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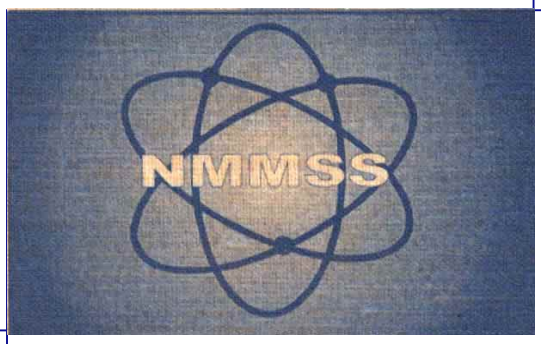
НАЦИОНАЛЬНАЯ СНСТЕМА УЧЕТА И КОНТРОЛЯ ЯДЕРНЫХ МАТЕРИАЛОВ США



U.S. NATIONAL NUCLEAR MATERIAL CONTROL AND ACCOUNTING SYSTEM

MOSCOW 1998

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Institute for Management, Information, and Automation (Atominform) as a deliverable to a contract to Lawrence Livermore National Laboratory under the auspices of the Department of Energy's Material Protection, Control and Accounting program wrote this document. This deliverable represents one part of the collaboration between DOE and Atominform to develop a state-wide system of nuclear material accountancy for the Russian Federation. This document represents the authors' understanding of briefings given in the U.S. on the development, architecture, and use of the U.S. Nuclear Materials Management and Safeguards System (NMMSS).

After this document was translated a number of errors were detected by the DOE Materials Protection, Control and Accounting Project team. Those errors/omissions have been highlighted in this version of the document.

It should also be noted that the DOE regulations listed under Section 3.2, page 16-17, and Section 9.1, page 72, are a combination of current and expired orders which were in place when the training was conducted in May 1997.

Here is a list of the major problems:

1. Table 2.4 on page 9 has several major omissions and incomplete expressions for the column headings $10 \leq A < 20$ and $A \geq 20$. In addition, the published Russian book contains 500 g instead of the correct 1000 g as the combined values for uranium-233, plutonium, and uranium-235 for material of moderate strategic significance.
2. Figure 4.1 on page 19 omitted directional arrows to indicate accurate informational flow between the NMMSS and DOE and USEC facilities reporting data to the system.
3. Section 5.1.1 on page 29 incorrectly states that the second character of the reporting identification symbol (RIS) identified the facility as "integrated or non-integrated prices i.e. the price is established by the facility or the field office." This should read "integrated or non-integrated financial accounting, i.e. the facility does their own financial accounting or it is done by the field office." Only DOE Headquarters establishes the financial values for nuclear materials.
4. Section 5.1.2 on page 29 misrepresents the retention of hard copies of the NMMSS forms. The forms are retained in hard copy archive only for those facilities reporting in hard copy. In actuality, very few facilities report to the NMMSS in hard forms.
5. Section 5.1.2 on page 39 omitted the final unique identifier after Action code which is Line number.
6. Section 5.2 on page 44 misrepresents information about special reports. It states that special reports are provided upon request "only to DOE facilities after DOE permission has been received." It should state that special reports are provided upon request "to any user of the NMMSS with proper authorization."
7. Figure 6.1 on page 50 omitted directional arrows to indicate accurate informational flow for the reporting of input information.
8. Section 6.3, page 53 incorrectly states the inventory cycle is based on quarterly reporting. This should be monthly and quarterly reporting since some DOE facilities report monthly and some report quarterly. Therefore, the next sentence should state the system processes inventory data on a monthly basis.
9. Figure 6.2, page 54 incorrectly states in the lower left-hand corner Quarterly Inventory Report. This should be changed to Monthly Inventory Report.
10. Section 6.3.1, page 55 incorrectly states the actions that take place when "close out" occurs. The example says the "system enters into the transaction data records the date that processing was completed." This information is not stored within the transaction data records although it is stored in the database. It should also be noted here that "all discrepancies between shippers and receivers have been reconciled" is not an accurate statement. The shipper and receiver data must be compatible, however, this does not mean there can not be shipper-receiver differences in the weights reported by each party of the transfer.
11. Section 6.3.2, page 57 incorrectly states the inventory cycle is based on quarterly reporting. This should be monthly and quarterly reporting since some DOE facilities report monthly and some report quarterly. Therefore, the next sentence should state the system processes inventory data on a monthly basis.

This is not an official NMMSS publication.

The U.S. FIS project team wishes to acknowledge Roberta Pedigo for the many hours spent in reviewing and editing this document.

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RUSSIAN FEDERATION MINISTRY OF ATOMIC ENERGY

CENTRAL RESEARCH INSTITUTE
FOR MANAGEMENT, ECONOMICS AND INFORMATION

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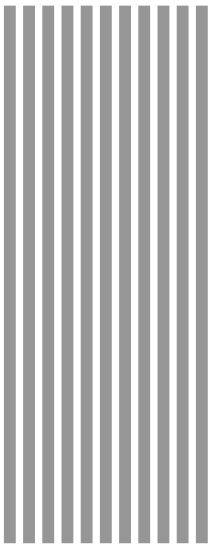

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The U.S. National Nuclear Material Control and Accounting System/**T.V. Bystrova, N.N. Venkova, A.M. Dolgushev, L.A. Kasumova, V.N. Maksimov, N.A. Poluektova, O.Z. Sashnev, S.A. Sergeev, V.M. Smirnov, V.S. Rudenko, V.S. Chernykh**. —Moscow: Atominform, 1998. 84 pages.

The basic concepts underlying the U.S. National Nuclear Material Control and Accounting System are examined in this book, focusing primarily on the principles and criteria related to designing and operating the system's central component, the nuclear material management and safeguards information system.

This book is intended for nuclear material control and accounting specialists and other individuals who wish to familiarize themselves with the approach of the U.S. to this problem.

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This document was prepared, in the Russian language, by the Russian Federation Central Research.

Contents

List of Acronyms

Acronyms Used in Russian

ДБ	**DB**	Database
ИВЦ	**DPC**	Data processing center
КТС		Computer hardware
ЛВС	**LAN**	Local area network

Acronyms Used in English

AEC	Atomic Energy Commission
ANSI	American National Standards Institute
BBS	Electronic bulletin board system
CFR	Code of Federal Regulations
DOE	Department of Energy
DOE/MAPD	DOE Management Accounting and Pricing Division
DOE/OSS	DOE Office of Safeguards and Security
ERDA	Energy Research and Development Administration
IAEA	International Atomic Energy Agency
ICR	Inventory change report
IEEE	Institute of Electrical and Electronics Engineers, Inc.
INMTS	International Nuclear Materials Tracking System
LLNL	Lawrence Livermore National Laboratory
LMES	Lockheed Martin Energy Systems
MBR	Material balance report
NAC	Nuclear Assurance Corporation International
NMMSS	Nuclear Materials Management and Safeguards System
NPT	Nuclear Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NRC/ONMSS	NRC Office of Nuclear Material Safety and Safeguards
ORNL	Oak Ridge National Laboratory
RIS	Reporting identification symbol
SIMEX	Secure information management exchange
UEA	Uranium enrichment activity
USEC	United States Enrichment Corporation

Foreword

Issues related to nuclear material control and accounting and illegal dealing in these materials were discussed at the April 19–20, 1996 Moscow summit meeting (G7 + Russia). The declaration from this meeting reaffirmed that governments are responsible for the safety of all nuclear materials in their possession and for the effectiveness of the national control and accounting system for these materials. The Russian delegation at this meeting stated that ". . .the creation of a nuclear materials accounting, control, and physical protection system has become a government priority. . . ." Therefore, in order to create a government nuclear material control and accounting system for the Russian Federation, it is critical to study the structure, operating principles, and regulations supporting the control and accounting of nuclear materials in the national systems of nuclear powers. In particular, Russian specialists have a definite interest in learning about the National Nuclear Material Control and Accounting System of the United States of America, which has been operating successfully as an automated system since 1968.

The report consists of ten chapters.

Chapter 1 gives brief historical chronology of the establishment, evolution, and modification of the U.S. National Nuclear Material Control and Accounting System.

Chapter 2 is devoted to nuclear materials subject to control and accounting under the national material control and accounting system. It provides a list of nuclear materials and nuclear materials categories developed by the U.S. Department of Energy (DOE), the Nuclear Regulatory Commission (NRC) and the International Atomic Energy Agency (IAEA).

Chapter 3 describes the legal and regulatory foundation for nuclear material control and accounting. It identifies the reports required from Department of Energy contractors and Nuclear Regulatory Commission licensees so that information on all transactions involving nuclear materials and the results of nuclear materials balance reports and inventories may be reported to NMMSS.

Chapter 4 describes the general structure of the U.S. National Material Control and Accounting Information System, lists the primary U.S. agencies engaged in nuclear material control and accounting, and identifies their activities and responsibilities. It describes the purpose, activities, functions, and organizational principles of the NMMSS information system.

Chapter 5 describes the structure of the database and output of the NMMSS. It describes the output in terms of its breakdown into categories.

Chapter 6 covers automated data processing in NMMSS. It discusses the way data processing is organized and details the steps in this process.

Chapter 7 presents the mechanism by which NMMSS reports are disseminated. It reviews the procedure for tracking special requests.

Chapter 8 describes the hardware and software at the NMMSS data analysis center in operation at NAC in Atlanta.

Chapter 9 analyzes the main factors in the quality and reliability of the NMMSS information system (standards and procedures, personnel and users, data reliability, data protection, technical reliability, software reliability, and post-crash recovery).

Chapter 10 contains recommendations to Russian Specialists from Specialists at ORNL based on their experience developing and operating the NMMSS.

A group of Russian Specialists have prepared this book based on the following materials:

- The workshop "Nuclear Materials Management and Safeguards System," April 29–May 10, 1996 in Oak Ridge and in Atlanta;
- Documents obtained in the lab-to-lab program;
- Published documents.

The workshop was conducted by Specialists from:

Oak Ridge National Laboratory:

Billy Matthews
Evelyn McKamy
Frankie Hughes
Tate Brown
Roberta Pedigo
Deb Reece
Carl Thomas
Randy Reagen
Ann Teeters
Lynn Adams
Jean Shipp
Sam Ruple

Lawrence Livermore National Laboratory:

Judith Littleton
Jim Wolford
Dan Disch

NAC International:

Garland Proco
Arbra Davis
Richard Edwards
Amy Kinnard
Gary Hirsch
Alexander Pavlov

The authors are sincerely grateful to all Specialists with whom the Russian experts collaborated during the workshop.

The high quality of the lectures and visual aids prepared by the American Specialists should be acknowledged.

The Russian Specialists are especially grateful to the initiators and organizers of the workshop, Judith Littleton and Billy Matthews, and to the American co-chair Sandy Taylor.

Terms and Definitions*

Highly enriched uranium—uranium enriched to 20% or more with uranium-235.

Fissile isotopes:

1) Uranium-233.
2) Uranium-235 found in enriched uranium.
3) Plutonium-239.
4) Plutonium-241.

Licensee—a privately owned facility licensed by the NRC for the possession, use or shipment of nuclear materials.

Material—special nuclear material.

Class 1A material—strategic special nuclear materials directly useable in the production of a nuclear explosive. There are, however, three exceptions, indicated in the 10CFR74.4.

Class 1B material—all types of strategic special nuclear materials which are not in class 1A.

Low-enrichment uranium—uranium enriched less than 20% with uranium-235.

Special nuclear material include:

1) Plutonium, uranium-233, uranium enriched with an isotope of uranium-235; or,
2) Any material artificially enriched with any of the aforementioned material, excluding source material.

Strategic special nuclear material includes:

- Plutonium.
- Uranium-233.
- Uranium-235 found in enriched uranium (20% or more).

Formula kilogram—an amount (1000 g) of strategic special nuclear material in any combination, calculated with the formula:

- $1000 = [m_1(Pu) + m_2(^{233}U)]2.5 + m_3(^{235}U)$ where m_i is the weight of the nuclear material, g.
  - $i = 1, 2, 3$.
  - $m_1(Pu)$—weight of plutonium.
  - $m_2(^{233}U)$—weight of uranium-233.
  - $m_3(^{235}U)$—weight of uranium-235.

Formula quantity—an amount (5000 g or more) of strategic special nuclear material in any combination calculated with the formula:

$$\{2.5[m_1(Pu) + m_2(^{233}U)] + m_3(^{235}U)\} \geq 5000 .$$

* These terms and definitions do not necessarily agree with the terms and definitions used in Russia. The purpose of this section is to preserve the integrity of the document.

1. Brief History of the Development of a Nuclear Material Control and Accounting System in the U.S.

The United States is the birthplace of the full-scale nuclear industry and is therefore the first government to create a national nuclear material control and accounting system.

The nuclear material control and accounting system was established, developed, and modified as the use of nuclear materials in the U.S. increased. We can identify the following main stages in its establishment and development [1-4]:

1940s Manhattan Project. This period is characterized by the handling of comparatively small amounts of nuclear materials. The focus was on ensuring the secrecy of all types of work with nuclear materials and with their physical protection.

1946 Atomic Energy Act enacted; this established a government monopoly on the possession and use of special nuclear materials (SNM) for peaceful purposes. AEC (Atomic Energy Commission) was established to oversee atomic energy research and development.

1948–1963 Nuclear Material Management and Safeguards System (NMMSS) established to collect, process, analyze, and disseminate information pertaining to nuclear materials control and accounting in the country, as well as nuclear materials exported from the U. S.

1954 The new Atomic Energy Act permits private use, but not ownership, of special nuclear materials.

1954–1964 Measurement methods, rules, and regulations regarding special nuclear materials developed; guidelines enacted (Code of Federal Regulations/Energy, 10 CFR 70) which established general requirements for control and accounting of SNM.

1964 Private ownership of special nuclear materials permitted under U.S. Law 88-189; requirements and criteria established for managing nuclear materials; measurement methods and procedures modified; control and accounting practice introduces the concept “material balance area;” annual inventory of nuclear materials introduced.

1964 NMMSS computerized and becomes an automated information system (run on mainframes at Oak Ridge National Laboratory, Tennessee).

1974 U.S. law reorganizing energy management eliminates the Atomic Energy Commission (AEC).

1974 The Nuclear Regulatory Commission (NRC), an organization which shall regulate special nuclear materials management, is created.

1977 The Department of Energy (DOE) is created.

1981 The Nuclear Regulatory Commission issues clarification of proposed rules for revising regulations on control and accounting to explain the following criteria and concepts:

- Detection of strategic special nuclear material (SSNM) within 24 hours.
- Probability of detection of the loss of 5 formula kilograms of SSNM.
- Protection of the material control and accounting system from internal interference.

1982–1995 A period of further refinements of regulations on nuclear material control and accounting, including:

- Approval and implementation of revisions to the appropriate portions of the Code of Federal Regulations (10 CFR 74, "Nuclear Materials Control and Accounting").
- Development of national standards and guidelines on the application of the standards.
- Development of Nuclear Regulatory Commission guidelines.
- Development of the concept of DOE nuclear materials safeguards categories.

1995 In September 1995, the plan to transfer automated centralized material control and accounting database management to PCs (NAC, Atlanta) was completed.

2. Nuclear Materials Subject to Control and Accounting in the U.S.

The nuclear materials in Table 2.1 indicate reportable elements and their isotopes which are subject to control and accounting in the NMMSS.

Table 2.1. Nuclear materials.

Element, isotope	Unit of measure	Isotope content[1]	Reported	
			Element	Isotope
Depleted uranium[2]	kg	Uranium-235	Uranium	Uranium-235
Enriched uranium[2]	g	Uranium-235	Uranium	Uranium-235
Plutonium-242[3]	g	Plutonium-242	Plutonium	Plutonium-242
Americium-241	g	—	Americium	Americium-241
Americium-243	g	—	Americium	Americium-243
Curium	g	—	Curium	Curium-246
Berkelium	mcg	—	—	Berkelium-249
Californium	mcg	—	—	Californium-252
Plutonium[2]	g	Plutonium-240	Plutonium	Plutonium-239 and plutonium-241
Enriched lithium	kg	Lithium-6	Lithium	Lithium-6
Uranium-233[2]	g	Uranium-232[4]	Uranium	Uranium-233
Natural uranium[2]	kg	—	Uranium	—
Neptunium-237	g	—	Neptunium	—
Plutonium-238[2,5]	0.1g	Plutonium-238	Plutonium	Plutonium-238
Deuterium[6]	0.1 kg	—	D_2O	D_2
Tritium	0.01 g	—	Tritium	—
Thorium[2]	kg	—	Thorium	—
Uranium in cascades[7]	g	Uranium-235	Uranium	Uranium-235

The following rules must be followed in preparing reports:

[1] Indicated isotope content, %.

[2] Nuclear materials in civilian industry.

[3] The material is indicated in the report as plutonium-242 if its total content by mass of ^{242}Pu is at least 20%; if its total ^{242}Pu content by mass is less than 20%, the material is indicated as plutonium-241.

[4] ^{232}U content is indicated in units, 10^{-6}.

[5] The material is indicated as plutonium-238 if its total content by mass of ^{238}Pu is more than 10%; if its total ^{238}Pu content by mass is less than 10%, the material is indicated as plutonium-239 and -241.

[6] Tritium contained in light or heavy water (H_2O or D_2O) used as a moderator in a nuclear reactor is not reportable material. If the tritium is in the form of heavy water, both the element and isotope weight fields will be used; otherwise, report isotope only.

[7] Cascaded uranium is indicated as enriched uranium.

Nuclear materials are controlled and accounted for on the basis of the classification dividing such materials into categories according to their strategic or financial importance and their potential environmental threat.

Table 2.2 shows a five-level classification system of material “attractiveness” defined by the corresponding U.S. Department of Energy directive. [5]

Table 2.2. Attractiveness levels and safeguards categories.

