



Fermilab  
ES&H Section

## FERMILAB NUCLEAR MATERIALS CONTROL AND ACCOUNTABILITY IMPLEMENTATION PLAN

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## **List of References**

1. DOE Order 471.1-1, Identification and Protection of Unclassified Controlled Nuclear Information (current revision).
2. DOE Order 474.1A, Control and Accountability of Nuclear Materials (current revision).
3. DOE Order 5660.1B, Management of Nuclear Materials (current revision).
4. DOE M 474.1-1B, Manual for Control and Accountability of Nuclear Materials (current revision).
5. DOE M 474.1-2, Nuclear Materials Management and Safeguards System Reporting and Data Submission (current revision).
6. DOE N 471.3, Reporting Incidents of Security Concerns (current revision).
7. Fermilab Nuclear Materials Control and Accountability Program (current revision).
8. Fermilab Site Security Plan (current revision).
9. Fermilab Hazard Assessment (current revision).
10. DOE Chicago Operations Office, Safeguards and Security Services Nuclear Materials Management Handbook (current revision).
11. Fermilab Nuclear Materials Control and Accountability Program Task Analysis and Training Needs Assessment (current revision).
12. Fermilab Radioactive Source Control and Accountability Program (current revision).
13. Fermilab NMC&A Program On the Job Training Form, R.P. Form # 100.
14. Fermilab Security Department Vulnerability Assessment (current revision).

## **Introduction and Purpose**

The purpose of Fermilab's nuclear materials control and accountability (NMC&A) Program is to provide a complete audit trail for all nuclear materials from receipt through disposition. Fermilab's Nuclear Materials Control and Accountability Program describes the structure and

operation of Fermilab's nuclear materials accounting system. Fermilab's NMC&A Program describes Fermilab's organizational responsibilities, nuclear materials inventory database, nuclear materials data flow and information process, reconciliation of nuclear materials inventory, nuclear materials transactions and reports, physical inventories, access controls, internal audits, and occurrence investigation and reporting.

Chapter 2 of the Fermilab Site Security Plan (Ref. 8) describes the security and access controls associated with nuclear materials.

The majority of Fermilab's nuclear materials inventory consists of depleted uranium contained in the DZero calorimeter and other DZero prototype modules. All depleted uranium is in the form of metal plates. Both pure metal and uranium/niobium-alloyed plates are used in the DZero hadron calorimeter and the prototype modules. Fermilab also has several Americium-Beryllium (Am-241Be) and Californium-252 (Cf-252) sealed neutron sources. These neutron sources are used for instrument calibration and related studies. Fermilab has deuterium in the form of gas contained in cylinders and tanks.

Fermilab has no reportable quantities of special nuclear materials (SNM).

### **Hazard Evaluation**

Nuclear materials at Fermilab are graded as Category IV, attractiveness level E as defined by relevant DOE Orders. Nuclear materials safeguards categories are outlined in DOE M 474.1-1A, Table I-4. Graded Safeguards Category IV materials are considered to be the least hazardous type of nuclear materials. Likewise, attractiveness E materials are considered to be low grade.

The Department of Energy Order 474.1-1A, Control and Accountability of Nuclear Materials, sets forth requirements for control and accountability of nuclear materials. DOE M 474.1-1B prescribes material types, material type codes and reportable quantities of nuclear material to be controlled and accounted for.

Fermilab's nuclear materials inventory consists of:

- Americium-241 (Am-241) in the form of Americium-Beryllium (AmBe) neutron sources and Am-241 radioactive sources.
- Californium-252 in the form of sealed neutron sources.
- Depleted uranium (DU) in the form of uranium plates and individual pieces. DU plates are assembled into calorimeter units within detectors.
- Deuterium in the form of gas and liquid contained in tanks and cylinders.

- Minimal quantities of Uranium-238 in the form of radioactive sources.

A hazard evaluation and a vulnerability assessment have been performed for nuclear materials at Fermilab.

