

13.0 SAFEGUARDS

13.2 MATERIAL CONTROL AND ACCOUNTING (MC&A)

13.2.1 PURPOSE OF REVIEW

The purpose of this review is to ensure that the Fundamental Nuclear Material Control Plan (FNMCP) submitted by the applicant describes how an MC&A system will be established, implemented, and maintained, and to ensure that the FNMCP is adequate to protect against, detect, and respond to the loss or theft of strategic special nuclear material (SSNM) by achieving the following five performance objectives stated in the Code of Federal Regulations (CFR), Title 10, Part 74.51(a):

- A. Prompt investigation of anomalies potentially indicative of SSNM losses;
- B. Timely detection of the possible abrupt loss of five or more formula kilograms of SSNM from an individual unit process;
- C. Rapid determination of whether an actual loss of five or more formula kilograms occurred;
- D. Ongoing confirmation of the presence of SSNM in assigned locations; and
- E. Timely generation of information to aid in the recovery of SSNM in the event of an actual loss.

These objectives will be achieved by meeting the system capabilities requirements stated in 10 CFR 74.51(b).

13.2.2 RESPONSIBILITY FOR REVIEW

Primary: Safeguards Technical Analyst (MC&A Specialist)

Secondary: Project Manager

Supporting: MC&A Physical Scientist (MC&A Inspector)
Physical Protection Reviewer

13.2.3 AREAS OF REVIEW

The staff should review the applicant's FNMCP to ensure that the plan, in meeting the five performance objectives stated in Section 13.2.1, addresses:

- A. Process Monitoring Program: For each unit process, the applicant's establishment of a production quality control program capable of monitoring the status of material in process;

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- B. Item Monitoring Program: The applicant's establishment of a process to verify the presence and integrity of SSNM items on a statistical sampling basis;
- C. Alarm Resolution Program: The applicant's establishment of an alarm resolution program that is capable of:
 - i. Resolving the nature and causes of any MC&A alarm within approved time periods;
 - ii. Notifying NRC of any MC&A alarms that remain unresolved beyond the time periods;
 - iii. Determining the amount of actual SSNM lost and taking corrective actions;
 - iv. Providing an ability to rapidly assess the validity of alleged thefts; and
 - v. Taking appropriate actions when the abrupt loss detection estimate exceeds two kilograms of plutonium.
- D. Quality Assurance and Accounting Programs: The applicant's establishment of a quality assurance and accounting capability to address the following 11 elements: management structure, personnel qualification and training, measurements, measurement control, physical inventory, accounting, shipping and receiving, scrap control, human errors, independent assessments, and custodial responsibility.

13.2.4 ACCEPTANCE CRITERIA

13.2.4.1 Regulatory Requirements

Regulatory requirements applicable to the MC&A program and the FNMCP are specified in 10 CFR Part 74, "Material Control and Accounting of Special Nuclear Material." Subpart E, Formula Quantities of Strategic Special Nuclear Material, particularly applies to mixed oxide (MOX) fuel fabrication facilities.

13.2.4.2 Regulatory Guidance

NUREG-1280, "Standard Format and Content Acceptance Criteria for the Material Control and Accounting (MC&A) Reform Amendment," Rev. 1, April 1995.

13.2.4.3 Regulatory Acceptance Criteria

The performance objectives and acceptance criteria discussed below pertain to plutonium, both before and after processing into MOX. MOX contains uranium in the form of either depleted, natural, or low enriched uranium (LEU). The reviewer must be aware of which type of uranium will be processed into MOX and verify that this is stated in the process description section of the FNMCP. If the applicant uses LEU to produce MOX, the reviewer must verify that, up until the

time of processing, the LEU feed material is adequately controlled to enable the MC&A system to meet the objectives and requirements of 10 CFR Part 74.31.

It is important that the applicant establishes the basis for determining the formula quantity of SSNM for a facility processing MOX. Formula kilogram (FKG) means SSNM in any combination in a quantity of 1,000 grams computed by the formula:

$$\text{grams} = (\text{grams contained U-235}) + 2.5 (\text{grams U-233} + \text{grams plutonium}).$$

Formula quantity means SSNM in any combination in a quantity of 5,000 grams or more computed by the above formula. Where the uranium oxide used in the process has an enrichment level lower than 20%, the determination of FKG is based on the amount of plutonium only. Therefore, two kilograms of plutonium yields five FKG or a formula quantity of SSNM.