Material type	Level of attract-iveness	Safeguards category (I - max. concern) as a function of the amount of material contained (kg)							
		Plutonium or uranium-233				Uranium-235			
		I	II	III	IV	I	II	III	IV
Weapon[1]	A	Any amount—category I				Any amount—category I			
Pure product[2]	B	>2	0.4–2	0.2–0.4	<0.2	>5	1–5	0.4–1	<0.4
High-grade material[3]	C	>6	2–6	0.4–2	<0.4	>20	6–20	2–6	<2
Low-grade material[4]	D	—	>16	3–16	<3	—	>50	8–50	<8
All other[5]	E	Any reportable quantities[6]— category IV				Any reportable quantities[6]— category IV			

[1] Assembled weapon or test device.
[2] Components, disks, ingots, re-melted metal, directly convertible materials.
[3] Carbides, oxides, solutions with concentration greater than 25 g/liter, nitrates etc., fuel rods and assemblies, UF_4 and UF_6 with enrichment greater than 50%.
[4] Solutions with concentration from 1 to 25 g/liter, process residues requiring extensive reprocessing, moderately irradiated materials, ^{238}Pu (except wastes), UF_4 and UF_6 with enrichment from 20 to 50%.
[5] Heavily irradiated forms, solutions with concentration below 1 g/liter, uranium in any form and amount with enrichment above 20%.
[6] Reportable quantity—more than 1 g of ^{239}Pu to ^{242}Pu or enriched uranium, or more than 0.1 g ^{238}Pu.

As the data in Table 2.2 demonstrate, assembled weapons systems are the most desirable in terms of theft or diversion. They always require the highest degree of safeguarding (which means the maximum care in terms of accounting and security). It is also assumed that pure plutonium and highly enriched uranium are one level lower, but the highest safeguard category should also be applied to them, even to quantities somewhat smaller than those necessary to produce a single nuclear explosive device (see Table 2.3).

Table 2.3. Significant quantity of nuclear material utilized by the IAEA. [6]

Material	Significant quantity (kg)	Safeguard applicability
Direct-use nuclear material		
Plutonium[1]	8	All isotopes of the element
Uranium-233	8	Only the isotope
Uranium[2]	25	U-235 content
Indirect-use nuclear material		
Uranium[3]	75	U-235 content
Thorium	2000	All isotopes of the element

[1] For plutonium containing less than 80% plutonium-238.
[2] For uranium containing not less than 20% uranium-235.
[3] For uranium containing less than 20% uranium-235, including natural and depleted uranium.

From the standpoint of the possibility of using strategic special nuclear material in a nuclear weapon, NRC documents [7] define two categories.

1) Category 1A material.

2) Category 1B material.

The strategic significance of special nuclear material depends on its quantity (see Table 2.4).

In terms of strategic significance, the following categories are identified: special nuclear materials of low and moderate strategic significance and strategic special nuclear material.

Table 2.4. Strategic significance of special nuclear material. [7, part 74.4]

Material significance	**Amount of material (g)**				
	Plutonium	**Uranium-233**	**Uranium-235**		
			Enrichment (A), %		
			0.7<A<10	**10<A<20**	**A>20**
Material of low strategic significance	>15	—	—	—	—
	—	>15	—	—	—
	—	—	—	—	>15
	$[m_1(Pu) + m_2(^{233}U) + m_3(^{235}U)] > 15$				
Material of moderate strategic significance	>500	—	—	—	—
	—	>500	—	—	>500
	$[m_1(Pu) + m_2(^{233}U) + m_3(^{235}U)] > 500$				
Strategic special nuclear material	Nuclear materials in any combination totaling 5000 g or more, defined as $2.5[m_1(Pu) + m_2(^{233}U)] + m_3(^{235}U) \geq 5000$.				

U.S. version of Table 2.4.

Material significance	**Amount of material (g)**				
	Plutonium	**Uranium-233**	**Uranium-235**		
			Enrichment (A), %		
			0.7<A<10	**10≤A<20**	**A≥20**
Material of low strategic significance	>15	>15	≥10,000	1,000 < x <10,000	>15
	$[m_1(Pu) + m_2(^{233}U) + m_3(^{235}U)] > 15$				
Material of moderate strategic significance	>500	>500	—	≥10,000	1,000< x <5,000
	$2[m_1(Pu) + m_2(^{233}U)] + m_3(^{235}U) \geq 1000$				
Strategic special nuclear material	Nuclear materials in any combination totaling 5000 g or more, defined as $2.5[m_1(Pu) + m_2(^{233}U)] + m_3(^{235}U) \geq 5000$ where $A \geq 20$.				

3. Legal and Regulatory Basis for Nuclear Material Control and Accounting in the U.S.

The current U.S. national MC&A system is based on:

- Laws on the use of atomic energy.
- National standards.
- Rules and regulations developed by the Department of Energy and the Nuclear Regulatory Commission.
- NMMSS procedures and standards.

3.1 Laws on the Use of Atomic Energy

On September 1, 1946 the law on peacetime control of nuclear energy, based on the McMahon legislative proposal, was passed. [2, 8]

This law established a government monopoly on the production of fissile materials. This law created the Atomic Energy Commission (AEC) to replace the Manhattan Project. The AEC was responsible for carrying out the national program for the production and use of atomic energy and its regulation.

The law authorized the AEC to engage in business in all areas related to atomic energy, including both industrial use and research. The scope of its activities included the mining and processing of nuclear raw material, design and construction of nuclear reactors, and the production of nuclear materials and the generation of electricity at nuclear power plants.

The 1946 law established strict regulations for secrecy. Violation of these regulations was punishable by life imprisonment or the death penalty. The law also provided for very strict control of the dissemination of scientific and technical information about atomic energy.

On August 30, 1954, a new atomic energy law was enacted. According to the new law, the AEC retained the right to be the country's sole owner of all special nuclear materials.

This law now serves as the basis for the management of nuclear materials in the U.S.

In 1974, Congress enacted the Law on the Reorganization of Energy Management. This law abolished the AEC and separated the licensing functions of the former AEC from oversight of energy research and development. [9] Oversight of energy research and development was transferred to the Energy Research and Development Administration (ERDA). ERDA was also given the government program for the development of nuclear weapons. [10]

The NRC became responsible for legal regulation and licensing of all aspects of activities at privately owned nuclear facilities as defined in laws enacted by Congress and amended by the NRC. The objective of the NRC is to regulate the peaceful use of atomic energy and to ensure the safety and health of the population in accordance with national standards in the construction and operation of nuclear plants and in the use of nuclear materials for peaceful purposes. The NRC is responsible also for controlling nuclear materials used at commercial nuclear power facilities. [11]

In 1977, ERDA became the Department of Energy (DOE). [12, 13] It was given responsibility for the development, testing, and improvement of nuclear weapons and the development of power generation in the U.S.

3.2 National Standards, Rules, and Regulations Developed by the Department of Energy and the Nuclear Regulatory Commission

Nuclear material control and accounting requirements are set forth in regulations developed by the Department of Energy and the Nuclear Regulatory Commission, as well as in national standards. Additional reporting requirements have been established for material control and accounting at facilities under IAEA safeguards.

The main document governing nuclear material control and accounting requirements in the Department of Energy is DOE5633.3B, "Control and Accounting of Nuclear Materials," dated 7 September 1994 [14], and DOE5633.3B (sic), "User Guidance."

This document describes the requirements and procedures established by the Department of Energy for nuclear material control and accounting. The document applies to nuclear materials at facilities owned by the Department of Energy and facilities leased by it, as well as nuclear materials belonging to the Department of Energy and located at other facilities which the NRC has excluded from the list of facilities and companies which must have licenses.

The provisions of this document apply to all contractors to the extent to which they must be fulfilled in compliance with their contract or other agreement.

The document does not apply to nuclear materials belonging to the Department of Energy which are located at Defense Department or foreign facilities.

There are several other DOE guidelines related to the organization of the national nuclear materials control and accounting system, safety and safeguards issues, conduct of inspections of nuclear materials and their physical protection, management of radioactive wastes, etc.

The List of Primary DOE Guidelines [5, 14, 15]:

- DOE 1270.2B "Safeguards Agreement with the International Atomic Energy Agency."
- DOE 1360.2B "Unclassified Computer Security Program."
- DOE 4200.33 "Approval of Purchase Orders" [English language title not verified].
- DOE 5000.3B "Occurrence Reporting and Processing Operational Information."
- DOE 5400.1 "General Environmental Protection Standards."
- DOE 5480.20 "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities" dated 20 February 1991.
- DOE 5480.22 "Technical Safety Requirements" dated 25 February 1992.
- DOE 5484.1 "Requirements for Submitting Information on Environmental Protection, Safety and Health" dated 24 February 1981.
- DOE 5500.1B "Emergency Management System" dated 30 April 1991.
- DOE 5630.11B "Safeguards and Security Program."
- DOE 5630.13A "Master Safeguards and Security Agreement" dated 8 June 1992.
- DOE 5630.14A "Safeguards and Security Program Planning" dated 9 June 1992.
- DOE 5630.16A "Safeguards and Security Acceptance and Validation Testing" dated 28 August 1992.

- DOE 5630.17 "Safeguards and Security (S&S) Standardization Program" dated 29 September 1992.
- DOE 5632 "Physical Protection" [English language title not verified].
- DOE 5632.1C "Protection and Control of Safeguards and Security Interests."
- DOE 5633.3B "Control and Accounting of Nuclear Materials" dated 7 September 1994.
- DOE 5633.3B (sic) "Guide of Implementation Instructions for Nuclear Materials Management and Safeguards System Reporting and Data Submission."
- DOE 5820.2F "Radioactive Waste Management" [English language title not verified].

Document DOE 5633.3B notes in the section "Accounting Structure":

- A facility may have one or more areas for recording nuclear material balance; these are used to identify the location and amount of nuclear materials at the facility. In each material balance area at a facility, data reflecting the inventory amount of nuclear materials, the amount of nuclear materials received and shipped, and other inventory changes should be continuously recorded and available for tabulation.
- The accounting structure at the materials balance area must make it possible to isolate discrepancies detected during inventories. Inspection and control facilities must also be provided to confirm the accuracy of the accounting data and records.
- Material balance areas should be designed with regard to the types of nuclear materials on hand as well as the processes and functions related to them. There must be a sufficient number of nuclear material balance areas to identify and isolate discrepancies detected during inventories and their causes.

Inventory changes are identified at the nuclear material balance area and are recorded in reports.

Private companies in the U.S. holding NRC licenses are required to adhere to the following NRC regulatory documents [7, 15]:

- NUREG/BR-0006 "Instructions for Completing Nuclear Material Transaction Reports and Concise Note Forms."
- NUREG/BR-0007 "Instructions for Completing Material Balance Area Report and Physical Inventory Listing."
- NUREG/BR-0096 "Instructions and Guidance for Completing Physical Inventory Summary Reports."
- NUREG/CR-0602 "Active Nondestructive Assay of Nuclear Materials: Principles and Applications," Parts 1 and 3.
- NUREG/CR-0773 "Training and Qualifying Personnel for Performing Measurements for the Control and Accounting of Special Nuclear Material."
- NUREG/CR-0829 "A Measurement Control Program for Nuclear Material Accounting."
- NUREG/CR-1192 "Material Accounting as Required by the United States Nuclear Regulatory Commission: Capabilities and Vulnerabilities."
- NUREG-1329 "Entry/Exit Control at Fuel Fabrication Facilities Using or Possessing Formula Quantities of Strategic Special Nuclear Material."

- NUREG/CR-1528 "Safeguards Users Manual for Nuclear Material Management and Safeguard Systems."
- NUREG/CR-2078 "Handbook of Nuclear Safeguards Measurement Methods," Parts 1, 2, and 3.
- NUREG/CR-2820 "Resolution of Shipper/Receiver Differences."
- NUREG/CR-4695 "Material Control and Accounting (MC&A) Loss Detection During Transition."
- NUREG/CR-5003 "Design of a Material Control and Accounting System to Protect Against Concealment of Diversion by Falsification and Collusion."
- Regulatory Guide 5.26 "Selection of Material Balance Areas and Item Control Areas (April 1975)."

Government standards developed by ANSI are used in nuclear material. Some of these standards are listed below [15]:

- ANSI No. 15.2-71 "Record and Reporting Units for Nuclear Materials Control."
- ANSI No 15.5-72 "Statistical Terminology and Notation for Nuclear Materials Management."
- ANSI No. 15.11-73 "For Nuclear Materials Balance Reports Audit Opinions."
- ANSI No. 15.17-75 "Concepts and Principles for the Statistical Evaluation of Shipper-Receiver Differences in the Transfer of Special Nuclear Materials."
- ANSI No. 15.38-82 "Generic Requirements for Auditing Nuclear Materials Safeguards Systems."
- ANSI No. 15.36-83 "For Nuclear Materials—Nondestructive Assay Measurement Control and Assurance."
- ANSI No. 15.41-84 "For Nuclear Facilities—Derivation of Measurements Control Programs-General Principles."
- ANSI No. 15.28-91 "For Nuclear Materials Control Guide for Qualification and Certification of Safeguards and Security Personnel."

3.3 Department of Energy and Nuclear Regulatory Commission Reports

Department of Energy contractors and Nuclear Regulatory Commission licensees must document all operations with nuclear materials and the results of nuclear materials balances and inventories.

Facilities in NMMSS are to report on the approved forms in compliance with the instructions in DOE 5633.3B "Guide of Implementation Instructions for Nuclear Materials Management and Safeguards System Reporting and Data Submission" and are to rely on NRC Report Preparation Instructions (NUREG/BR-0006, NUREG/BR-0007).

DOE/NRC report forms:

- Special Nuclear Material Transaction Report—form 741/741A; (741A—continuation page). These forms contain information necessary to document the transfer of nuclear material, including the transfer of nuclear materials among facilities, corrections to inventory amounts, scheduled transfers at the facilities and changes in financial responsibility, and changes in inventory amounts at all DOE installations subject to the provisions of the U. S.-IAEA agreement.
- Physical Inventory Listing—form 742C. Contains information necessary for reporting on the actual amount and composition of nuclear materials on hand.

- Material Balance Report—form 742. Contains information necessary for reporting on the material balance.
- Concise Notes—form 740M. Submitted by facilities under the appropriate clauses of the U. S.-IAEA agreement. These notes for the Agency may pertain to additional data on nuclear materials transfer, nuclear material balance reports, or inventory amounts of materials.

Notes are prepared in one of the following manners: in undefined formats, at the preference of the facilities, or in accordance with the facility attachment, or with a transitional facility attachment.

Concise notes are also submitted by facilities involved in the import and/or export of nuclear materials.

In addition to the routine forms (e.g., form 740M) which may be used, exporters of nuclear materials are to use a special preprint version of DOE/NRC form 740 M (it contains column 207 “Export Note” under 8.B “Input Instructions”) for each shipment to a foreign company, except for defense purposes.

Summary report on physical inventory—form 327. A summary report is prepared following each physical inventory and sent to NRC headquarters—not to NMMSS.

Report forms and other documents to be submitted to the IAEA.

- Information on installation design – form No. 71.
- Material Balance Report – form No. 742.
- Physical Inventory Listing – form 742C.
- Nuclear Material Transaction Report – form 741.
- Physical inventory summaries (based on form 742).
- Concise note to the report on changes in inventory amounts (based on form 740M).

Facility reporting documents regarding material balance areas are submitted directly to the IAEA—not via NMMSS.

In addition to these documents, there are reports on transfer of special nuclear material between the Department of Energy and the Department of Defense.

3.4 Electronic DOE/NRC Report Forms

Each DOE/NRC report form has a DOE-approved electronic equivalent:

- Forms DP-733 and DP-733A—descriptive sheets on data on inventory quantities.

  These forms contain information necessary for reporting on inventory quantities of nuclear materials in a format required for input into the NMMSS central information system.

  These forms are identical except for form DP-733A, which contains additional fields required for facilities under IAEA safeguards.

  Form DOE/NRC 742C is the source document for forms DP-733 and DP-733A.

- Form DP-735—descriptive sheets for data on the material balance report.

  This form contains information necessary for reporting nuclear materials balance data in the format required for input into the NMMSS central information system.

  Form DOE/NRC 742 is the source document for forms DP-735.

- Form DP-740 is a descriptive sheet from the nuclear material transactions journal. Form DP-740A is a continuation of DP-740. These forms contain all information necessary for reporting on nuclear materials transactions in the format required for input into the NMMSS central information system.

  Forms DOE/NRC 741, 741A are the source documents for forms DP-740 and DP-740A.

- Form DP-749 is a descriptive sheet on nuclear materials transfer on internal projects. They contain all information necessary for reporting on nuclear materials transfers for DOE projects or programs under one identification symbol in the format required for input into the NMMSS central information system.

  Forms DOE/NRC 741, 741A are the source documents for form DP-749.

- Form DP-734 is a descriptive sheet for concise notes. Submitted by facilities under the provisions of the U.S.-IAEA agreement, and facilities importing and/or exporting nuclear materials in the format required for input into the NMMSS central information system.

  Form DOE/NRC 740M is the source document for form DP-734.

- Form DOE/NRC 742 is a material activity chart. The form is used to transfer information about leased special nuclear materials, belonging to the DOE, in the possession of a DOE contractor and accounted for with a different report identification symbol.

4. Organization of U.S. Nuclear Materials Control and Accounting Using the NMMSS Information System

4.1 General Structure of the Control and Accounting System

Under the U.S. national MC&A system, all facilities where nuclear materials control and accounting are carried out are divided into three groups on the basis of their affiliation, licensing requirements, and participation in projects.

The U.S. Department of Energy (DOE) is responsible for developing, testing, and improving nuclear weapons and developing nuclear power generation in the country. It is also responsible for organizing nuclear material control and accounting at subordinate facilities and sponsors the MC&A program on a national scale.