A hazard evaluation for depleted uranium is contained in Section VI of Fermilab Hazard Assessment (Ref. 9). The results of this evaluation indicate that buildings which house depleted uranium within a calorimeter are classified as low risk in accordance with DOE Order 5480.23.

Fermilab Security Department conducted a vulnerability assessment (Ref. 14) for each building that contains hazardous materials (including nuclear materials). Americium-241 and Californium-252 in the form of sealed neutron sources are stored at the Radiation Physics Calibration Facility (RPCF). These sources are stored in a locked concrete vault within a locked cave. The threat of material theft, loss, diversion, dispersion, or sabotage has been evaluated. To mitigate these threats, the RPCF has a lock and security intrusion alarm system that is under ES&H Section control.

Deuterium is stored in cylinders within locked areas at the Railhead. These areas have been evaluated in the same manner as other areas of the ES&H Section and were found to have no potential for sabotage. Even though accessibility to this area is low, the vulnerability assessment indicates a moderate threat to target susceptibility. To mitigate these threats, fences and gates are locked and barbed wiring is used to prevent entry.

If loss, theft, diversion, dispersion, or sabotage of material should occur, the investigation and reporting procedures listed in Fermilab's NMC&A Program are followed.

### **Program Description**

Fermilab's Environment, Safety and Health (ES&H) Section is responsible for managing and operating the Nuclear Materials Control and Accountability Program. The ES&H Section reports to the Directorate. The Nuclear Materials Representative (NMR) and Nuclear Materials Representative Alternate are members of the Radiation Physics Team of the ES&H Section. Division/Section Heads are responsible for nuclear materials in use or storage within their areas.

Fermilab's Nuclear Materials Representative (NMR) is responsible for maintaining accounting system records, nuclear material inventory databases, data input to Safeguards Management Software (SAMS), data submission to Nuclear Materials Management and Safeguards System (NMMSS), and completion of inventory reports. The NMR coordinates nuclear material

physical inventories, on site transfers, transaction reports, material balance reports, forecast and inventory assessment reports, excess material declarations, inventory adjustments, updates to nuclear materials control and accountability procedures, and maintenance of nuclear materials logs.

Both the Associate Head for Radiation Protection of the ES&H Section and the NMR sign Material Balance Reports. The NMR or Alternate signs transaction reports.

The Associate Head for Radiation Protection appoints the NMR, the NMR Alternate, and the Source Physicist.

Fermilab's deuterium inventory data is obtained from the Particle Physics Division (PPD). The NMR or NMR Alternate maintains a file on all correspondence from Particle Physics Division regarding deuterium inventory. Deuterium pressure gauges are measured when deuterium is in use or when losses are suspected.

Radioactive and sealed neutron sources are contained in a radioactive source inventory database. The Source Physicist is responsible for maintaining and updating this database. The Source Physicist enters all new sources into the inventory and deletes any disposed sources, updates source loans, returns, and transfers.

The depleted uranium inventory database contains data for each discrete item of depleted uranium. This database is updated whenever there is a receipt, shipment, or transfer of depleted uranium. Database additions, deletions, and changes are controlled by the system log-on password. Only persons authorized to make database entries have access to this password.

### **Personnel Training and Qualification**

The scope and level of nuclear material control and accountability training is tailored to the NMR and NMR Alternate's assigned duties and responsibilities. The training is based on an analysis of skills, prior experience, and training in nuclear materials control and accountability. A task analysis and training needs assessment was conducted for Fermilab's nuclear materials program. Fermilab Nuclear Materials Control and Accountability Program Task Analysis and Training Needs Assessment (Ref. 11) identifies functions, responsibilities and tasks performed by the NMR. It describes job tasks and training requirements for each task. To ensure that all training objects were met, a Training Approval Program (TAP) Self-Evaluation Checklist was completed.

Nuclear materials training consists of self-study, on-the-job training (OJT), attendance at DOE

National Training Center (NTC) courses, completion of NTC correspondence courses, and NTC computer-based training. An on-the-job training program for the NMR Alternate has been established. On-the-job training for the NMR Alternate is validated and documented on R.P. Form # 100, Fermilab NMC&A Program On-the-Job Training Form (Ref. 13). These training functions are validated biennially.