13.2.4.3.1 Performance Objectives

Reviewers should use a risk-informed, performance-based approach to review the applicant's program and capability in meeting the performance objectives in 10 CFR 74.51(a). The reviewers should give high priority to the overall timely detection and resolution program. The reviewers should evaluate if the applicant appropriately considered and incorporated a collusion protection program in the MC&A system (i.e., threats from an insider; and potential diversion strategies during fuel processing, in material storage, or from recovery/recycling products). The primary reviewer of this section should coordinate with the primary reviewer of Section 13.1 where the applicant designed the detection program to be complimentary to the physical protection requirements in 10 CFR Part 73 to minimize redundant systems while maintaining adequate safeguards assurance.

13.2.4.3.2 Process Monitoring

Part 74.53 requires that licensees monitor internal transfers, storage, and processing of SSNM. The applicant's process monitoring program should be capable of: (1) promptly detecting a significant abrupt loss, diversion, or theft of two kilograms of plutonium with 95% power of detection, and (2) monitoring the status of material in process. The "prompt" detection is dependent upon the classification of the materials, i.e., Category IA or IB, as specified in §74.53.

The applicant's process monitoring program should at least consist of:

- A. Clearly defined process subdivisions and measurement points to satisfy unit detection criteria and the category of material being processed;
- B. Adequate material control tests for each unit process for detecting abrupt losses with at least 95% power of detection, evaluation and update of the action threshold on semi-annual basis, and ability to detect losses involving material substitution;

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- C. Basis for material classification, i.e., Category IA and IB materials;
- D. Clear classification of inaccessible locations;
- E. Identification of all credible substitute materials and the methods of preventing substitution;
- F. A listing of material types exempted from the abrupt loss detection tests with their locations and basis for exemption;
- G. Adequate trend analysis techniques and decision criteria, especially for the indication of trickling diversions; and
- H. Adequate material balance tests and evaluation for research and development operations.

It is necessary for the applicant to submit a study of potential diversion scenarios as supporting information. Such study should include, but not be limited to, abrupt losses, trickle diversion, insider and/or outsider diversion, unauthorized production, and material substitution.

The applicant's process monitoring program should be found acceptable if it meets the criteria specified in Chapter 1 of NUREG-1280, Rev. 1, April 1995. In addition, NUREG/CR-4604, *Statistical Methods for Nuclear Material Management*, provides guidance on statistical tests in providing 95% power of detection.

13.2.4.3.3 Item Monitoring

Part 74.55 requires that licensees establish an item monitoring program capable of providing timely plant-wide detection of the loss of items that total two kilograms of plutonium with 99% power of detection. The "timely" detection is dependent upon the classification of the materials, i.e., Category IA or IB, and the degree of tamper-safing that is employed, as specified in §74.55. The applicant's item monitoring program should at least consist of:

- A. A clear item identification system;
- B. A basis for item classification, i.e., Category IA and IB materials;
- C. A tamper-safing procedure and system;
- D. Accessibility control;
- E. Accounting and control procedures;
- F. Item measurement systems;
- G. Item verification procedures; and
- H. Item sampling techniques.

The applicant's item monitoring program should be found acceptable if it meets the criteria specified in Chapter 2 of NUREG-1280, Rev. 1, April 1995. In addition, NUREG/CR-4604, *Statistical Methods for Nuclear Material Management*, provides guidance on statistical tests in providing 99% power of detection.

13.2.4.3.4 Alarm Resolution

Part 74.57 requires that the licensees' alarm resolution and reporting programs assure:

- A. Resolution of the nature and cause of any MC&A alarm within approved time periods;
- B. Reporting to NRC within 24 hours of any unresolved MC&A alarm beyond the specified time period;
- C. Determining the amount of SSNM lost and taking corrective actions when a material loss has occurred;
- D. The ability to rapidly assess the validity of alleged thefts; and
- E. Taking appropriate actions when an abrupt loss detection estimate exceeds two kilograms of plutonium.

Specifically, the programs should address alarm resolution procedures, decision rules and their basis, and response time.

The applicant's programs for resolving and reporting indications of missing SSNM should be found acceptable if they meet the criteria specified in Chapter 3 of NUREG-1280, Rev. 1, April 1995. In addition, the applicant should establish the capability to respond rapidly to alarms occurring externally to the MC&A system, as stipulated in Chapter 3.3 of NUREG-1280, Rev. 1, April 1995.