The Nuclear Regulatory Commission is responsible for control and accounting of nuclear materials used at commercial facilities licensed by the NRC, including nuclear power plants, universities, and hospitals.

The USEC was established by an act of Congress in 1993 to manage uranium enrichment facilities and to regulate the sale of enriched uranium.

The U.S. national MC&A system provides the U.S. Government with information to:

- Prevent unchecked loss, theft, and unauthorized use of nuclear materials.
- Manage nuclear materials.
- Manage finances.
- Fulfill U.S. international obligations.
- Improve legal regulations on nuclear activities and define licensing policy.
- Oversee and coordinate Government-approved nuclear research and development.
- Define Federal Government policy regarding enrichment services and leasing and trade policy.

Requests for information also come from foreign governments, state and municipal legislative bodies, Congress, and social organizations through the Freedom of Information Act.

The central information source for the national nuclear materials control and accounting system is the NMMSS information system. Its main purpose is to gather information, maintain the national database, and provide information about nuclear materials control and accounting to the U.S. Government.

NMMSS collects, processes, and stores information about nuclear materials that are: used by the U.S. Government and owned by it; used under license or as the property of private U.S. companies; the property of foreign governments but in the sphere of interest of U.S. national security; produced in the U.S. but transferred under license or sold to foreign countries.

The U.S. Department of Energy, the NRC, USEC, and the NMMSS executive committee oversee and manage the NMMSS.

The NMMSS executive committee was founded in 1985 under the auspices of the DOE. Its members are DOE and NRC headquarters divisions, DOE field offices, and USEC. The committee coordinates system activity and is not charged with administering the system. Its main functions are to:

- Define NMMSS activity for the short and long term.
- Develop proposals for making changes to NMMSS.

Government level coordinators between NMMSS, cabinet departments, and organizations are DOE, NRC and USEC. All requests for information from NMMSS are sent through these organizations.

Figure 4.1 shows the organizational chart for the U.S. material control and accounting system based on the NMMSS information system.

4.2 Stages in NMMSS Development and Modernization

The NMMSS was established in 1948 and functioned until 1964 without automated report processing.

The system became computerized in 1964 and continues to evolve together with the U.S. national material control and accounting system. The philosophy behind nuclear materials control and accounting has been refined; system software and data processing capability have been improved, as have the validity of the information and the reliability of the entire system. At the same time, the amount of information processed by NMMSS has increased to encompass not only all types of activity in the nuclear sphere in the U.S., but also nuclear material import and export transactions.

In 1995, the NMMSS contained more than 400 computer programs and issued about 500 types of reports. This system developed in a somewhat cumbersome manner, but it did the job assigned to it.

Recently, because of the end of the cold war, work with nuclear materials in the U.S. has diminished considerably. In 1994, the decision was made to transfer NMMSS from LMES in Oak Ridge, where it was operating at a large computer center on IBM mainframe computers, to NAC, a private corporation in Atlanta, where it was transferred to PCs operating within a LAN. The main reason for this transfer was the need to reduce NMMSS operating costs. In addition, NMMSS was confronted by the problem of updating its hardware and software to ensure more flexibility in developing and using applications and databases.

In September, 1995 NAC began commercial operation of NMMSS on an Ethernet/Novell LAN in a FoxPro 2.5 environment.

4.3 Functions and Organizational Principles of NMMSS Activities

The functions of NMMSS personnel have remained unchanged:

- Information gathering.
- Data processing, DB development and maintenance, and ensuring the validity, integrity and security of the data.
- Analysis of the information in the database and development of output reports according to U.S. national standards, as well as international treaties and agreements.
- System development: compliance with changing requirements for information services to its users; tracking the current level of development in computers and information technologies.
- Consulting and training on NMMSS functioning issues of interest to system users.

As the system has been operated and developed, fundamental organizational principles for its operation were formulated by its Specialists when the system was operated at Oak Ridge:

- NMMSS writes into its database only information supplied to it in compliance with regulations (it enters nothing on its own initiative).

– NMMSS does not prepare any reports on its own initiative (only in compliance with regulations or on request).

– All data received by NMMSS are retained.

– NMMSS issues reports and notes only on the basis of information entered into its database.

The main condition for the transfer of NMMSS from LMES to NAC was to keep the same information structure and processing technology. This condition was dictated by the fact that during the transfer NMMSS had to remain a useable, “living” system with its current information structure and wide range of users accustomed to certain rules of interaction with the system. The main factors that had to be taken into account during the transformation of NMMSS were [16]:

– The existence of users trained to work with NMMSS.

– Requirements already developed for appendices.

– Pre-defined structure and composition of NMMSS input data.

– Established DB interfaces.

– Established data editing rules.

– Established report formats and output content.

– Maintenance of the existing historical database in an accessible form.

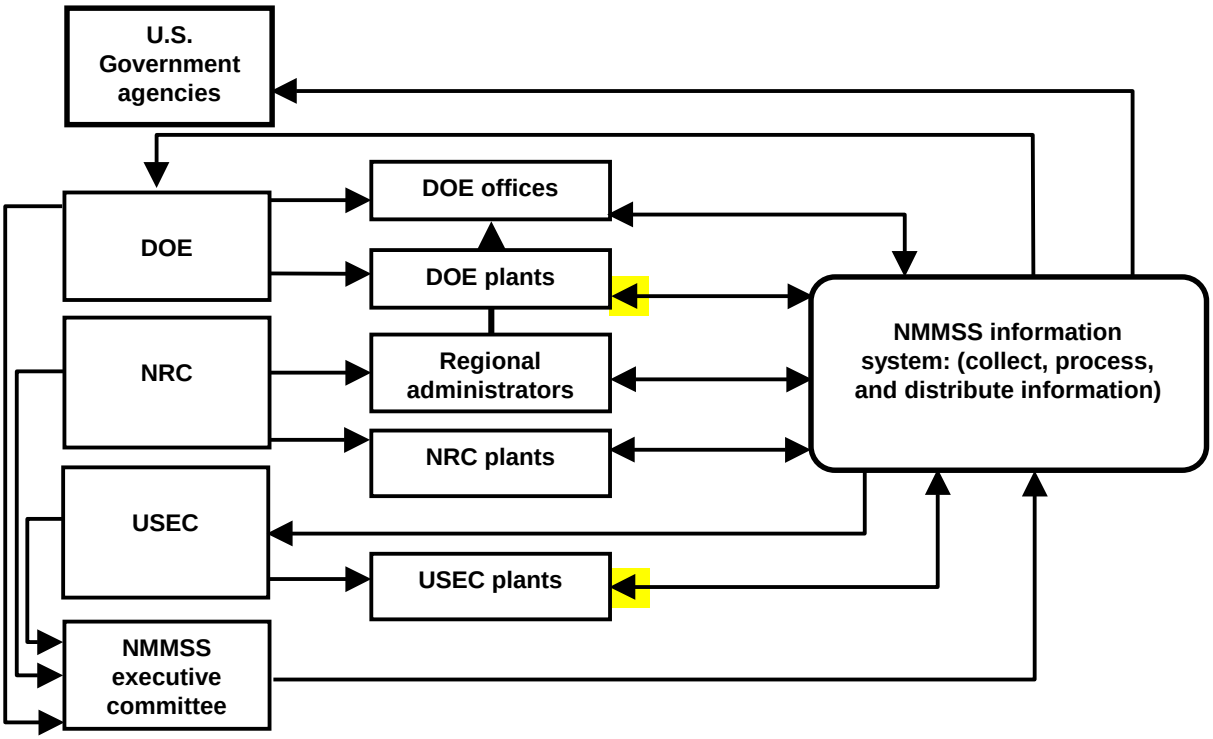


Figure 4.1. Structural diagram of the material control and accounting system.

5. NMMSS Information Structure

The NMMSS information system collects and stores information for decision-making regarding nuclear materials control and accounting and outputs that information to the appropriate U.S. and international organizations.

All facilities included in the national MC&A system must regularly provide NMMSS with data on the nuclear materials at their disposal.

DOE contractors, NRC licensees, and USEC uranium enrichment facilities (Fig. 5.1) submit reports to NMMSS. DOE directives and NRC instructions regulate facility report forms and the procedure for completing them.

The DOE/NRC original report forms signed by material custodians are legal documents and are stored in a hard copy archive.

Each DOE/NRC report form has a DOE/NRC-approved electronic equivalent for submitting data for automated information processing.

Table 5.1 lists the main reporting documents to be prepared by control and accounting departments at installations for transmission to NMMSS.

Report information from installations is entered into the NMMSS database.

Table 5.1. Facility report forms.

Information category	Original form of report for facilities	Data processing form
Inventory listing	DOE/NRC form 742C	DOE DP-733
Inventory listing for a facility under IAEA safeguards	DOE/NRC form 742C	DOE DP-733A
Transactions:		
Transfer from project to project within a facility	DOE/NRC form 741, 741A	DOE DP-749
Transfer from facility to facility	DOE/NRC form 741, 741A	DOE DP-740/740A
Concise notes for facilities under IAEA safeguards	DOE/NRC form 740M	DOE DP-734
Material balance	DOE/NRC form 742	DOE DP-735

5.1 NMMSS Database

The NMMSS database includes both reported information and the standards and background information required to process it; this information pertains to the editing process for nuclear material control and accounting, as well as the data necessary to produce NMMSS report information.

It is divided into two subsystems: a reference tables and the primary database.

5.1.1 Reference Tables

Background files contain the data necessary to monitor and edit reports submitted by installations to NMMSS. They are used in generating output reports to supplement the information stored in the primary database. They form the basis from which reference materials, manuals, and procedures for NMMSS personnel and users are compiled.

All reference tables and background information contained in the NMMSS database is approved by the DOE and NRC. [17]

Reference Information Previously Included in the Reference Tables:

- ANSI codes for metal wastes—contains codes and a description of non-irradiated plutonium and uranium scrap developed by the ANSI. Revisions are made with the approval of the DOE/OSS.
- Types of nuclear materials—contains codes for the types of material, as well as descriptive and management information for each of the 18 types of nuclear materials under the DOE and NRC control. Revisions are made with the approval of the DOE/OSS and the NRC Office of Nuclear Material Safety and Safeguards (NRC/ONMSS).
- Nuclear material composition codes—includes descriptive and management information about the chemical composition and physical state of the nuclear material and its place in the nuclear fuel cycle or in the nuclear industry. Revisions are made with the approval of the DOE/OSS and the NRC/ONMSS.
- Purpose codes—contains codes that establish allowable end uses for nuclear materials received at foreign facilities. Code revisions are approved by the NRC, the Office of Government and Public Affairs/International Programs.
- DOE field offices—contains descriptive information about each DOE field office. Revisions are made with the approval of DOE/OSS.
- DOE headquarters divisions—contains descriptive information that defines the relationship of projects with DOE main production offices for each fiscal year. Revisions are made with the approval of the DOE Office of Nuclear Weapons Management.
- Cargo carriers—contains identifiers of transport companies (government, commercial, and private) carrying nuclear materials between facilities. Revisions were made until 1 October 1985 on the basis of changes made in the Guidelines for the National Automotive Freight Association.
- National Association of States/Counties—contains information about the county and state for each national facility. This information is revised concurrently with the DOE Reporting Identification Symbol Directory (D-2).
- Project numbers—contain the identification of DOE projects using or producing nuclear materials. Revisions are approved by DOE field offices and the DOE Office of Nuclear Weapons Management.

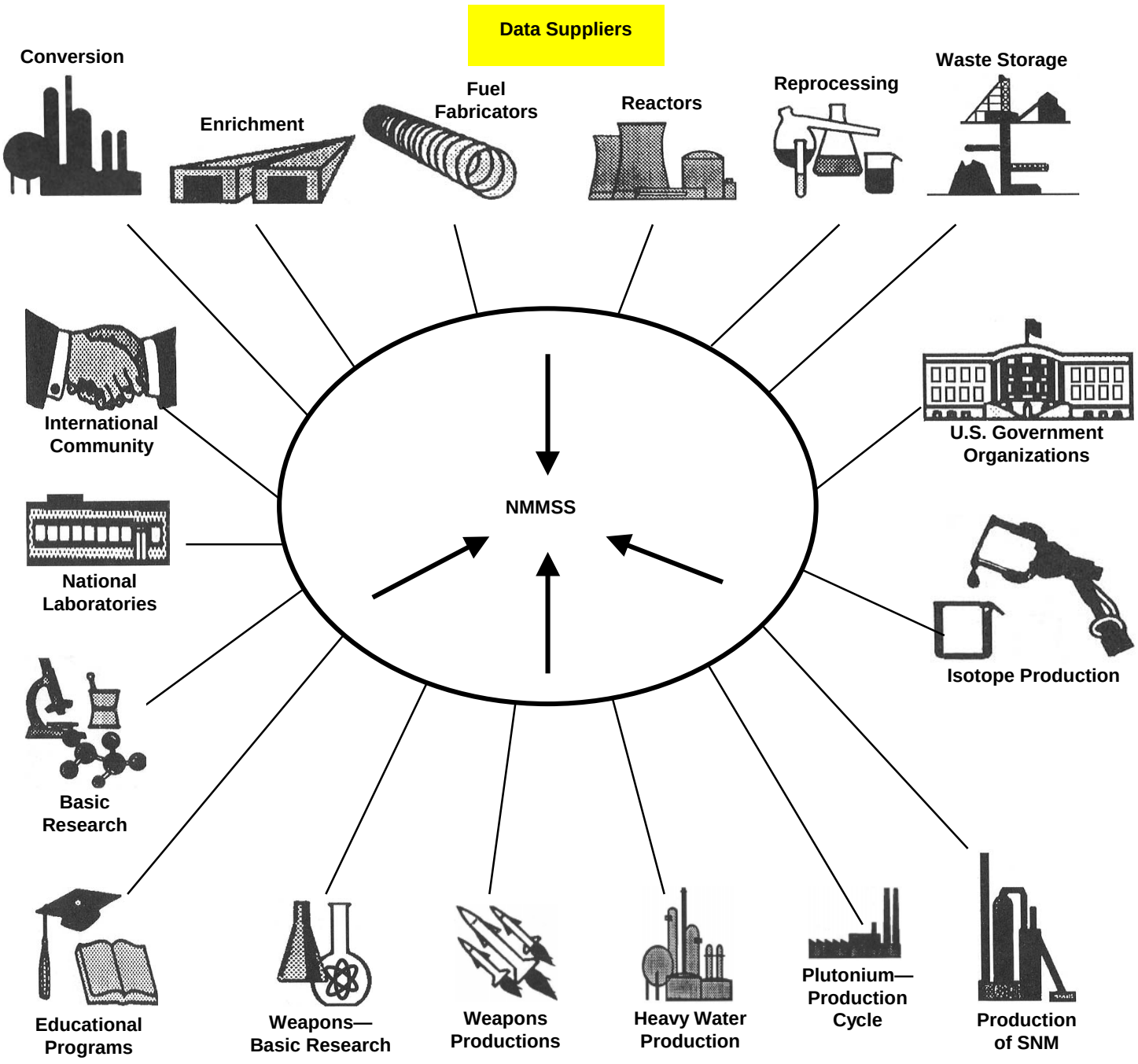


Figure 5.1. Data suppliers.

- Contract numbers in the INMTS system—contain descriptive information pertaining to international aspects of the regulation, possession, and use of nuclear materials.
- Country control numbers—contain alphabetic codes for countries that are sources of nuclear materials or a country responsible for tracking nuclear materials of foreign origin. Revised by installations.
- Reporting identification symbol (RIS/Facility)—contains descriptive and management information for each contractor and licensee, nuclear material storage facility, foreign plant or country. Revisions are made with the approval of the DOE/OSS and the NRC Office of Nuclear Material Security and Safeguards (NRC/ONMSS).
- RIS pairs—contain facility identifiers for facilities physically located at the same site. The handbook is revised by the facilities.
- Possession limits—contains descriptive and management information about the maximum permissible amount of nuclear materials that a facility may possess according to its license number. Revisions are made with the approval of the NRC/ONMSS.
- Entry/exit port codes—contains identification codes for ports, cities, and states. Revisions are made with the approval of the NRC/ONMSS.
- Packaging model identifiers—contains the identification codes for models of packaging as well as the specifications and description for packaging models. Revisions were made until 1 October 1985 on the basis of changes to the AEC "Directory of Packaging of Radioactive Materials" and the NRC "Directory of Certificates for Radioactive Material Packages."
- Facility attachments for facilities subject to IAEA safeguards—additional information about facilities belonging to the U.S. (type of material, key measurement points, etc.) which are selected, or may have been selected sometime in the past, under IAEA safeguards in compliance with the NPT. Revisions are made with the approval of the DOE/OSS and the NRC/ONMSS.
- IAEA facility attachment history—uses facility reports to describe the historical status of facilities meeting requirements under IAEA safeguards in compliance with the NPT. Revisions are made with the approval of DOE Office of Safeguards and Security (DOE/OSS) and the NRC Office of Nuclear Material Security and Safeguards (NRC/ONMSS).
- Key measurement points—contains descriptive information about key measurement points at U.S. facilities which have ever come under IAEA safeguards in compliance with the NPT. Revisions are made with the approval of the DOE/OSS and the NRC/ONMSS.
- Inventory profile—contains material composition codes which each RIS/facility may use to report inventory and inventory-related information. Revisions are made with the approval of the DOE/OSS and the NRC/ONMSS.
- Material balance report item categories—contains the codes and management information describing categories of increases and decreases in material balance reports. Revisions are made with the approval of the DOE/OSS and the NRC/ONMSS.
- Latitude/longitude—contains data on the geographic latitude and longitude of nuclear materials transfer points. Revisions were made until 1 October 1985, based on a list of zip codes and their coordinates by latitude and longitude.
- Acceptable limit of error—contains information about acceptable limits on measurement errors in determining the mass of isotopes and elements. Revisions are made by the facilities.

