being followed and that the procedures are appropriate for conditions in the process area. While observing the performance of the process monitoring procedures the inspector can determine whether the descriptions of the process units in the FNMCP are accurate. If discrepancies are identified, the inspector discusses them with the licensee and contacts the MC&A licensing unit at NRC Headquarters to determine whether licensing action is necessary.

Assessment of Loss Detection Capability. The inspector should review the false alarm rate and the resolution efficiency in determining whether a sufficient number of control units have

been established. There is no limit or restriction on the number of control units into which a facility can be divided. Loss detection sensitivity, false alarm rate, and loss localization capability are the key determining factors. In some cases, the process characteristics may dictate the control unit structure and the availability of measurements for some material may make it less effective to establish additional control units.

- c. While auditing the process monitoring system as part of 02.02 above, the inspector can determine compliance with requirement 02.03 by reviewing the standard deviations of the process monitoring estimators, evaluating the quality control checks to determine whether any estimator exceeded the 3 standard deviation control limit, and as appropriate, reviewing the resolution of and corrective actions for all investigated process monitoring estimators.

Review of Methods for Establishing Control Limits. The standard deviation calculated by the inspector should be tested against the licensee's value using an appropriate statistical test (see NUREG-4604).

The statistical methods used to evaluate the process monitoring data shall include, as appropriate, tests of individual and cumulative differences, tests of randomness, and tests of distribution. The results of all such analyses shall be discussed with the licensee during a subsequent inspection and thoroughly documented in an inspection report. If the results obtained are inconclusive, the evaluation could be continued by evaluating a longer time period or by having the licensee evaluate the control unit identified by the inspector. However, once an inspector verifies that a process monitoring problem exists, the licensee shall be required to perform any analyses deemed necessary by the inspector to isolate the specific source of the problem.

Evaluation of Quality Control Tests. The inspector should determine for each control unit the frequencies for process difference estimates (resulting from process unit tests) exceeding 1) two times the standard deviation of their estimators, and 2) three times the standard deviation of the estimator. If either frequency is considerably higher than what would be statistically predicted, further investigation is warranted in order to determine whether it is a case of underestimating the standard deviation or an occurrence of actual losses. The inspector should review the quality control tests by asking whether the power of the loss detection test inspected in requirement 02.02 above has been maintained as described in the FNMCP.

Assessment of Resolutions and Corrective Actions. As part of the inspection of quality control program, the inspector should review resolutions and corrective actions to determine whether the loss detection capability has been maintained.

- d. For requirement 02.04, the inspector should determine whether the licensee has implemented a program of trend analysis as described in the FNMCP. The inspector should compare the implemented trend analysis methods with the descriptions in the FNMCP, evaluate the assumptions in the trend analysis method, and evaluate the trend analysis results.

Review of Trend Analysis Methods. The licensee may accomplish trend analysis by the application of appropriate parametric or nonparametric statistical techniques such as Page's test, Runs Test, Dietz's Test, Power One Test, MOSUM Test, or other appropriate tests as described in the FNMCP. The inspector should compare the trend analysis methods implemented by the licensee with the descriptions in the FNMCP and determine whether the assumptions inherent to the methods are valid for the licensee's data. For example, some of the non-parametric methods assume that the distribution of the data is symmetric.

Review of the trend analysis methods should also determine how measurement data, that is not available at the time of process monitoring tests but that is generated at a later date, is incorporated into the data analyzed for trends and patterns.

Evaluation of Trend Analysis Assumptions. The inspector evaluates 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, measurements or accounting practices. The statistical methods used to evaluate the trend analysis assumption may be the same used to evaluate the quality data which included tests of individual and cumulative differences, tests of randomness and tests of distribution.

Evaluate Trend Analysis Results. The inspector evaluates the trend analysis results to determine whether the trend analysis has been performed as described in the FNMCP and that significant trends have been investigated and resolved. A trend should be considered significant to safeguards when the applied test indicates it to be so and the absolute quantity involved is in excess of 3 FKG. 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 evaluation of the trend analysis results will also contribute to the assessment of the process monitoring design in 3.03.01, e.g. the x.

- e. For research and development operations, the inspector should evaluate the process monitoring procedures and instructions for batch operations, audit the process monitoring records, observe process monitoring activities, and check experimental materials to confirm that they are in their designated locations.



The inspector should ensure that proposed materials groupings into lots or batches are acceptable, and that the groupings take into account the prompt loss detection objectives, measurement characterization, and processing constraints.

Research and development operations are dynamic in nature. Consequently, the prompt loss detection techniques that depend upon stable estimates of the uncertainties associated with material balances or process yields may be inappropriate for loss detection. Taking into account the low throughput of such operations, periodic material balance tests on a lot or batch basis or monthly are deemed acceptable for loss detection. The inputs to the standard error of the inventory difference (SEID) must be reasonable and include all sources of measurement error.

For samples containing greater than 0.05 FKG and scrap and waste containers in laboratories, the licensee shall perform monthly material balances.

03.04      Inspection Activities Flowchart. Figure 1 shows a flow chart of the process monitoring inspection activities.

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FIGURE 1

PROCESS MONITORING INSPECTION

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