13.2.4.3.5 Quality Assurance and Accounting Programs

Part 74.59 requires that licensees establish a quality assurance and accounting capability to address the 11 areas discussed in Sections 13.2.4.3.5 (A) through (K).

A. Management Structure

Part 74.59(b) establishes requirements for the licensees' MC&A management structure, organization, responsibilities, procedures, etc. The applicant's MC&A program's management structure should demonstrate the checks and balances of the program to ensure effective functioning of the MC&A program by providing:

- i. Clear overall responsibility for MC&A responsibilities;
- ii. Independence of MC&A functions from production responsibilities;
- iii. Separation of key MC&A responsibilities from each other to provide controls and checks; and

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- iv. Adequate review, approval, and use of approved written MC&A procedures.

The applicant's organization for developing and implementing the MC&A program and procedures should be found acceptable if it meets the criteria specified in Chapter 4.1 of NUREG-1280, Rev. 1, April 1995. (SRP Chapter 2.0 provides additional guidance on organization and administration, and SRP Chapter 11.5 provides additional guidance on procedures.)

B. Personnel Qualification and Training

Part 74.59(c) establishes qualifications and training requirements for key MC&A personnel. The applicant's personnel qualification and training programs should ensure that qualified and adequately trained personnel are implementing and maintaining an effective MC&A program by ensuring that:

- i. Personnel who work in key positions where mistakes could degrade the effectiveness of the MC&A program are trained to maintain a high level of safeguards awareness and are qualified to perform their duties and/or responsibilities;
- ii. Continuing qualification of key personnel will be verified on an ongoing basis or at least every 2 years; and
- iii. The training program emphasizes the job purposes and scope and provides a balance between theory and practice.

The applicant's personnel qualification and training programs should be found acceptable if they meet the criteria specified in Chapter 4.2 of NUREG-1280, Rev. 1, April 1995. (SRP Chapter 11.4 provides additional guidance on training and qualification.)

C. Measurement

Part 74.59(d) requires that licensees establish and maintain a system of measurements. The applicant's measurement program should ensure that:

- i. All source material, SNM, and SSNM information in accounting records are based on measured values;
- ii. Key measurement systems and measurement points are identified;
- iii. At each measurement point, the appropriate measurement method and system is used for the accurate and precise determination of the material type;
- iv. The MC&A system enables the estimation of the standard deviation associated with each measured quantity; and
- v. Necessary data are provided for performing material control tests.

The applicant's measurement program should be found acceptable if it meets the criteria specified in Chapter 4.3 of NUREG-1280, Rev. 1, April 1995. The following documents also provide additional guidance/information on measurement methods: NUREG-0228, *Calorimetric Assay of Plutonium*, NUREG-0256, *Methods for the Accountability of Mixed Oxide*, NUREG/CR-0602, *Active Nondestructive Assay of Nuclear Materials*, NUREG/CR-2078, *Handbook of Nuclear Safeguards Measurement Methods*, September 1983, and NUREG/CR-5550, *Passive Nondestructive Assay of Nuclear Materials*.

D. Measurement Control

Part 74.59(e) requires that licensees ensure the quality of measurement systems and material processing practices. The applicant's measurement control program should include:

- i. Performing engineering analyses and evaluations on all MC&A measurement systems;
- ii. Establishing and verifying procedures for mixing and sampling source material, SNM, and SSNM and maintaining sample integrity during transport and storage;
- iii. Generating current data on the performance of measurement processes;
- iv. Utilizing the measurement control data for the estimation of standard errors of inventory difference (SEID) and the standard deviation associated with the process differences;
- v. Ensuring SEID is less than 0.1% of the active inventory;
- vi. Applying bias corrections in accordance with approved written procedures;
- vii. Investigating and taking corrective actions when the associated measurement biases exceed limits; and
- viii. Establishing and maintaining a statistical control system to monitor the quality of each type of program measurement.

The measurement control program applies to measurement systems utilized for inventory, shipper-receiver measurement, monitoring cumulative shipper-receiver differences, and detection and response purposes. In addition, the applicant should ensure the traceability of calibration and control standard measurements to a national standard or nationally accepted measurement system.