- Financial classification and valuation criteria—contains cost estimates and algorithms for calculating facility balance sheets for the DOE on the basis of inventory and nuclear material transaction reports. Revisions are made by the DOE Management Accounting and Pricing Division (DOE/MAPD).
- Transfer voucher—historical information for the current fiscal year on payment documents confirming the transfer of nuclear materials between two finance offices. Monthly updates are made automatically.
- INMTS permits—contains information about permits to import, export and re-transfer of nuclear materials of U.S. interest.
- Uranium enrichment report codes—contain descriptive and management information which is used to categorize data on RIS and UEA (uranium enrichment activity) accounting codes and information about the procedure for issuing and summarizing data in UEA reports.
- Uranium enrichment contracts—contains descriptive information pertaining to uranium enrichment contracts.
- Unit dollar—contains cost information about specific nuclear materials in DOE's possession. Revisions are made by the DOE Office of Nuclear Weapons Management.

Contact Information

- Distribution—contains details on distribution of required reports. Each user is identified by name and organization. Revisions are made by the DOE/OSS, DOE field offices, the NRC/ONMSS, and the facilities themselves.
- DOE Directory of Reporting Identification Symbols (D-2)—contains the list of RIS/facilities of DOE contractors, names, addresses, telephones of personnel authorized to contact NMMSS, and information on transmission methods. Revisions are made by authorized DOE offices.
- NRC Directory of Reporting Identification Symbols (D-3)—contains a list of licensee RIS/facilities; includes all NRC licensees, names, addresses, and telephone numbers of those facility personnel authorized to contact NMMSS. Revisions are made by the NRC/ONMSS.
- List of personnel at each NRC licensee authorized to revise information entered into the system. The list of personnel is updated by the licensee as required.
- List of personnel at each DOE contractor authorized to revise data entered into the system. The list of personnel is updated twice a year by the facilities.
- SIMEX codes.
- List of NMMSS personnel (over the entire history of the system).
- List of NMMSS meetings and their participants (users list).
- Addresses of each staff member receiving NMMSS reports. (Complete information about each addressee).

All revisions to the Reference tables are made only with the approval of the U.S. Department of Energy and the Nuclear Regulatory Commission.

Table 5.2. Nuclear materials.

Element	Reporting unit of mass	% of isotope mass	Atomic masses used	
			Element	Isotope
Enriched uranium[*, *2]	Whole g	^{235}U	Total U	^{235}U
Depleted uranium[*]	Whole kg	^{235}U	Total U	^{235}U
Plutonium 242[1]	Whole g	^{242}Pu	Total Pu	^{242}Pu
Americium-241	Whole g	—	Total Am	^{241}Am
Americium-243	Whole g	—	Total Am	^{243}Am
Curium	Whole g	—	Total Cm	^{246}Cm
Berkelium	Whole mcg	—	—	^{249}Bk
Californium	Whole mcg	—	—	^{252}Cf
Plutonium[*]	Whole g	^{240}Pu	Total Pu	$^{239}Pu + ^{241}Pu$
Enriched lithium	Whole kg	^{6}Li	Total Li	^{6}Li
Uranium 233[*]	Whole g	^{232}U (ppm^{-1})	Total U	^{233}U
Normal uranium[*,*2]	Whole kg	—	Total U	—
Neptunium-237	Whole g	—	Total Np	—
Plutonium-238[*,2]	Tenths of a g	^{238}Pu	Total Pu	^{238}Pu
Deuterium[3]	Tenths of a kg	—	D_2O	D_2
Tritium	Gms to hundreths	—	Total H-3	—
Thorium[*,*2]	Whole kg	—	Total Tr	—
Uranium in cascades	Whole g	^{235}U	Total U	^{235}U
DOE reports all materials listed				

[*] Nuclear materials on which NRC reports.

[*2] Nuclear materials for which NRC reports only on Import/Export, individual IAEA facilities, or materials from abroad.

[1] The report indicates it as plutonium-242 if plutonium-242 constitutes more than 20% of the total mass of the plutonium. Otherwise it is included as plutonium.

[2] The report indicates it as plutonium-238 if plutonium-238 constitutes more than 10% of the total mass of the plutonium. Otherwise it is included as plutonium.

[3] If it is in the form of heavy water, the fields are used both for the element and for the atomic mass of the isotope. Otherwise only isotope data are given.

005	**Inventory Data**	300 354	Assembly	620 629	Tritiding
015 024	Mining	355 369	In the reactor	630 639	Sintering
025 039	Milling	370 379	During cooling	640 684	Isotope enrichment
040 054	Refining	380 399	Irradiated material awaiting processing	685 714	Recovery—unirradiated material
055 069	Hydrofluoridation	400 444	Separation	715 739	Scrap material awaiting recovery
070 094	Fluoridation	445 469	Oxide conversion	740 764	Other special-purpose use
095 114	Enrichment	470 499	Source fabrication	765 829	Other products
115 124	From hexa- to tetrafluoride	500 509	Distillation	830 839	DOE program material Computer generated data
125 139	Reduction	510 519	Rework of heavy water	840 854	Loan or lease
140 159	Casting	520 529	Tritium purification	855 890	Commercial license inventory
160 174	Rough machining	530 544	Heavy water electrolysis	899	**Total Inventory Data**
175 189	Briquetting	545 554	Lithium chloride	900	**Miscellaneous**
190 214	Forming	555 564	Deuteration	901 929	Section 91b material
215 229	Finishing machining	565 574	Hydriding	930 944	Section 91c material
230 244	Billet fabrication	575 584	Disassembly	945 954	Potentially available for recovery
245 264	Canning and cladding	585 599	Dissolution	955 969	Disposition of waste material
265 279	Powder metallurgy	600 609	Chloride	970 989	Semi-annual scrap data
280 299	Fuel element & target fabrication	610 619	Deuterium-tritium mixture	990 996	Origin of material

Figure 5.2. Composition codes.

NMMSS operating experience has shown that handbooks such as “INMTS Contract Numbers,” “INMTS Permits,” “Brief Physical Inventory Listings,” “RIS/Facilities,” “Uranium Enrichment Contracts,” and “Project Numbers” are the most frequently revised. [17]

The following are critical background files for developing and processing all types of input and output forms:

- Material types.
- Composition codes.
- RIS facility identifiers.

The background file “Types of Nuclear Materials” contains a list of nuclear materials, reporting unit of mass, isotope mass content by percent, and isotope (Table 5.2). [17]

The background file “Composition Codes” contains a detailed description of nuclear materials in terms of their chemical composition and physical state or use (Fig. 5.2). [18]

The background file “RIS/Facilities” is a central reference file on all facilities in the U.S. It contains data on 200 DOE contractors, 1200 NRC licensees, 10 uranium enrichment facilities belonging to USEC, and 2000 foreign facilities involved in import/export with the U. S. The file includes the following data:

- Facility identifier (RIS/Facility).
- Facility name.
- Security code for report on:
  - Receipt/transfer of nuclear materials.
  - Inventory listings.
  - Material balance reports.
- NRC regional office code.
- Facility operation code.
- RIS category code (DOE contractor, storage facility—only for foreign facilities).
- Responsibilities under safeguards.
- Management of joint operations.
- RIS reporting status (is the facility operating?).
- Inventory listing.
  - Report on receipt/transfer of nuclear materials. | (Gives date of last facility report).
- Foreign facility code.
- Location.
  - City.
  - State.
  - Zip code.
- License code (Federal or state permit).
- IAEA material balance area code.
- IAEA country code.
- Price center code (indicates who is responsible for financial activities).
- Facility identification (RIS) structure:
  - 1st character—RIS category (e.g., DOE contractor, NRC licensee, foreign facility, etc.)
- For DOE contractors [17]:
  - 1st character—joint operations management.

- 2nd character—integrated or non-integrated ~~prices~~ financial accounting, i.e., ~~the price is established by the facility or the field office~~; The financial accounting is done by the facility or the field office. Only DOE Headquarters, Office of the Controller establishes the financial values for nuclear materials.
- 3rd character—excluded or not excluded under 10 CFR (Code of Federal Regulations).
- 4th character—type of waste storage facility.

5.1.2 Primary NMMSS Nuclear Materials Accounting Database

A procedure for organizing and carrying out control and accounting of nuclear materials used and stored on facility territory has been established in compliance with DOE/NRC codes and regulations.

The basic principle underlying nuclear materials control and accounting at a facility is the prompt recording of each receipt, shipment, or movement of nuclear material and each change in the inventory quantity because of nuclear decay, burn-up, etc.

Documents from each facility's control and accounting organization are the primary source of information for creating the NMMSS database.

All facilities in the U.S. national nuclear materials control and accounting system are required to regularly submit data on the status and location of nuclear materials to NMMSS.

U.S. Department of Energy contractors, NRC licensees, and USEC uranium enrichment facilities submit reports to NMMSS.

Report forms for facilities and the procedure for completing them are regulated by U.S. Department of Energy directives and NRC instructions.

Copies of original DOE/NRC report forms with the signatures of material custodians are legal documents and are stored in the NMMSS hard copy archive only for those facilities reporting in hard copy.

Each DOE/NRC report form has an electronic equivalent approved by the Department of Energy and the NRC that provides data for automated data processing. The electronic form is a spreadsheet convenient for automatic data entry and processing.

Table 5.1 lists the primary report documents prepared by control and accounting services at facilities for transfer to NMMSS.

In reports submitted to NMMSS by facilities, detailed information is recorded on all nuclear materials arriving and leaving the facility, including the quantity, type, material composition, type of change, safeguard responsibilities, etc. These reports also indicate changes in inventory amounts which differ at material shipment and receipt (e.g., nuclear conversion as a result of irradiation).

The primary NMMSS database consists of three technologically related independent information sections:

- Inventory reports.
- Transaction reports.
- Material balance reports.

Inventory Reporting

The inventory reporting system was automated and put into operation in 1965. At that time, 4,500 records per quarter were processed. NMMSS currently processes about 55,000 inventory records per quarter. The inventory listing reflects the status of the material inventories, i.e., the amount of each nuclear material at the plant's disposal at month's end.

Facilities entitled to store nuclear material inventories must report data on the inventories to the NMMSS inventory system under DOE and NRC orders.

Data are entered into the Primary NMMSS Database using established procedures; the data constitute a unified inventory listing of all nuclear material subject to accounting at the facility starting from the initial inventories. The NMMSS Database contains only reported data or data on the estimated inventories for all reporting facilities.

NMMSS tracks not only the volume of the material inventories, but its composition and status. This is possible because facilities report on the composition of materials in their reports on final inventories.

Report data on plant inventories are submitted to NMMSS at the end of the inventory period in compliance with DOE DP-733 or DP-733A. These forms contain information necessary to report on inventory amounts of nuclear materials in a format required for input into the primary database.

Form DP-733 is used to report on the status of the inventory quantity by all Department of Energy regional organizations and contractors and all Nuclear Regulatory Commission licensees.

DOE form DP-733A is used instead of DP-733 for reports by U.S. Department of Energy facilities subject to the U. S.-IAEA Agreement.

DOE/NRC form 742C is the original document for forms DOE DP-733 and DP-733A (Fig. 5.3-5.5, see Appendix). [18]

Report forms for the inventory include the following information for entry into the primary database.

- General information about the inventory includes:
  - Date the book inventory was reported.
  - Facility identifier (RIS).
  - Whether the facility is under IAEA safeguards.
- Detailed information for each individual material:
  - Material type.
  - Composition code.
  - Element mass (mass is given without error correction since it is rounded to the unit of measure).
  - Isotope mass.
  - Number of units.
  - DOE project number to which this material belongs.
  - Owner code.

Page _____ of _____ Pages

DOE/NRC FORM 742C (10-88) MANDATORY DATA COLLECTION AUTHORIZED BY 10 CFR 30, 40, 50, 70, 75, 150, Public Laws 83-703, 93-438, 95-91 (Previously DOE F 5630.1)	U.S. DEPARTMENT OF ENERGY AND U.S. NUCLEAR REGULATORY COMMISSION **PHYSICAL INVENTORY LISTING**	Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Chief of Information Management, U.S. Department of Energy, 1000 Independence Ave., S.W., Room 4D-024, MA-213.3, Washington, DC 20585; and to the Office of Information and Regulatory Affairs, Office of Management and Budget (OMB), Washington, DC 20503.	OMB CONTROL NO. 1910-1800 3150-0058 (NRC)

1. NAME STREET ADDRESS CITY / STATE / ZIP CODE	2. DOE/NRC FORM 740M ATTACHED ☐ YES ☐ NO 3. INVENTORY DATE	4. REPORTING IDENTIFICATION SYMBOL (RIS) 5. LICENSE NUMBER(S)

6. BATCH DATA

a. MATERIAL TYPE	b. COMP/FAC CODE	c. ELEMENT WEIGHT	d. ISOTOPE WEIGHT	e. DOE PROJECT NO.	f. SCRAP PROGRAM	g. WEIGHT PERCENT ISOTOPE	h. OWNER CODE	i. SEQUENCE NUMBER	j. BATCH NAME	k. NO. OF ITEMS	l. KEY MEASURE POINT	m. MEASUREMENT I.D. MEAS. BASIS	OTHER MEAS. POINT	MEAS. METHOD	n. ENTRY STATUS
7. TOTALS															

To the best of my knowledge and belief, the information given above and in any attached schedules is true, complete, and correct.

8. SIGNATURE *(See instructions for provisions regarding confidentiality.)*	9. TITLE	10. DATE

18 U.S.C. SECTION 1001; ACT OF JUNE 25, 1948; 62 STAT. 749; MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTERS WITHIN ITS JURISDICTION.

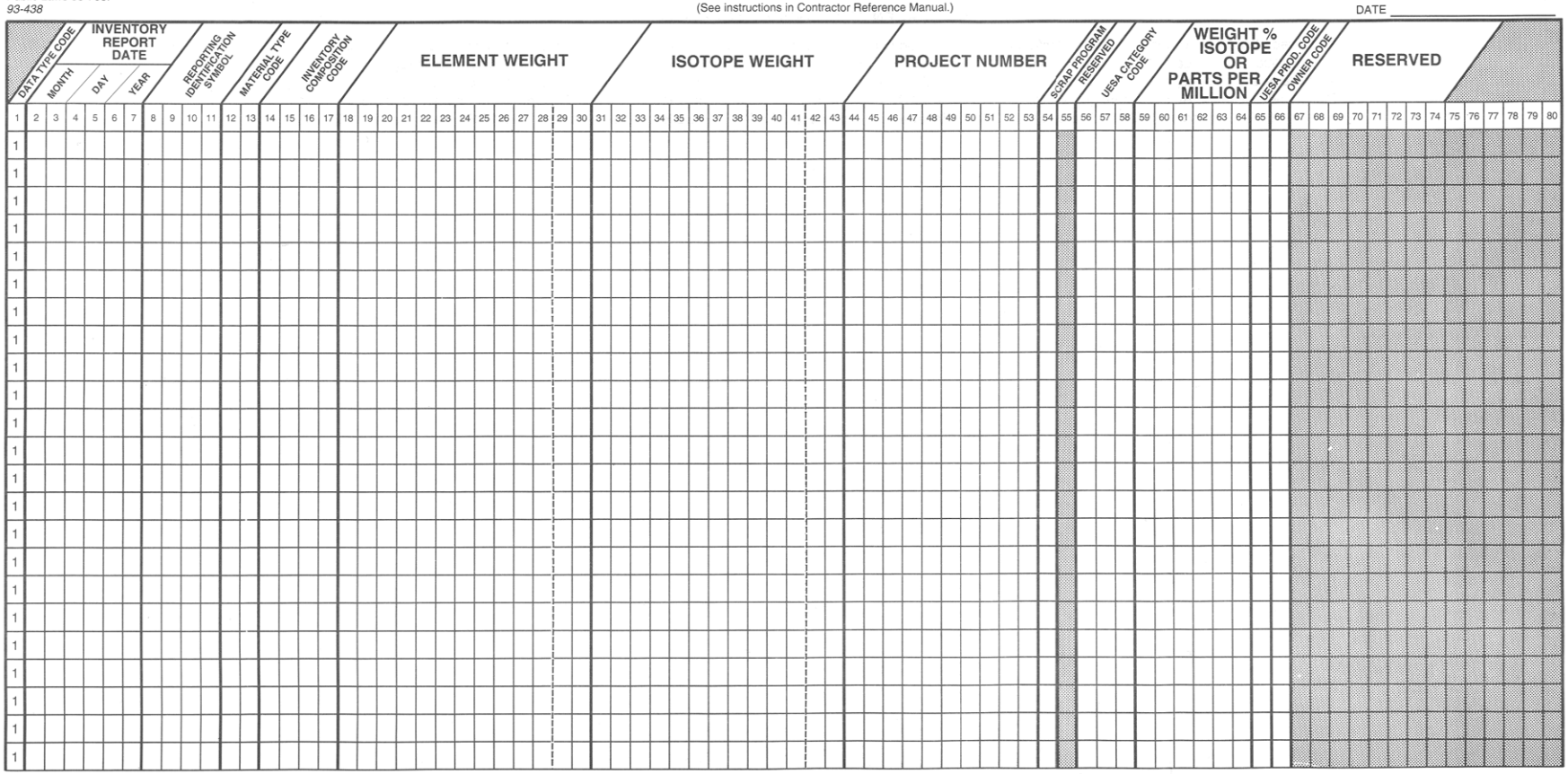
Figure 5.3. DOE/NRC form 742C exists in hard copy only.

DOE F DP-733
(12-93) Previous editions are obsolete.
MANDATORY DATA COLLECTION AUTHORIZED BY Public Laws 83-703. 93-438

POSTED BY _____
JOB NAME _____
FIELD OFFICE _____

U.S. DEPARTMENT OF ENERGY
AUTOMATED DATA PROCESSING TRANSCRIPTION SHEET FOR INVENTORY DATA
(See instructions in Contractor Reference Manual.)