Records to document NMC&A training are maintained by the Nuclear Materials Representative.

### **Program Improvement Processes**

The key measures used to evaluate Fermilab's nuclear materials control and accountability program improvement processes are timeliness, completeness and accuracy of reports, monitoring, access authorization, cost-effectiveness, and successful prevention of loss of nuclear material.

Reporting errors are identified by Nuclear Materials Management and Safeguards System (NMMSS). Fermilab's materials accounting record system accurately reflects the item identity and material location in at least 99 per cent of the cases.

The Nuclear Materials Representative updates the nuclear materials accounting procedures and Chapter 2 of the Fermilab Site Security Plan as needed to reflect program/policy changes. Revisions to these documents may reflect modifications to DOE orders. Updates may be based on recommendations from DOE Chicago Operations Office, Safeguards and Security Services (CH SSS) reviews and internal audits of the program.

### **Documents and Records**

Fermilab Nuclear Materials Control and Accountability Program (Ref. 7) is the primary document which describes Fermilab's nuclear materials accountability and control. The Radioactive Source Control and Accountability Program (Ref. 12) is the document which describes control and accountability of radioactive sources, including sealed neutron sources. These documents are reviewed periodically and updated as needed to reflect program/policy changes.

Nuclear materials records and reports are completed and disseminated in accordance with DOE Orders 474.1A, 474.1-1B, and DOE M 474.1-2.

Nuclear materials records and reports are generated by the Nuclear Materials Representative or NMR Alternate and maintained in the ES&H Section files. Nuclear materials records are documented in the ES&H Section records inventory. The following is a description of some

records and reports generated and maintained for Fermilab's nuclear materials program.

1. Forecast of Nuclear Materials Requirements Report

The Nuclear Materials Representative or NMR Alternate prepares an Annual Forecast of Nuclear Materials Requirements Report for all existing, authorized, and contemplated research and development projects having or needing nuclear materials. The Forecast of Nuclear Material Requirements Report is completed in accordance with DOE Order 5660.1B, Chapter I. The assessment report is sent to DOE Fermi Site Office for transmittal to DOE CH SSS.

2. Revisions to Forecast of Nuclear Materials Requirements Report

A Fermilab's NMR or NMR Alternate conducts a review of inventory adjustments at the end of each fiscal year. The review is conducted in accordance with DOE M 474.1-2. The assessment report is sent to DOE Fermi Site Office for transmittal to DOE CH SSS.

### 3. Annual Assessment of Nuclear Materials Inventory Report

Fermilab's NMR prepares an annual assessment of nuclear materials inventory for each project number. The assessment is completed for all material types in accordance with a guidance document generated by the National Nuclear Security Administration (NNSA). This guidance document prescribes reporting requirements and these requirements may vary from year to year. The inventories assessed in this report are taken from the 9/30 Material Balance Reports. The assessment report is sent to DOE Fermi Site Office for transmittal to DOE Chicago Operations Office, Safeguards and Security Services by 1/15 unless a different due date is specified via letter received from DOE CH SSS.

### 4. Nuclear Materials Transaction Reports (NRC/DOE Form 741)

Nuclear materials transaction reports document shipments and receipts of nuclear materials. This form is completed in accordance with DOE 474.1-2 (Ref. 5). Nuclear Materials Transaction Reports are sent to DOE Fermi Site Office for transmittal to DOE Chicago Operations Office, Safeguards and Security Services.

### 5. Nuclear Material Balance Reports (NRC/DOE Form 742)

The NMR or NMR Alternate completes a quarterly Material Balance Report (MBR) in accordance with DOE Order 474.1A and DOE M 474.1-1B. The report is recorded on Nuclear Material Balance Report, DOE/NRC Form 742. This report is submitted to DOE Fermi Site Office for transmittal to DOE Chicago Operations Office, Safeguards and Security Services.