The applicant's measurement control program should be found acceptable if it meets the criteria specified in Chapter 4.4 of NUREG-1280, Rev. 1, April 1995. NUREG/CR-4604 and TID-26298, *Statistical Methods in Nuclear Material Control*, 1973, provide additional guidance on measurement error standard deviation.

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E. Physical Inventory

Part 74.59(f) contains the basic requirements for scheduling, performing, and evaluating physical inventories. The applicant's physical inventory program should ensure that it provides for:

- i. Performing a physical inventory at least every 6 calendar months (unless otherwise required to satisfy 10 CFR Part 75);
- ii. Within 45 days after the start of the ending inventory:
 - a. Calculating inventory difference (ID) and estimating SEID;
 - b. Investigating, resolving, and reporting excessive ID and SEID;
 - c. Reconciling and adjusting the book inventory; and
 - d. Performing reinventory as necessary.
- iii. Implementing policies, practices, and procedures designed to ensure the quality of physical inventories; and
- iv. Control and maintenance of records and documentation associated with the physical inventories.

The applicant should appropriately describe the procedures and/or processes for verifying the location and identity of all quantities of SSNM and for verifying that all quantities are based on measurements, inventory cutoff and cutoff verification, and reconciliation. It is critical that the applicant demonstrates its ability to eliminate holdup before physical inventory and to measure holdup if it cannot be eliminated.

The applicant's physical inventory program should be found acceptable if it meets the criteria specified in Chapter 4.5 of NUREG-1280, Rev. 1, April 1995. NUREG/BR-0096, *Instructions and Guidance for Completing Physical Inventory Summary Reports*, provides additional guidance on completing NRC Form 327, *SNM and SM Physical Inventory Summary Report*.

F. Accounting

Part 74.59(g) requires that licensees establish auditable records sufficient to demonstrate that the requirements of 10 CFR 74.51, 74.53, 74.55, 74.57, and 74.59 have been met. The applicant's accounting programs should establish and maintain records in an auditable form, available for inspection, for at least 3 years, unless a longer retention time is required by 10 CFR Part 75. The programs should specify in what form those records will be kept. The programs should provide adequate safeguards against tampering with and loss of records. (SRP Chapter 11.8 provides additional guidance on Records Management.)

The applicant's programs for record keeping should be found acceptable if they meet the criteria specified in Chapter 4.6 of NUREG-1280, Rev. 1, April 1995. NUREG/BR-0006,

Instructions for Completing Nuclear Material Transaction Reports and Concise Note Forms (Form DOE/NRC 741, 741A, and 740M), and NUREG/BR-0007, Instructions for Completing Nuclear Balance Report and Physical Inventory Listing (Forms DOE/NRC 742 and 742C), provide additional guidance on the use of NRC-required forms for reporting transactions involving nuclear materials.

G. Shipments and Receipts

Part 74.59(h)(1) requires that licensees establish procedures for the measurement of shipments and receipts and for the review, evaluation, and investigation of shipper-receiver differences (SRD). The applicant should establish a program to timely and accurately quantify the content of SSNM and other nuclear materials in shipments and receipts. The program should provide:

- i. Accurate identification and measurements of the quantity shipped and received;
- ii. Clear definition of statistically significant SRDs;
- iii. Review and evaluation of SRD;
- iv. Investigation and corrective actions when SRD exceed the specified limit; and
- v. Documentation of SRD evaluations, investigations, and corrective actions.

The program should identify a reasonable time frame for completing the verification measurements of receipts. The documentation of shipments and receipts should be completed and transmitted within the time frame specified in NUREG/BR-0006. The applicant's program for shipper-receiver comparisons should be found acceptable if it meets the criteria specified in Chapter 4.7 of NUREG-1280, Rev. 1, April 1995.

H. Scrap Control

Part 74.59(h)(2) establishes requirements regarding the segregation of internally generated scrap from scrap received from other nuclear facilities and regarding the prompt recovery of scrap which cannot be measured to within $\pm 5\%$. The applicant's scrap control program should ensure that:

- i. Internally generated scrap and scrap from other licensees or contractors are segregated until accountability is established; and
- ii. Any scrap measured with a standard deviation greater than 5% of the measured amount is recovered, so that the results are segregated by inventory period and received within 6 months of the end of the inventory period in which the scrap was generated, except where it can be demonstrated that the scrap measurement uncertainty will not cause noncompliance with 10 CFR 74.59(e)(5).