OMB Control No. 1910-1800
OMB Burden Disclosure Statement on Reverse
PAGE _____ OF _____
DATE _____



18 U.S.C. SECTION 1001; ACT OF JUNE 25, 1948; 62 STAT. 749; MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR PRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTERS WITHIN ITS JURISDICTION.

Printed with soy ink on recycled paper

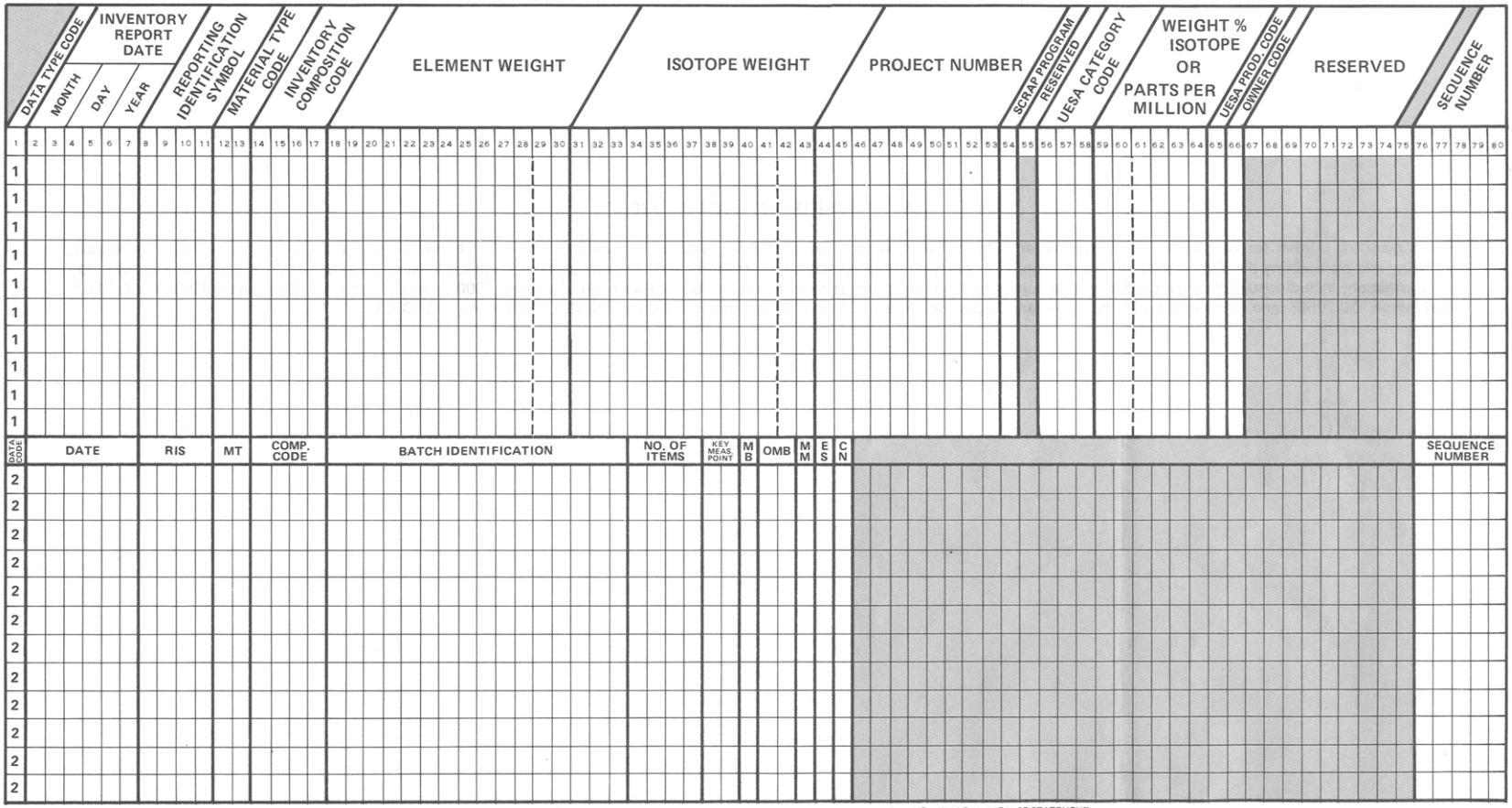
Figure 5.4. Form DP 733 exists in hard copy only.

DOE Form DP-733-A
(10-88)
MANDATORY DATA COLLECTION AUTHORIZED BY Public Laws 83-703, 93-438

POSTED BY _____
JOB NAME _____
FIELD OFFICE _____

U.S. DEPARTMENT OF ENERGY
ADP TRANSCRIPTION SHEET
FOR INVENTORY DATA
(See instructions for provisions regarding confidentiality.)

OMB CONTROL NO. 1910-1800
PAGE _____ OF _____
DATE _____
(Disclosure of Estimated Burden on back page.)



18 U.S.C. SECTION 1001; ACT OF JUNE 25, 1948; 62 STAT. 749; MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR PRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTERS WITHIN ITS JURISDICTION.

Figure 5.5. Form DP 733A exists in hard copy only.

Measurement Data for IAEA Forms

Lines in the records in each report from facilities subject to IAEA safeguard are numbered consecutively starting with “1” without omissions or repetitions (form DP-733A).

Transaction Reporting

Automated control and accounting of the movement of nuclear materials began in 1968. It is based on the accounting of all changes in the inventory of materials involving receipt, shipment, and material in-transit, as well as in the production cycle.

The transaction reporting system is the most active system and constitutes the largest part of the primary NMMSS database. It stores all information about all movements of nuclear materials, beginning from when the database became operational in 1968.

Input reports must be submitted within 24 hours after inventory quantity changes have occurred or are discovered.

In terms of content, the information in the reports is divided into two groups:

- Real-time information about all transfers of nuclear materials, including imports and exports.
- Information about the nuclear material itself.

A facility submits an inventory quantity change report for each change in inventory. The transaction report documents:

- Transfer from one facility to another.
- Increases and decreases at the facility as a result of production, combustion, radioactive decay, etc.
- Facilities must submit a report when there is a change in ownership of the nuclear material at one facility from one federal program to another federal program.

Reports on the movement of nuclear material are prepared separately by the shipper and the receiver and contain the following information:

- General information about the transfer.
- Detailed information about specific amounts with a description of the nuclear material.
- Special information about imports and exports.
- General information about mass.

Inventory quantity change reports are submitted on forms DOE/NRC 741, 741A, 740M, which are the source document of computer forms DOE DP-749, DP-740/740A, DP-734 (Fig. 5.6–5-9, see appendix). [19]

All inventory quantity change reports for entry into the primary database include the following information:

- General information for the transfer of all materials:
  - Facility identifier.
  - RIS.
  - Date of the activity.
  - Date of transfer/receipt.

DOE/NRC Form 741
(10-88) *Previous editions are obsolete.*
MANDATORY DATA COLLECTION
AUTHORIZED BY 10 CFR 30, 40, 50 70,
75, 150, Public Laws 83-703, 93-438, 95-91

U.S. DEPARTMENT OF ENERGY AND U.S. NUCLEAR REGULATORY COMMISSION

NUCLEAR MATERIAL TRANSACTION REPORT

OMB Control No.
1910-1800
Public Reporting Notice
Disclosure on Back

1. SHIPPER'S RIS (1-4)	2. RECEIVER'S RIS (5-8)	3. TRANSACTION NO. (9-14)	4. CORRECTION NO. (15)	5. PROCESSING CODE (16): SHIPPER	5. PROCESSING CODE (16): RECEIVER	6. RESERVED (17)	7. ACTION CODE (18): SHIPPER	7. ACTION CODE (18): RECEIVER	8. DATA CODE (19)	DOCUMENTATION (Only if document is classified SECRET): PAGE OF PAGES COPY OF COPIES, SERIES

NO.	DISTRIBUTION OF COPIES
1	
2	
3	
4	
5	
6	
7	
8	
9	

9.A. NAME AND ADDRESS OF SHIPPER	B. LICENSE NO.	10.A. NAME AND ADDRESS OF RECEIVER	B. LICENSE NO.	11. NO. OF DATA LINES 1(20-21)	12. NATURE OF TRANSACTION 1(22)
C. ATTENTION D. TELEPHONE		C. ATTENTION: D. TELEPHONE:		13.A. SHIPPED FOR ACCOUNT OF	B. RIS 1(23-26)
				14.A. SHIPPED TO ACCOUNT OF	B. RIS 1(27-30)

15. TRANSFER AUTHORITY-CONTRACT, NM DRAFT, OR ORDER NUMBER 1(34-50)	16. EXPORT OR IMPORT TRANSFERS: A. LICENSE NO. 3(22-31)
	B. U.S. PORT EXIT/ENTRY 3(32-35)

17. MATERIAL TYPE AND DESCRIPTION	21. MISCELLANEOUS	B. CONCISE NOTE ATTACHED YES NO	C. CONCISE NOTE ATTACHED YES NO

18. TRANSPORTATION PROFILE

A. TRIP SEG.	B. CARRIER IDENTIFICATION	C. TRANSFER POINT	A. MODEL ID.	B. NUMBER
1	3(36-39)	3(40-44)	4(22-25)	4(26-28)
2	3(45-48)	3(49-53)	4(29-32)	4(33-35)
3	3(54-57)	3(58-62)	4(36-39)	4(40-42)
4	3(63-66)	3(67-71)	4(43-46)	4(47-49)
5	3(72-75)		4(50-53)	4(54-56)

19. PACKAGE IDENTIFICATION

20. ACTION DATE

	MONTH 1(70-71)	DAY 1(72-73)	YEAR 1(74-75)
A. SHIPMENT			
B. SHIPPER'S CORRECTION			
C. RECEIPT			
D. RECEIVER'S MEASUREMENT			
E. RECEIVER'S CORRECTION			

22. TOTAL GROSS WEIGHT 4(57-66)

23. TOTAL VOLUME *(Waste Transfers only)* 4(67-75)

	LINE NO. 2(5 (20-21) A	TYPE OF INV. CHANGE 2(22-23) B	IDENTIFICATION (BATCH NAME) 2(24-39) C.	NO. OF ITEMS 2(24-39) C.	PROJECT NUMBER 2(44-53) E.	MATERIAL TYPE 2(54-55) F	COMP/ FACILITY CODE 2(56-59) G	PROD CODE 2(60) H.	OWNER CODE 2(61) I	COUNTRY CONTROL NUMBER 2(62-69) J.	*(1) MEAS POINT 3(70-71) K	MEAS. IDENT. L. 1 BASE 2(72)	2 DMP 2(73-74)	3 METHOD 2(75)	GROSS WEIGHT M.	NET WEIGHT N.	ELEMENT WEIGHT 5(43-53) O.	ELEMENT LIMIT OF ERROR 5(54-58) P.	WEIGHT % ISOTOPE 5(59-64) Q.	ISOTOPE WEIGHT 5(65-75) R.	ISOTOPE LIMIT OF ERROR 5(76-80) S.
24. SHIPPER'S DATA																					

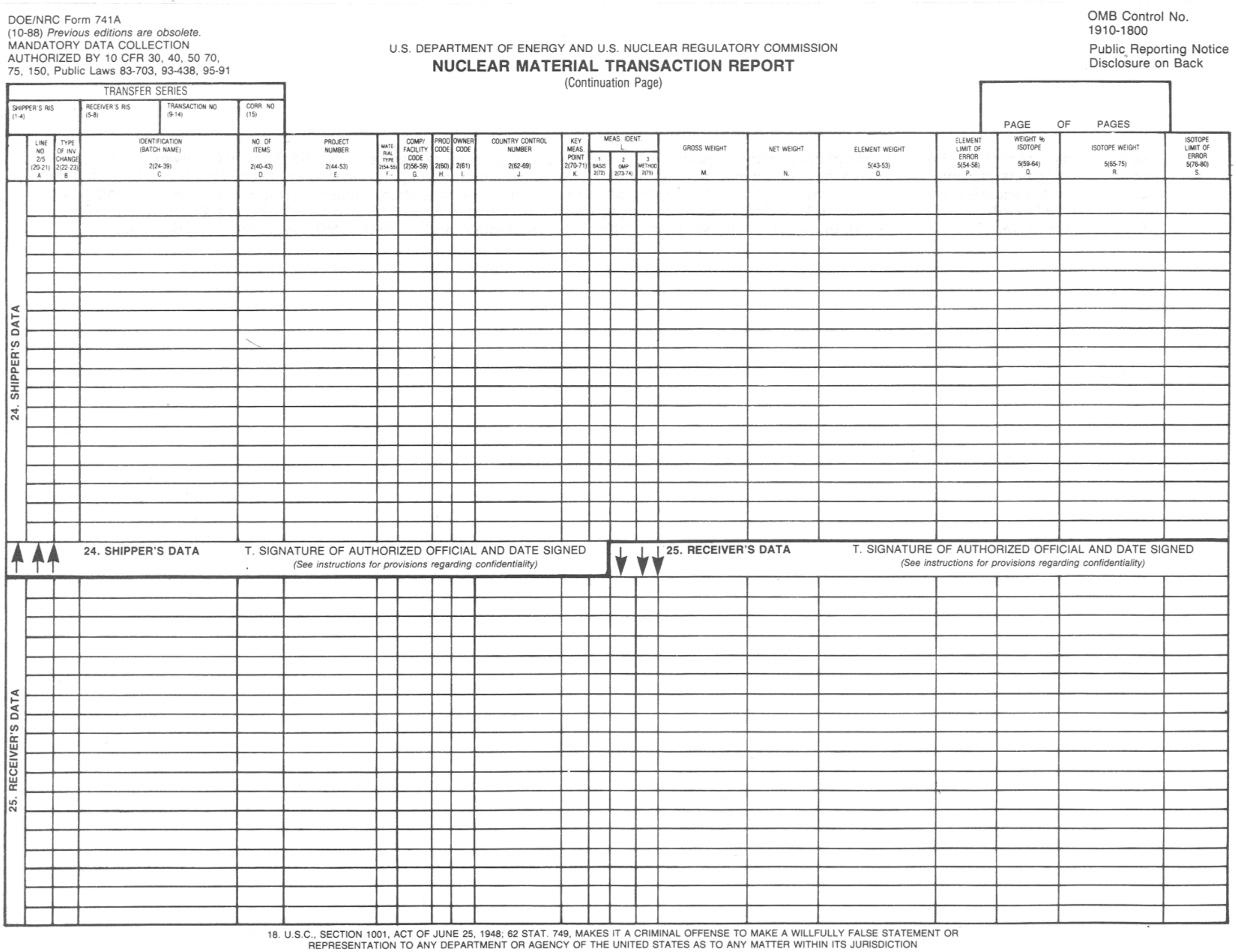
24. SHIPPER'S DATA T. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED
(See instructions for provisions regarding confidentiality)

25. RECEIVER'S DATA T. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED
(See instructions for provisions regarding confidentiality)

25. RECEIVER'S DATA																						

18. U.S.C., SECTION 1001, ACT OF JUNE 25, 1948; 62 STAT. 749, MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION

Figure 5.6. Form 741 DOE/NRC exists in hard copy only.



DOE/NRC Form 741A
(10-88) *Previous editions are obsolete.*
MANDATORY DATA COLLECTION
AUTHORIZED BY 10 CFR 30, 40, 50 70, 75, 150, Public Laws 83-703, 93-438, 95-91

U.S. DEPARTMENT OF ENERGY AND U.S. NUCLEAR REGULATORY COMMISSION
NUCLEAR MATERIAL TRANSACTION REPORT
(Continuation Page)

OMB Control No. 1910-1800
Public Reporting Notice
Disclosure on Back

PAGE OF PAGES

TRANSFER SERIES			
SHIPPER'S RIS (1-4)	RECEIVER'S RIS (5-8)	TRANSACTION NO (9-14)	CORR NO (15)

LINE NO 2/5 (20-21) A	TYPE OF INV CHANGE 2(22-23) B	IDENTIFICATION (BATCH NAME) 2(24-39) C	NO OF ITEMS 2(40-43) D	PROJECT NUMBER 2(44-53) E	MATERIAL TYPE 2(54-55) F	COMP/ FACILITY CODE (2)56-59) G	PROD CODE 2(60) H	OWNER CODE 2(61) I	COUNTRY CONTROL NUMBER 2(62-69) J	KEY MEAS POINT 2(70-71) K	MEAS. IDENT. L: 1 BASIS 2(72)	2 OMP 2(73-74)	3 METHOD 2(75)	GROSS WEIGHT M	NET WEIGHT N	ELEMENT WEIGHT 5(43-53) O	ELEMENT LIMIT OF ERROR 5(54-58) P	WEIGHT % ISOTOPE 5(59-64) Q	ISOTOPE WEIGHT 5(65-75) R	ISOTOPE LIMIT OF ERROR 5(76-80) S

24. SHIPPER'S DATA

24. SHIPPER'S DATA — T. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED
(See instructions for provisions regarding confidentiality)

25. RECEIVER'S DATA — T. SIGNATURE OF AUTHORIZED OFFICIAL AND DATE SIGNED
(See instructions for provisions regarding confidentiality)

25. RECEIVER'S DATA

18. U.S.C., SECTION 1001, ACT OF JUNE 25, 1948; 62 STAT. 749, MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION

Figure 5.7. Form 741A DOE/NRC exists in hard copy only.