## **NMC&A Work Processes**

Procedures, forms, and types of reports for the work processes involved in Fermilab's nuclear materials program are given in Reference 7, which can be found in the ES&H Section central file. The Nuclear Materials Representative maintains and updates this documentation whenever new processes that reflect more efficient operation are put into effect. All of these processes have ES&H impact in that they provide for proper accountability, storage, and safe use of nuclear materials at Fermilab.

## **Nuclear Materials Procurement**

The Nuclear Materials Representative coordinates procurement of nuclear materials. Nuclear

materials receipt procedures are outlined in Fermilab's NMC&A Program.

## **Nuclear Materials Access Controls, Transfer Checks, and Acceptance Criteria**

Fermilab has implemented material access controls to ensure only authorized personnel gain access to nuclear materials. Locked fences, doors, and padlocks control material access for depleted uranium and deuterium in storage. Depleted uranium contained in the DZero calorimeter is sealed within stainless steel plates and is not accessible to personnel.

Sealed neutron sources are stored in a concrete vault located inside Cave 1 of the Radiation Physics Calibration Facility (RPCF). Access to the neutron storage vault is controlled by use of a combination lock. Only authorized persons are granted the combination to this lock. The NMR grants these authorizations. An intrusion alarm system is installed on the doors of the RPCF, which upon unauthorized entry, set off an alarm at the Communications Center. ES&H Section personnel perform a monthly security check of the security system that controls nuclear materials at the Radiation Physics Calibration Facility.

Data access control is used prevent unauthorized access to nuclear materials control and accountability data. A log-on password is required to access nuclear materials inventory data. The NMR or NMR Alternate establishes and controls the log-on password. The radioactive source and depleted uranium databases are contained on the Fermilab network, which is backed up every evening during the workweek. This data can be obtained from the network system back up if necessary.

Fermilab's physical inventory reconciliation program is designed to provide assurance that all nuclear materials are accounted for and that the record system reflects the physical inventory. All nuclear materials at Fermilab are in the form of discrete items. Therefore, accessible items and systems containing nuclear materials are verified.

In certain circumstances, Fermilab conducts special physical inventories. Conditions requiring this kind of physical inventory may include a change in custodial responsibilities, apparent missing items, inventory differences, abnormal occurrence, or a breach or failure in RPCF security system. Non-routine physical inventories may be conducted at the request of authorized facility personnel or DOE office personnel.

A transfer check is completed upon receipt of nuclear materials. A transfer check is a confirmation of shipping container or an item count. This item count is compared with shipping documentation to ensure that the shipment was received in tact. If there is a discrepancy in the item count, a representative of the division/section receiving the material notifies the NMR or NMR Alternate to resolve the problem. If a discrepancy cannot be resolved, the NMR or NMR Alternate notifies DOE Fermi Site Office and DOE Chicago

Operations Office, Safeguards and Security Services to report a possible diversion of nuclear materials. Transfer checks are recorded on Radiation Physics Form # 20, Record of Radioactive Receipts and Shipments.

Acceptance/rejection criteria for resolution of nuclear materials receipts are based on verification of the inventory upon receipt of the material. If there is a discrepancy in the container or item count, the Nuclear Materials Representative or NMR Alternate notifies the shipper to resolve the problem. If a significant discrepancy cannot be resolved, Fermilab notifies DOE Fermi Site Office and DOE Chicago Operations Office, Safeguards and Security Services to report the discrepancy.

### **Self-Assessments and External Reviews**

Self-assessments of Fermilab's nuclear materials program are conducted biennially. Internal audits include review of accounting procedures, nuclear materials transaction reports, internal transfer records, nuclear materials logs, and accountability reports. The assessments are conducted by knowledgeable representatives.

The DOE Chicago Operations Office, Safeguards and Security Services conducts independent assessments of Fermilab's nuclear materials program when deemed necessary. Such appraisals assess compliance with DOE orders.

This document is updated on an as needed basis to reflect program/policy changes.