In addition, the applicant's scrap control program should address that:

- iii. Scrap and waste will only be stored in approved locations and disposed by approved methods;

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- iv. The facility's recovery capability is adequate to preclude buildup of excess amounts of scrap;
- v. Special handling procedures for waste or independent measurement verification are described;
- vi. Scrap generated onsite and offsite are adequately separated, and the individuals performing measurements on scrap materials have the authority to reject containers that demonstrably violate segregation practices; and
- vii. Procedures and processes for offsite scrap recovery are discussed.

The applicant's scrap control program should be found acceptable if it meets the criteria specified in Chapter 4.8 of NUREG-1280, Rev. 1, April 1995.

I. Human Errors

Part 74.59(h)(3) requires that the licensees incorporate checks and balances in MC&A system to control the rate of human errors in MC&A information. The applicant's program should minimize human errors in the following areas:

- i. The development and management of MC&A procedures, especially procedures for processing MC&A data;
- ii. The use of job performance aids, such as illustrations and graphs;
- iii. The methods and technologies used to automate MC&A functions; and
- iv. The quality control system used to monitor the frequency and types of human errors.

The applicant's human error controls should be found acceptable if they meet the format and criteria specified in Chapter 4.9 of NUREG-1280, Rev. 1, April 1995. (SRP Chapter 16 provides additional guidance on human factors.)

J. Independent Assessment

Part 74.59(h)(4) requires that the licensees independently assess the past performance of MC&A program. The applicant's audit and assessment program should be acceptable if it:

- i. Independently assesses the effectiveness of MC&A system at least every 12 months;
- ii. Documents the results of the assessment;
- iii. Documents management's findings on whether the MC&A system is effective;

- iv. Documents any actions taken on recommendations from prior assessments; and
- v. Assesses the measurement control program of any outside contractor laboratory performing MC&A measurements for the applicant.

The selection of assessment team members should assure and balance independence and knowledge in the MC&A area. An assessment by a third party organization is not required, but is often an effective way to bring both knowledge and independence to the assessment effort. (SRP Section 11.6 provides additional guidance on Audits & Assessments.)

The applicant's program for assessing and reviewing the MC&A program should be found acceptable if it meets the criteria in Chapter 4.10 of NUREG-1280, Rev. 1, April 1995.

K. SSNM Custodianship

Part 74.59(h)(5) establishes requirements for assigning custodial responsibility for SSNM. The applicant's assignment of custodial responsibility should ensure that such responsibility is clearly defined and can be effectively executed. The applicant's SSNM custodial assignments should be found acceptable if they meet the criteria specified in Chapter 4.11 of NUREG-1280, Rev. 1, April 1995.

13.2.5 REVIEW PROCEDURES

13.2.5.1 Acceptance Review

The primary reviewer should perform an acceptance review to determine if the application for construction approval or license application adequately addresses the items in Section 13.2.3, "Areas of Review."

Guidance specific to the application for construction approval and the license application is provided below.

A. Application for Construction Approval

Specifically, the safeguards assessment of the design basis should address Section 13.2.3 at the level of commitments and program goals.

B. License Application

Specifically, the license application should address Section 13.2.3 in full and should include the FNMCP. The secondary and supporting reviewers should confirm that the FNMCP is consistent with descriptions in other sections of the application. Information provided in the FNMCP should be of comparable quality and detail, and should not contradict or adversely impact information contained in other sections of this application.

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If the primary reviewer verifies that MC&A is adequately addressed (application for construction approval or license application), the primary reviewer should accept the application for the safety evaluation in Section 13.2.5.2. If the primary reviewer identifies significant deficiencies in the material provided, the primary reviewer should request that the applicant submit additional information prior to the start of the safety evaluation.

13.2.5.2 Safety Evaluation

After determining that the application is acceptable for review in accordance with either Section 13.2.5.1(A) (application for construction approval) or 13.2.5.1(B) (license application for operations), the primary reviewer should perform a safety evaluation against the acceptance criteria described in Section 13.2.4. On the basis of its review, the staff may request that the applicant provide additional information or modify the application to meet the acceptance criteria in SRP Section 13.2.4.

Guidance specific to the application for construction approval and the license application is provided below.