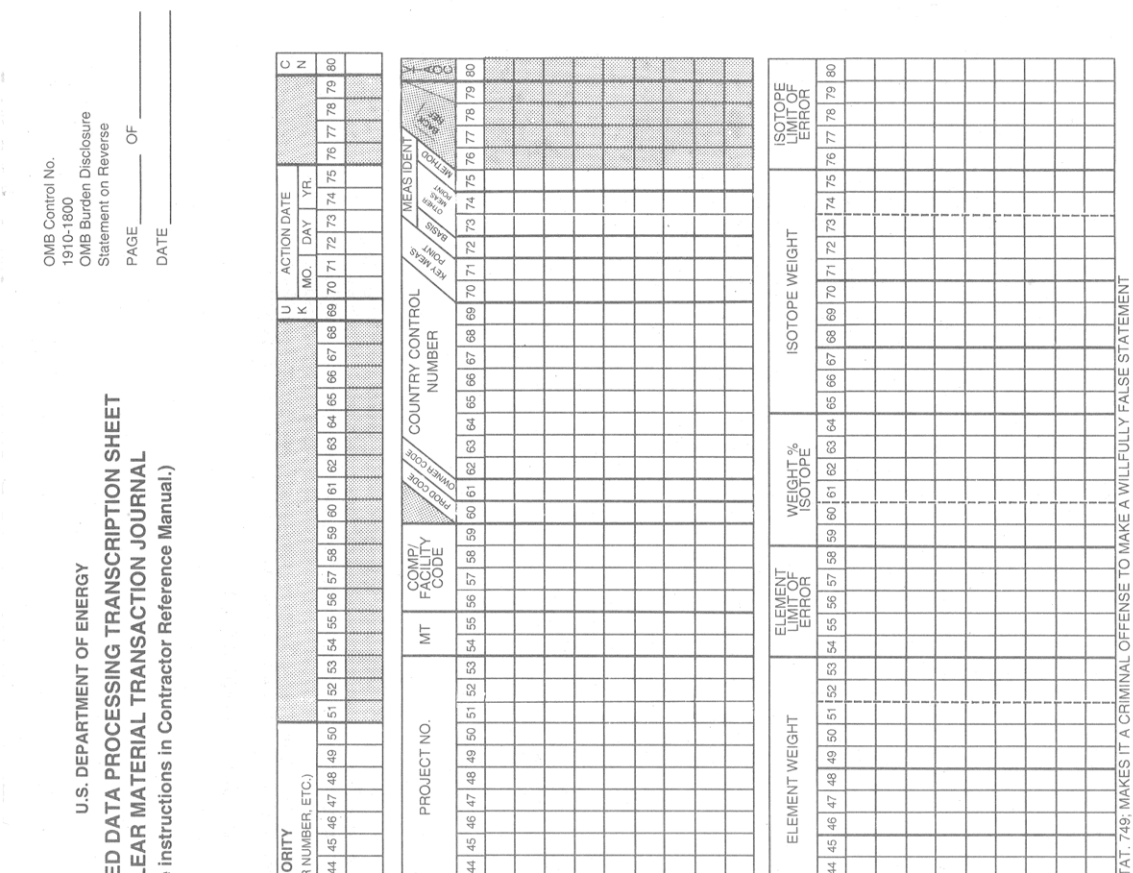


Figure 5.8. Form 740 DOE exists in hard copy only.

DOE/NRC Form 740M
(10-88)
MANDATORY DATA COLLECTION
AUTHORIZED BY 10 CFR 30, 40, 50
70, 75, 150, Public Laws 83-703,
93-438, 95-91

U.S. DEPARTMENT OF ENERGY
AND
U.S. NUCLEAR REGULATORY COMMISSION

CONCISE NOTE

OMB Control No.
1910-1800

Public Reporting Notice
Disclosure on Back

1. NAME	2. ATTACHMENT TO a. ☐DOE/NRC 741 b. ☐DOE/NRC 742 c. ☐DOE/NRC 742c	3. RIS	4. REPORTING PERIOD FROM / TO
STREET ADDRESS	5. TRANSACTION DATA		
CITY / STATE / ZIP CODE	a. SHIPPER'S RIS / b. RECEIVERS RIS / c. TRANS. NO. / d. CORR NO. / e. PC / f. AC / g. DATA CODE		6. REPORTING DATE 7. LICENSE NUMBERS

8a. LINE NO.	b. ENTRY REFERENCE	c. TEXT OF CONCISE NOTE

To the best of my knowledge and belief, the information given above and in any attached schedules is true, complete, and correct.

9. SIGNATURE *(See instructions for provisions regarding confidentiality.)*	10. TITLE	11. DATE

18 U.S.C. SECTION 1001; ACT OF JUNE 25, 1948; 62 STAT. 749; MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTERS WITHIN ITS JURISDICTION.

U.S. Government Printing Office: 1981–341-075/1969

Figure 5.9. Form 740M DOE/NRC exists in hard copy only.

- Unique identifier:
  - Shipper RIS.
  - Receiver RIS.
  - Transfer number.
  - Correction number.
  - Processing code.
  - Action code.
  - Line Number.
- Financial activity:
  - Activity type code.
  - Shipped to account no. xxx.
  - Received by account no. xxx.
  - Transfer of authorization.

Detailed information about the amount of each specific material and their description in a transfer include:

- Type of inventory changes and identifier for the entire lot.
- Number of units and corresponding government project.
- Type and composition of nuclear material.
- Ownership (private or government).
- Country control number (8-digit).
  - Supplier country.
  - Enrichment country.
  - Source country for reactor products (Pu or ^{233}U).
  - Country providing additional guarantees.
- Additional information submitted to IAEA.
- Back-reference number.
- Chemical element mass.
- Maximum permissible error in chemical element mass.
- Isotope weight.
- Maximum permissible error in isotope mass.
- Mass percent of the isotope.

The following special information relates to import or export operations:

- Number of import or export license (NRC import license, general license).

- Port at which imported to the U.S.
- Port at which exported from the U.S.
- Special IAEA codes.

General mass information:

- Total gross mass of shipment in pounds.
- Total volume of shipment in cubic feet.

Lines in the records in each report are numbered consecutively starting with “1” without omissions or repetitions.

Material Balance Report

The material balance report for a facility describes the applicable inventory status for each type of material over a certain period of time. Inventory changes for various categories of increases and decreases are summarized on DOE/NRC form 742.

Material balance reports must take into account the fact that the material balance is a continuous process—when one balance period ends, another immediately begins. The ending inventory from the preceding time period becomes the beginning inventory for the current reporting period. Inventory changes during this period are used to determine the ending inventory for this period, etc.

The inventory status for each type of material at the facility over this specific time period is determined according to the:

- Beginning inventory.
- Receipts and expenditures.
- Ending inventory.

NMMSS tracks the beginning and ending inventories in material balance periods for each type of material at each installation according to whether or not it belongs to the U.S. Department of Energy (DOE). Materials belonging to the Department of Energy are tracked separately from materials not belonging to the Department of Energy.

Receipts and Expenditures include material transfers from one facility to another and on-site material increases or losses.

The original document, DOE/NRC form 742, forms the basis for the report format used by NMMSS in material balance calculations (Fig. 5.10, see the Appendix). This form contains the following logically grouped data entry fields:

- Beginning inventory for the period.
- Receipts during the period.
  - Received from other facilities.
  - On-site increases.
- Expenditures during the period.
  - Transferred to other facilities.
  - On-site losses.
  - Ending inventory for the period.

The material balance report forms also include the following information to be entered into the main database [20]:

- General information for each type of material:
  - Reporting identification symbol (RIS).
  - License number.
  - Reporting period.
  - Material type.
- Detailed information:
  - Owner of the material.
  - Type of inventory changes represented by summary information.
  - Chemical element mass for each entry.
  - Isotope mass for each entry.

5.2 NMMSS Output Information

On the basis of the reported data for the facility contained in the database, NMMSS produces reports for various U.S. organizations and agencies, as well as international reports prepared under various international agreements. [21]

The following are recipients of NMMSS data (Fig. 5.11): departments within the major DOE divisions, DOE field offices and facilities, departments within major NRC divisions, NRC regional offices and facilities; USEC, other U.S. Government agencies, and international organizations.

Production reports are routine reports generated by NMMSS on a regular basis and distributed to persons on distribution lists approved by the appropriate offices within DOE and NRC in accordance with regulations. NMMSS production reports are described in Handbooks D-22 and D-22-1; they are prepared from inventory data, transaction data, and material balance data. Depending on the level of data representation, these reports may be either detailed reports containing data for individual facilities, reports which contain summary data for DOE field offices and NRC regional offices, or reports which contain summary data for the major divisions within DOE, NRC, and the USEC. [22] This group consists of the following: inventory reports, inventory difference reports, inventory reports on a project-by-project basis (programs within DOE), transaction reports, material balance reports, uranium enrichment reports, analysis reports, financial reports, etc.

DOE/NRC FORM **742**
(10-88)
MANDATORY DATA COLLECTION
AUTHORIZED BY 10 CFR 30, 40, 50, 70, 75, 150. Public Laws 83-703, 93-438, 95-91.

U.S. DEPARTMENT OF ENERGY
AND
U.S. NUCLEAR REGULATORY COMMISSION

MATERIAL BALANCE REPORT

OMB Control No. 1910 – 1800 (Public Disclosure on Back)

1. NAME AND ADDRESS	2. LICENSE NUMBER(S)	3. REPORTING IDENTIFICATION SYMBOL (RIS)
	4. REPORT PERIOD: FROM / TO	5. MATERIAL TYPE (Submit separate report for each type)

SECTION A — MATERIAL ACCOUNTABILITY		A. ELEMENT WEIGHT	B. ISOTOPE WEIGHT
7. DOE/NRC 740M ATTACHED ☐ YES ☐ NO			
8. BEGINNING INVENTORY — DOE OWNED			
9. BEGINNING INVENTORY — NOT DOE OWNED			
RECEIPTS			
11. PROCUREMENT FROM DOE	RIS		
FROM:			
13. PROCUREMENT — FOR THE ACCOUNT OF DOE			
14. DOE RETURNS — USE A			
15. DOE RETURNS — USE B			
16. DOE RETURNS — OTHER USES			
21. PRODUCTION			
22. FROM OTHER MATERIALS	a. ICT		
	b. ICT		
	c. ICT		
30. RECEIPTS REPORTED TO DOE/NRC ON DOE/NRC FORM 741 *(Not listed elsewhere)*			
FROM:	RIS		
38. DONATED MATERIAL — FROM DOE TO OTHERS			
39. DONATED MATERIAL — FROM OTHERS TO DOE			
40. TOTAL *(Lines 8-39)*			
REMOVALS			
41. EXPENDED IN SPACE PROGRAMS			
42. SALES TO DOE RIS TO:	RIS		
TO:			
43. SALES TO OTHERS FOR THE ACCOUNT OF DOE	RIS		
TO:			
44. DOE — USE A			
45. DOE — USE B			
46. DOE — OTHER USES			
47. EXPENDED IN DOE TESTS			
48. ROUTINE TESTS			
49. SHIPPER — RECEIVER DIFFERENCE			
51. SHIPMENTS REPORTED TO NRC/DOE ON DOE NRC FORM 741 *(Not listed elsewhere)*			
TO:	RIS		
58. DONATED MATERIAL — TO DOE BY OTHERS			
59. DONATED MATERIAL — TO OTHERS BY DOE			
71. DEGRADATION TO OTHER MATERIALS	a. ICT		
	b.ICT		
72. DECAY			
73. FISSION AND TRANSMUTATION			
74. NORMAL OPERATIONAL LOSSES/MEASURED DISCRDS			
75.ACCIDENTAL LOSSES			
76. APPROVED WRITE-OFFS			
77. INVENTORY DIFFERENCE			
80. ENDING INVENTORY — DOE OWNED			
81. ENDING INVENTORY — NOT DOE OWNED			
82. TOTAL *(Lines 41-81)*			
83. BIAS ADJUSTMENT			

SECTION B — COUNTRY CONTROL NUMBER DATA		
1. COUNTRY CONTROL NUMBER	2. ELEMENT WEIGHT	3. ISOTOPE WEIGHT
4. TOTAL WEIGHT *(Total must agree with total on line 80 or 81 or both)*		

SECTION C — CERTIFICATION

To the best of my knowledge and belief, the information given above and in any attached schedules is true, complete, and correct.

SIGNATURE *(See instructions for provisions on confidentiality.)*	*TITLE*	*DATE*

18 U.S.C. SECTION 1001; ACT OF JUNE 25, 1948; STAT. 749; MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTERS WITHIN ITS JURISDICTION

NRC/DOE FORM 742 (10-88) (Previous editions are obsolete)

(PUBLIC REPORTING NOTICE DISCLOSURE ON BACK)

U.S. GOVERNMENT PRINTING OFFICE: 1990 0—944-926

Figure 5.10. DOE/NRC form 742 exists in hard copy only.

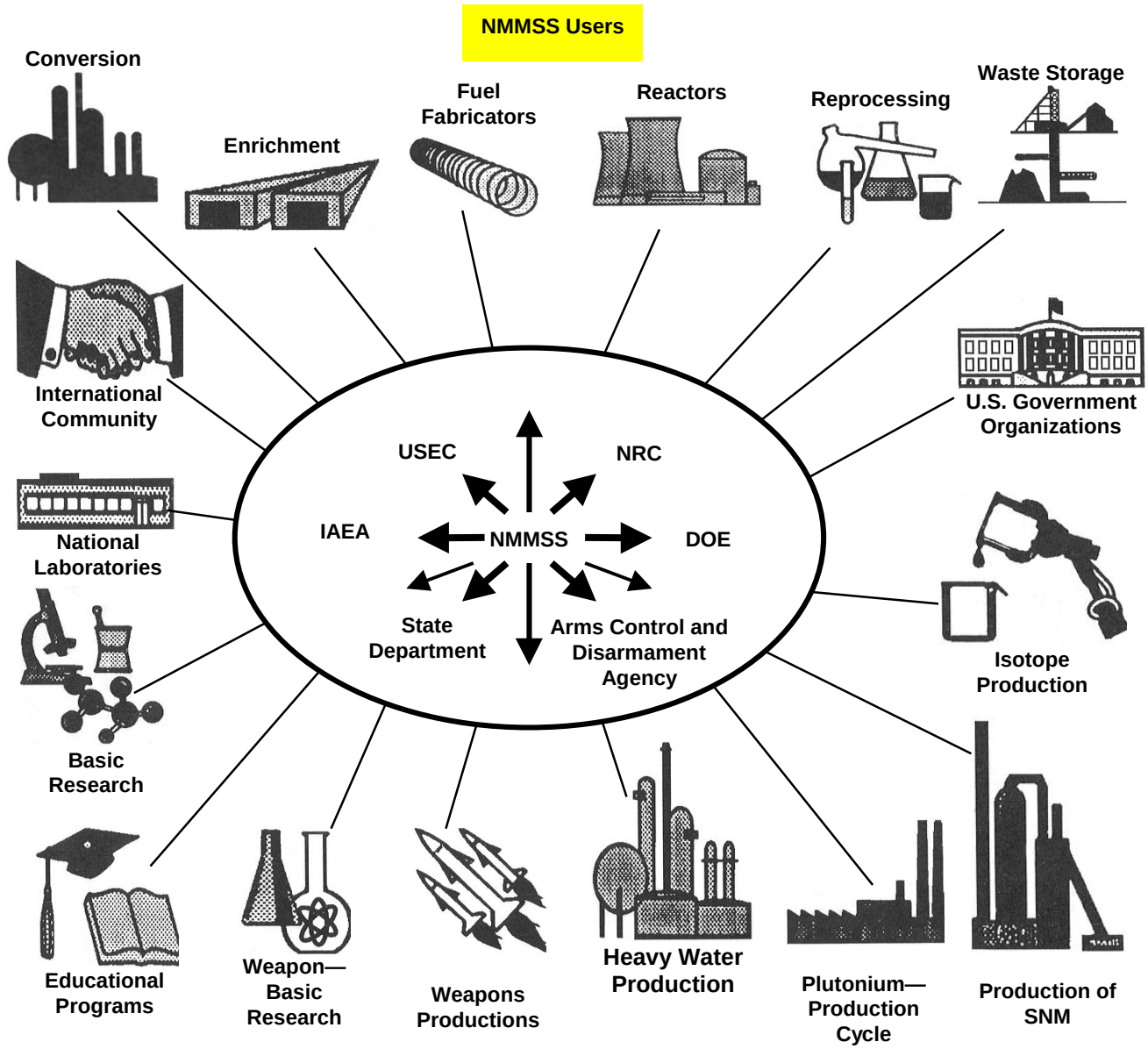


Figure 5.11. NMMSS users.

The following types of production reports, with the following NMMSS internal (accounting) codes, are promulgated:

No.	Type of report	Report code
1	Allotment reports—used in materials management programs involving DOE-owned materials	A
2	Background data—published from information contained in the database of background data	D
3	Financial reports—contain financial information for inventories and transactions involving nuclear materials owned by the DOE. Prices for inventory and transaction quantities, as well as cost reference manuals, are presented in dollars by financial categories.	FN
4	Inventory difference reports—contain information about differences in inventory data. Explanatory data and data on individual differences may be summarized for inventory difference codes and material type codes.	H
5	Inventory reports—inventory data supplied by facilities are the raw input data for many reports involving the Nuclear Materials Management and Safeguards System. The scope ranges from individual facilities to summary data for all U.S. Government-controlled materials, sorted by agreement or specific owner.	I
6	IAEA reports—(in accordance with the U.S.–IAEA safeguards agreement) for U.S. facilities under IAEA safeguards and for importers/exporters	IA
7	Material balance reports—provided for each nuclear material in the system, for all facilities for a specified period of time. The output balance is based on the contents of the inventory and transaction databases.	M
8	Project inventory reports—provide information about DOE nuclear materials sorted by production or research programs. The distribution over programs is derived from the inventory data.	P
9	DOE project indicators report	T
10	Transaction reports—contain a broad spectrum of data combinations involving transactions; used in analysis and control of all reported changes in nuclear material inventory.	TJ
11	Uranium-enrichment reports	U

Special reports are reports not included among the routine reports received by the requesting user. Such reports are provided upon request ~~only to DOE facilities after DOE permission has been received.~~ (Note: any NMMSS user can receive special request with proper authorization) DOE facilities must receive approval to request a special report. Special effort, sometimes a significant amount of effort, is required to produce these reports.

NMMSS international reports are produced in compliance with the requirements presented in IAEA Circulars INFCIRC/288, INFCIRC/207, and GOV/2588, with bilateral and trilateral agreements between the U.S. and Australia, Canada, Japan, Sweden, Euratom, and with DOE orders and NRC reporting instructions concerning secondary international proliferation of nuclear materials. [23]

The following reports are submitted to IAEA:

- Nuclear material inventory change report (ICR), submitted within 30 days after the end of the month in which there is a reported or detected change in nuclear material inventory quantities.
- A list of the names and codes for the material balance areas involved in transaction activity during the month is transmitted together with the ICR.
- Concise notes attached to the inventory change report to explain the inventory changes.
- Material balance report, transmitted annually, no more than 30 days after the conclusion of the reporting month.
- Inventory lists reflecting the actual inventory of nuclear materials, transmitted together with the MBR.

NMMSS handbooks intended for users at various levels [24], including the following:

- DOE Directory of Reporting Identification Symbols (RIS) (National Facility Codes).
- NRC Directory of Reporting Identification Symbols (RIS).
- International Nuclear Facilities Codes Directory.
- Reports Description Directory.
- Reports Description Directory Sample Reports.
- Internal Reports Description Directory.

The **NMMSS newsletter** is intended to inform the general user community of issues involving nuclear materials control and accounting. The bulletin includes information such as changes to facility reporting requirements, reporting deadlines, reports on NMMSS products, announcements (user-group meetings, management committee meetings, and training sessions), technical news, contact information, etc. The newsletter is published quarterly. [24]

6. NMMSS Data Processing Technology

6.1 NMMSS Data Processing Structure

The automated data processing technology used in NMMSS utilizes two databases: an auxiliary database containing background data and a primary database for tracking nuclear materials.

The reference tables contains information on facilities, data on element codes, codes describing possible operations on nuclear materials, measurement codes, country codes, etc. The structure of the reference tables is described in Sec. 5 of this document.

Storage of data in the reference tables is performed in accordance with DOE/NRC-approved standards.

The reference tables is conditionally static, and changes are only made when the basic data items in the corresponding DOE or NRC documents change.

The basic purpose of the reference tables is to provide centralized storage of the information required for computerized monitoring of facility reported data for acceptability and correctness of coding requirements within that information and of the computer output report forms.

Moving the background data to a separate database supports: centralization of data storage, increased reliability of data in the primary NMMSS database, elimination of data duplication, significant decrease of input volumes, and correct selection of data from the database during report compilation.

One of many reasons for using data codes (rather than the actual values contained in the database of background data) in the reported data makes possible more effective use of disk space.

The primary source of data for the NMMSS primary database are the reporting documents filed by various facilities.

Independent of the various procedures used for the submission and processing of each type of reporting document, all data received from each of the various facilities passes through the following phases upon entry into the NMMSS primary database: preparation of reported data at the facility and transmission of the data to NMMSS; receipt, logging, and entry of facility reported data into an input working file; input check, correction of errors, and entry of the corrected data into the primary database; and generation of reports from the input data and distribution of reports to the facilities that provided reported data to NMMSS.

NMMSS processes and procedures ensure that system users do not have direct access to the NMMSS database. All database entry is performed by NMMSS employees, and all reports are produced by NMMSS employees and distributed to users using established communications facilities.

A detailed description of the phases for the entry of facility reported data into the NMMSS database will be provided in the next section of this document.

The procedures for management of the NMMSS primary database were developed to conform with the regulations governing processing of the three main types of reporting documents used by NMMSS. These documents are: transaction reports, inventory reports, and material balance reports.

For each type of reporting document, NMMSS policies and procedures incorporate the following: special forms for presentation of NMMSS reported data, regulations governing NMMSS reporting deadlines for facilities, a deadline for processing document data, and regulations governing the processing of document data at the end of the accounting period and the creation of output reports for different levels of NMMSS users from the information in each reporting document.

The procedural cycles for processing NMMSS reporting documents include the following steps:

- Obtaining reported data from the facilities in the DOE/NRC-approved formats in accordance with the regulations governing reporting deadlines for each document.
- Using information in the reference tables and NMMSS-derived information to verify correctness of the reporting information received.
- Analysis of the data following the completion of established accounting periods.
- Creation of routine output report forms for management organizations and facilities from the data on the forms.

Sec. 6.3 describes the data-processing cycles for the transaction, inventory, and material balance data.

In addition to the major routine transaction reports, inventory reports, and material balance reports, NMMSS data processing procedures also allow a variety of output reports to be produced for NMMSS users at various levels. NMMSS report distribution procedures are described in Sec. 7.

One important feature of the NMMSS data management process is the procedure for resolving data discrepancies between NMMSS and the individual facilities. NMMSS processes and procedures allow NMMSS to communicate with the facilities immediately and perform editing of facility data if errors are detected in the information at any stage in the process. The resulting edited data are reflected in NMMSS reports and transmitted to the facilities for on-site accounting verification. [17] Additionally, reconciliation of NMMSS data is performed twice a year (at the end of March and the end of September, to coincide with the U.S. Government's fiscal year—see Table 6.1) to eliminate discrepancies in the data between NMMSS and the facilities. DOE facilities are required to present inventory reports, while NRC licensees are required to present inventory reports and material balance reports. During the reconciliation process, calculated NMMSS inventory data and material balance data obtained by taking all system transactions during the reporting period into account are compared against the facility reported data. Intermediate analysis reports are created in order to determine the sources of any NMMSS discrepancies identified, and the responsible individuals take corrective action. Once all discrepancies have been resolved, the data are "closed out," i.e., the basic data items are approved and fixed as of the date when processing was completed. The verified data are then used as the reference data for the next six month period. Reports reflecting reconciliation results are compiled and distributed to management organizations and to the facilities. Data reconciliation is a long, labor-intensive process, but it ensures that the data in the NMMSS database is highly reliable. [20, 25]

Table 6.1. NMMSS calendar.

NMMSS operates according to the U.S. Government fiscal year rather than the Julian calendar year. The following table describes the structure of the NMMSS production cycles:

Month	Monthly processing	Quarterly processing	Semiannual processing	Annual processing
October	+			
November	+			
December	+	+		
January	+			
February	+			
March	+	+	+	
April	+			
May	+			
June	+	+		
July	+			
August	+			
September	+	+	+	+

6.2 Processes and Procedures for Entry of Reported Data into the NMMSS Database

All reported data supplied by facilities to NMMSS passes through the following phases when being entered into the primary database:

- Preparation of reported data at each facility and transmission of the data to NMMSS.
- Receipt, logging, and entry of facility reported data into an input working file.
- Input check, correction of errors, and entry of the corrected data into the primary database.
- Generation of reports from the input data and distribution of reports to the facilities that provided reported data to NMMSS.

The phases involved in the entry of reported data into the NMMSS database are shown in Fig. 6.1.

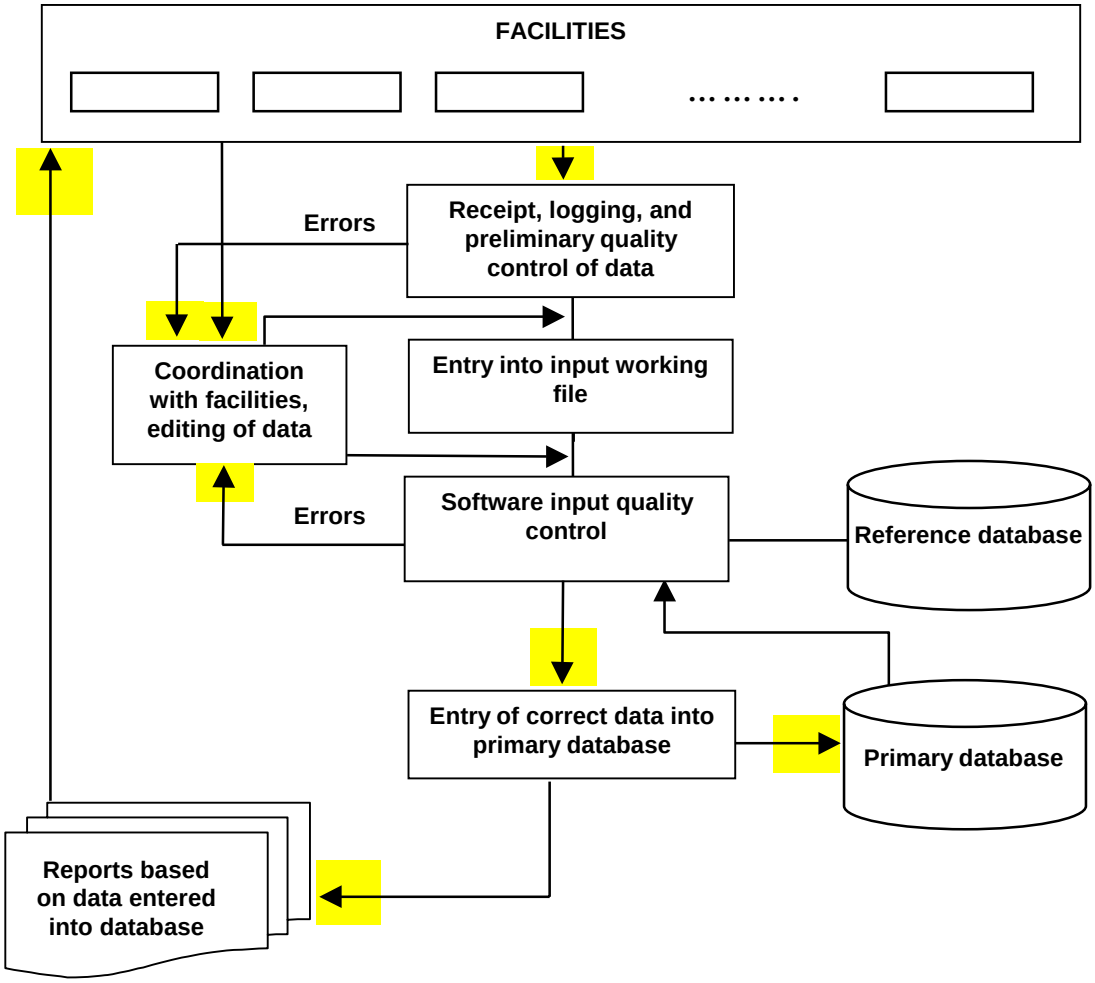


Figure 6.1. NMMSS reporting information input procedure.

6.2.1 Preparation of Reported Data at Each Facility and Transmission of the Data to NMMSS

Each facility providing data to NMMSS has a special department dealing with nuclear materials control and accounting.

Data is prepared for NMMSS by specially authorized individuals within the nuclear materials control and accounting group: these individuals are responsible for assuring that the data supplied are correct, correctly filling out the forms in strict conformance with the instructions, transmitting the data to NMMSS in a timely fashion, providing corrected data requested by NMMSS in a timely fashion, and correctly determining the security classification level indicated on the information forms.

The reporting information for each type of document is prepared in accordance with NMMSS input forms developed on the basis of DOE/NRC regulations.

The policies and procedures governing the transmission of the reporting information from the facilities depends on the type of reporting document, the facility category, and the category of nuclear materials involved.

Most NMMSS facilities are computerized, but there is no specialized software for the generation of nuclear materials control and accounting reports at individual facilities or for the generation of reports on NMMSS forms. Thus, facilities use a variety of software packages to generate their own reports, and then convert the report information to NMMSS format for transmission to NMMSS. [26]

If all required reported data from the individual facilities is not supplied within the required deadline, the accounting period for document processing cannot be closed out. If this happens, NMMSS operators first call the facilities which failed to submit reports, and then (if necessary) the DOE field office and DOE management, which is authorized to declare the accounting period closed out. In this event, the output report may contain footnotes indicating that certain facilities did not provide reported data. [22, 26]

6.2.2 Receipt, Logging, Initial Quality Control, and Entry of Facility Reported Data into an Input Working File

Facility reported data is transmitted to NMMSS via the following communications systems: SIMEX (Secure information management exchange); electronic communications; dedicated communications links; or by mail (diskette or paper). [27]

Twenty-six DOE facilities transmit their reported data via SIMEX. Most of the data received from NRC licensees is on diskettes. A very small fraction of the reported data is received in hard copy. In this case, the reported data is entered into the database by a system operator. [28] The choice of data transmission method depends on the capabilities of the facility and the security classification of the data. [26] The communications facilities and data transmission technologies used by NMMSS are described in Sec. 8.

Facility reported data is received primarily in electronic form. NMMSS procedures call for a preliminary virus scan of all electronic data received. [29]

As reports are received by NMMSS, the input information is logged and passed through an initial quality control check for correctness of data presentation. The initial quality control check for correctness of data presentation includes verification that the electronic and paper representations of the reports conform to NMMSS required formats and that the basic identifiers of the report document have been correctly coded. [17] Operators use the information contained in the reference tables for validation of the reported data.

The reference tables contains information concerning all NMMSS facilities, as well as the authorized personnel at each facility who are responsible for the correct and timely preparation of reports for NMMSS.

The background data for each facility includes the following basic data items: the full name of the facility and its code, the owner of the facility, a list of permitted operations involving nuclear materials, basic information concerning operational modes and parameters, location, a list of personnel responsible for transmission of reports to NMMSS, etc.

These data are used by NMMSS operators both for error analysis and for communicating with authorized personnel at the facilities. Any errors observed may be corrected upon agreement with the authorized personnel at that facility. [17] If immediate correction of the error is impossible, the facility is required to send a new report.

Once the reported data has been checked for correctness of presentation, it is entered into the input working file.

6.2.3 Incoming Quality Control, Error Correction, and Entry of the Corrected Data into the Primary Database

Upon entry of the facility reported data into the input working file, data are subjected to incoming quality control for completeness of input, errors in data elements, and illegal symbol combinations in accordance with the quality control algorithm. The incoming quality control program uses information from the reference tables as well as the primary NMMSS database. Each type of reporting information has an incoming quality control program. Running the incoming quality control program divides the data into those which pass quality control and those which contain errors.

Data containing errors are transmitted to the NMMSS analysis subsystem, which is responsible for analyzing and editing any errors that are detected. The analysis subsystem is a system of menus that provide operators with the capability to examine and edit all types of input data. The operator selects the desired form on the screen based on the type of input document involved. The analysis subsystem provides access to background information when working with facility reported data. When accessing fields which should include coded data, the subsystem will highlight lists of possible alternatives for that particular category of data; this facilitates data entry and data editing. [29]

NMMSS operators examine the submitted data, analyze errors, and contact authorized facility personnel to resolve any discrepancies. [17] Some errors may be edited out immediately with the agreement of authorized facility personnel. If documentary confirmation of the correction is required, this can be submitted via fax. If the errors are serious, and cannot be corrected immediately, NMMSS will send the facility a report describing the errors that were detected. In this case, the facility is required to prepare a new report taking these errors into account and submit the new report to NMMSS within a fixed time period.

Once the errors have been corrected, the edited data are once again passed through input quality control, and, if necessary, the error removal process is repeated.

Data which pass input quality control without error are transferred to the primary NMMSS database.

6.2.4 Generation of Reports Regarding Input Data and Distribution of Reports to Facilities

After processing of input data received from the facilities has been completed, reports are generated describing the data processed that day. One copy of the report is retained by the NMMSS archive, while a second report is distributed to the facilities which provided reported data. [19]

If facility data were edited during the incoming quality control process, the facilities use the edited results provided in the NMMSS report to correct errors in facility accounts.

NMMSS reports describing the data entered in electronic or paper form are transmitted to the facilities using the same communications links used by the facilities to transmit their data to NMMSS.

6.3 Procedural Cycles for Processing NMMSS Reporting Documents

The procedural cycles for processing NMMSS reporting documents include the following steps:

- Obtaining reporting documents from the facilities in DOE/NRC-approved format within the deadlines established for the submission of reported data on each document.
- Using information in the reference tables and NMMSS-derived information to verify correctness of the reporting information received.

- Analysis of the data following the completion of established accounting periods.
- Creation of routine output report forms based on the document data for management organizations and facilities.

Three types of reporting documents are used to obtain facility reported data under NMMSS:

- Nuclear material transaction reports describing all transactions in which the facility participated as receiver or shipper.
- Inventory reports describing inventories of nuclear materials performed at the facility.
- Material balance reports for each facility.

For each type of reporting document, NMMSS policies and procedures incorporate the following:

- Special forms for presentation of NMMSS reported data.
- Regulations governing NMMSS reporting deadlines for facilities.
- A deadline for processing document data.
- Regulations governing the processing of document data at the end of the accounting period.
- Regulations governing the creation of output reports for different levels of NMMSS users from the information in each reporting document.

The procedural cycles for processing NMMSS reporting documents are interrelated because the data contained in the documents are interrelated. For example, the calculated inventory and material balance data are obtained from the transaction data for the reporting period together with the data from the last inventory. Thus, completion of an inventory and material balance period can occur only after the accounting period has ended and the system of transactions has been processed and closed out. The interrelationship between the procedural cycles for NMMSS document processing is shown in Figure 6.2.

The ending dates of the accounting periods used for processing NMMSS data are tied to the U.S. Government fiscal year.

NMMSS transaction accounting and processing (close-out) occurs on a monthly basis. The transaction processing cycle results in a consistent data set of transactions for the reporting month. This data set is then used to obtain the calculated inventory and material balance and to generate a NMMSS monthly report of the transactions that occurred during the reporting month.

Also on a monthly basis, once the transaction system has been closed out, NMMSS generates a calculated inventory and material balance for DOE facilities, generates material balance reports for 130 DOE facilities, and distributes these reports to DOE and back to the facilities.