A. Application for Construction Approval

The primary reviewer should establish that the applicant's design basis for MC&A and related commitments will lead to an FNMCP that will meet or exceed the regulatory acceptance criteria in Section 13.2.4.

B. License Application

The primary reviewer should establish that the applicant's FNMCP provides reasonable assurance in satisfying the acceptance criteria in Section 13.2.4 of this SRP. Also the primary reviewer should ensure that adequate documentation is provided.

For an existing facility, the NRC reviewers may wish to visit the site and hold discussions with facility personnel in order to gain a better understanding of the safeguards systems. For a planned facility, the NRC reviewers may wish to meet with the design team in order to gain a better understanding of the process, its potential safeguards concerns, and safeguards system/design approaches.

When the evaluation is complete, the primary reviewer, with assistance from other reviewers, should prepare input for the Safety Evaluation Report (SER) as described in Section 13.2.6 using the acceptance criteria from Section 13.2.4.

13.2.6 EVALUATION FINDINGS

The primary reviewer should document the safety evaluation by preparing material suitable for inclusion in the SER. The primary reviewer should describe the review, explain the basis for the findings, and state the conclusions.

The staff could document the safety evaluation for the application for construction approval as follows:

The staff reviewed the application for construction approval for [insert name of facility] according to Section 13.2 of NUREG-1718. The staff evaluated [Insert a summary statement of what was evaluated] and found that [summarize the findings].

The staff concluded that the applicant provided adequate commitments and goals for the design basis as it applies to material control and accounting and that these commitments and goals should result in a MC&A program and FNMCP that will meet or exceed the regulatory acceptance criteria outlined in NUREG-1718. As a result, the applicant meets the requirements in the area of MC&A to approve construction of the facility under proposed 10 CFR Part 70.

The staff could document the safety evaluation for the license application as follows:

The staff reviewed the license application for [insert facility name] according to Section 13.2 of NUREG-1718. The staff evaluated [Insert a summary statement of what was evaluated] and found [insert a description of the findings]. Based on the review of the license application, the NRC staff concluded that the applicant's FNMCP satisfies the staff's acceptance criteria. Specifically, the applicant has satisfactorily addressed the applicable regulatory requirements in 10 CFR Parts 74.51, 74.53, 74.55, 74.57, and 74.59.

13.2.7 REFERENCES

- A. Code of Federal Regulations, Title 10, Part 74, Subpart E, *Formula Quantities of Strategic Special Nuclear Material*.
- B. NUREG-1280, *Standard Format and Content Acceptance Criteria for the Material Control and Accounting (MC&A) Reform Amendment*, Rev. 1, April 1995.
- C. NUREG/CR-4604, *Statistical Methods for Nuclear Material Management*, December 1988.
- D. NUREG-0228, *Calorimetric Assay of Plutonium*, May 1977.
- E. NUREG-0256, *Methods for the Accountability of Mixed Oxide*, April 1977.
- F. NUREG/CR-0602, *Active Nondestructive Assay of Nuclear Materials*, January 1981.
- G. NUREG/CR-2078, *Handbook of Nuclear Safeguards Measurement Methods*, September 1983.
- H. NUREG/CR-5550, *Passive Nondestructive Assay of Nuclear Materials*, March 1991.

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- I. TID-26298, *Statistical Methods in Nuclear Material Control*, 1973.
- J. NUREG/BR-0096, *Instructions and Guidance for Completing Physical Inventory Summary Reports (NRC Form 327)*, October 1992.
- K. NUREG/BR-0006, *Instructions for Completing Nuclear Material Transaction Reports and Concise Note Forms (Forms DOE/NRC 741, 741A, and 740M)*, Revision 3, January 1989.
- L. NUREG/BR-0007, *Instructions for Completing Nuclear Balance Report and Physical Inventory Listing (Forms DOE/NRC 742, and 742C)*, Revision 2, July 1989.

13.2.8 DEFINITIONS

formula kilogram (FKG): SSNM in any combination in a quantity of 1,000 grams computed by the formula: $\text{grams} = (\text{grams contained U-235}) + 2.5 (\text{grams U-233} + \text{grams plutonium})$.

formula quantity: SSNM in any combination in a quantity of 5,000 grams or more computed by the formula: $\text{grams} = (\text{grams contained U-235}) + 2.5 (\text{grams U-233} + \text{grams plutonium})$.