The NMMSS inventory cycle is based on monthly and quarterly reporting by the facilities. Thus, the NMMSS inventory system processes the inventory data on a ~~quarterly~~ monthly basis and generates output reports on the material balance of nuclear materials, which are then provided to regulatory agencies and the facilities. [18]

Twice a year NMMSS conducts a required semi-annual reconciliation of NMMSS data against facility data. NMMSS generates material balance output reports based on this reconciliation for management organizations and the facilities.

A detailed description of the procedural cycles for processing transactions, inventories, and material balances is provided below.

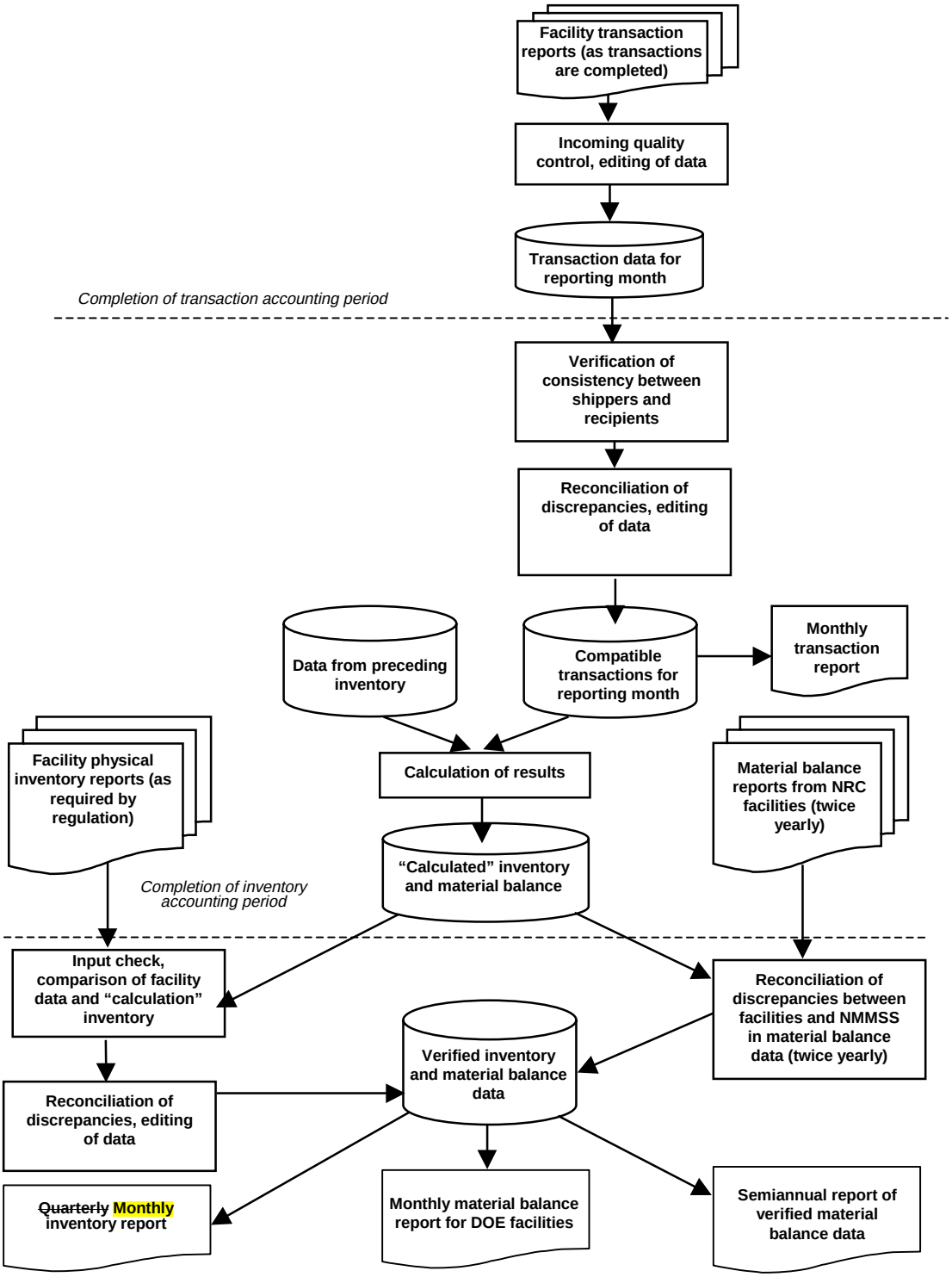


Figure 6.2. NMMSS monthly data processing cycle.

6.3.1 Procedural Cycle for Processing Transaction Reports

Facility transaction reports contain detailed information about any changes in the nuclear material inventory at each facility that may occur as a result of the transfer of nuclear materials between facilities, on-site increases or decreases of nuclear materials due to operations, intra-facility transfers from one government program to another, or the import and export of nuclear materials.

Each transaction consists of two events: the transfer of nuclear materials by a shipper and receipt of nuclear materials by a receiver. A report is submitted to NMMSS for each event. NMMSS treats each report submitted by a shipper or receiver as a "transaction report."

The reports are submitted in conformity with DOE/NRC paper forms 741, 741A, and 740M (for IAEA-required reports) and electronic forms 740, 740A, 734, and 749. These forms are described in Sec. 5.

The regulations governing the submission of transaction reports to NMMSS by the facilities specify a deadline of between one and seven days (depending on the type of material shipped) from the day on which the nuclear materials were shipped/received. [26]

According to the regulations, transaction reports may be provided to NMMSS on a daily basis, depending on the date of the transaction; the major steps in the data-entry process described in the preceding section are completed the same day.

All transaction reports received by NMMSS pass through software-based incoming quality control to verify the correctness of the data items provided. The input quality-control software is considered the "heart" of the NMMSS and contains 250 steps for verifying the correctness of the data. [29] Any errors detected during input quality control can be edited out by NMMSS operators in consultation with authorized personnel at the facilities; otherwise, the facility is required to submit a new report. The edited data are once again placed in the software quality-control input stream, and only correct data are placed in the NMMSS database.

NMMSS performs transaction accounting and processing (close-out) on a monthly basis. Since the regulations governing submission of transaction reports require that they be transmitted to NMMSS within seven days of the actual transaction, all data for transactions during the reporting month should be received by the eighth working day of the following month. If the data that has been received is complete, a decision is made to close the accounting period and begin processing the report for the ~~reporting~~ closed out month.

At the end of the accounting period, all transaction reports received by NMMSS during the reporting month must be analyzed for consistency of data reported by shippers and receivers. In order to ensure that this verification procedure leads to correct results in the case where the shipper's transaction report has been received by the system, but the receiver's report has not, NMMSS uses the DOE in-transit rule: *At the end of each reporting period for transaction processing, all shipped material is entered on the inventory of the intended recipient.* Special NMMSS software is used to verify consistency between shipper and receiver data. Any errors detected are analyzed by NMMSS operators and edited out in consultation with the facilities or DOE Field Offices. This process requires several days. [19]

When all discrepancies between shippers and receivers ~~have been reconciled~~ are compatible, the data are closed out, i.e., ~~the system enters into the transaction data records the data that processing was completed~~ the system retains the date that processing was completed (this information is not stored within the transaction data records) and the values of the data items are fixed as of that time. Once the data have been closed out, no changes are allowed. For correct archive management, NMMSS policies and procedures require that historical data not be edited. If errors are detected after close-out and it becomes necessary to make corrections, such corrections may be made by mutual agreement between shipper and receiver in accordance with a special procedure. [26]

Once processing is complete, and the data have been closed out, NMMSS generates the required output transaction reports for NMMSS users. Various summary reports are generated for users at different levels.

6.3.2 Procedural Cycle for Processing Inventory Reports

Facility inventory reports contain data on the inventory of nuclear material at each facility at a certain instant of time and describe the composition, quantity, and means of storage used for the nuclear material.

The reports are submitted in conformity with DOE/NRC paper form 742C and electronic forms DP-733 or DP-733A (for IAEA-required reports). These forms are presented in Sec. 5.

Regulations governing the submission of inventory reports to NMMSS are determined by the type of facility, category of nuclear material, and amount of nuclear material being reported; report submission conforms to the frequency of inventories at the site. All DOE facilities are required to report quarterly and the largest producers of nuclear materials are required to report monthly; however, there are also facilities with a reporting interval of 2 months. NRC licensees are required to report twice a year, if they have nuclear materials on hand (above a certain quantity) or as required by their contract or license. If NRC licensees use materials owned by DOE, they are required to report in accordance with DOE requirements. IAEA-regulated facilities report once a year. Thus, facility inventory reports are received by NMMSS on a monthly, bi-monthly, quarterly, semi-annual, annual, or other basis.

Additionally, some facilities (for example, scientific laboratories) are not required to file inventory reports under the regulations, but DOE requires NMMSS to track nuclear material inventories at all facilities in the NMMSS and at all facilities which interact with NMMSS. [18]

This capability of tracking nuclear material inventories (over any reporting period) for all facilities in the NMMSS and for all facilities that interact with NMMSS is ensured by calculating the nuclear material inventories at any given facility on the basis of the results of the preceding inventory and taking into account all transactions at that facility during the period since the preceding inventory. A verified starting inventory of nuclear materials at the facility may be used as the starting point for tracking facility inventories.

Inventory data (or a calculated inventory) is computed on a monthly basis for all RIS, once the transactions for the reporting month have been taken into account and closed out.

Inventory data from NRC licensees is processed once every six months, when NMMSS receives inventory reports from NRC licensees and the transactions from the last month of the six-month period have been processed.

According to NMMSS policies and procedures, the decision to terminate the accounting period for inventories is made on the fifteenth of the month following the reporting month (after the data in the transaction system have been closed out). [26]

Facilities which are required by regulation to perform inventories during a given reporting month must provide their reports to NMMSS no later than the fifteenth of the month following the reporting month.

Like calculated inventory data, inventory reports from facilities must pass through software input quality control.

The software for quality control of inventories verifies each data element, ensures that there are no improper combinations of symbols, and compares the facility data against the calculated inventory. All detected discrepancies are analyzed, the sources of the errors are identified, and the data edited in consultation with authorized facility personnel. The edited data are once again subjected to incoming quality control, and the error-elimination process is repeated as necessary.

Once all discrepancies have been reconciled, the data are entered into the NMMSS database and closed out. Reports describing the results of the data entry are then generated and distributed to the reporting facilities for verifying facility accounts.

The NMMSS inventory cycle is based on monthly and quarterly facility reports. Correspondingly, the NMMSS inventory system receives, edits, and processes facility data on a ~~quarterly~~ monthly basis. Summary material inventory reports are generated from the data processed in NMMSS and forwarded to management organizations. “Calculated” inventories are used for those facilities not required to report for the current month. [18]

6.3.3 Technological Cycle for Processing Material Balance Reports

The material balance report of an installation describes the inventory status of each type of accountable material at the installation over a certain time period, and includes data from the facility inventory listings at the start and end of the accounting period, as well as summarizes all transactions at the facility over the period between inventories.

The inventory changes are totaled by categories of increase and decrease per DOE/NRC form 742, as described in Sec. 5.

Because the data from the facility material balance report can be obtained on the basis of the facility's inventory and transaction data, material balance reports are compiled by the NMMSS program. The use of an automated nuclear materials management and protection system for reporting on the material balance began in 1965. It has operated to a large extent as a system for the input and editing of inventory listings. An agreed upon number of material balance ending inventory listings compiled by DOE contractors was entered into NMMSS in December 1969. From that moment forward (beginning in March 1970), NMMSS became the source of data on the material balance. [20]

NMMSS tracks the beginning and ending inventories of nuclear materials in order to compile two different material balance reports for each installation and each material type. These reports differentiate material belonging to the DOE, and material not belonging to the DOE.

As in the inventory system, the schedule for computing the material balance depends on the monthly accounting of transactions. A material balance report can be drawn up after transaction reports have been processed and the final inventory of nuclear materials at the facilities have been computed (the calculated inventory).

DOE requires that NMMSS generate an output report on the material balance for each of the 130 DOE installations **on a monthly basis**. A summary is sent to DOE as part of a package with the last verified semi-annual material balance. [19] Facility material balance data computed by NMMSS is distributed to the installations for purposes of monitoring the quality of the reporting being done at the facilities.

NRC licensees are obligated to submit report data on the material balance on form 742 once every six months. These reports are not entered into the NMMSS database, but are used for the routine semi-annual reconciliation of facility data against the data computed by NMMSS. [26] The process of routine semi-annual reconciliation is described in Subsec. 6.1.

NMMSS uses the reconciliation results to generate (a) summary output reports on the material balance of nuclear materials for submission to the administrative organizations, and (b) facility material balance reports that are distributed to the facilities for purposes of monitoring the quality of the reporting being done at the facilities. [20]

7. NMMSS Report Distribution

The primary functions of the NMMSS information system include the planning, generation, and dissemination of output reports based on the information contained in its database.

Each report generated by the NMMSS is identified by a number and prefix linking that report with some information category. The prefixes of the output reports and the categories linked with them are contained in the information reports, described in detail in Subsec. 5.2.

All NMMSS reports are compiled based on the information contained in its database, and none of the information contained in any reports can be altered in any way.

NMMSS output reports are generated in accordance with DOE and NRC requirements and satisfy the information requirements of system users.

7.1 Production Report Distribution

The NMMSS staff generates and sends production reports according to procedure. This signifies that the routine reports included on list D-22 are sent to users, without request on their part, in accordance with an approved distribution list for NMMSS reports and at the times stipulated for each of those reports. [22]

Routine NMMSS reports are sent out at the end of NMMSS data processing cycles in accordance with the stipulated reporting periods of the American fiscal year, which ends in September.

An internal form called the “master scheduler” has been developed to issue and monitor tasking for the generation and distribution of NMMSS reports. The master scheduler contains the following information:

1. Job name.
2. Report number (for example, M-742).
3. A report identifier, consisting of four parts: the number of the report, facility or field office data; a facility or field office identifier, the reporting period (monthly, quarterly, etc.).

   Example: M-742-FAC-FZE-MON
   - M-742 - Material balance report
   - FAC - Report for the facility
   - FZE - in Oak Ridge (F)
   - MON - Monthly Report.
4. Programmer (who performed the job) identification.
5. Job schedule code.

   Example: Q16—all data must be received by the 16th day of the month following the reporting month; otherwise the reporting month cannot be closed out.
6. Job number (NMMSS internal number).
7. Recorded by (identification of NMMSS employee completing the form).
8. Date of completion.
9. SIMEX report number. Also used for verification: “We have sent you number. . .”

10. Repeat requests. If someone requests a report that has already been generated and sent, the following information (items 6–9 above) is required: job number, recorded by, date of completion, SIMEX report number.

7.2 Special Requests

A special request is a request to obtain information outside of routine production. A special request may contain a demand to obtain one of the routine reports by an agency not included on the distribution list for that report. If a report not on the routine list is requested, special effort is required to fulfill it (special report). [17]

In all cases, authorization is required to obtain a special report by request. The procedure for the dissemination of reports by request is shown in Fig. 7.1.

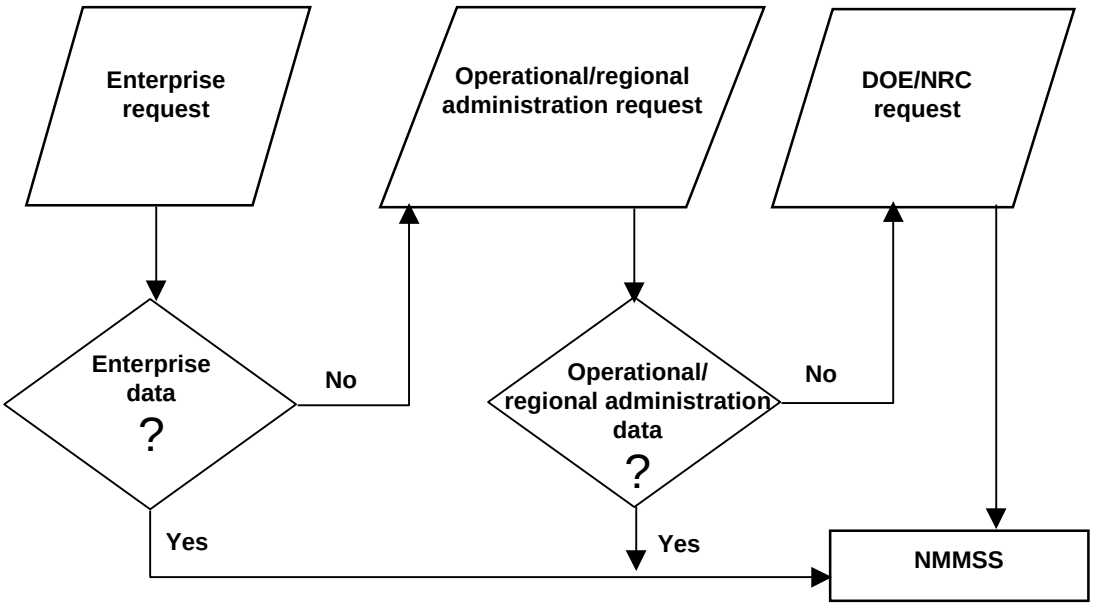


Figure 7.1. Information distribution within the NMMSS.

Authorization for the fulfillment of a special request is obtained by the appropriate NMMSS supervisor, he checks whether the requester has a sufficient access level. NMMSS personnel verify the authorization for special report requests by telephone whenever possible, and are required to record these conversations. [30]

The NMMSS has a goal that 80% of requests are fulfilled in 24 hours or less.

Most requests (80%) come from DOE, with 15% from the NRC and 5% from remaining agencies. Most of the requests concern transactions.

If the requesting party is a DOE facility, it must be authorized to obtain the report, even if it is the facility's own data. Authorization for the expenses associated with the request must be received from the DOE Office of Security and Safeguards (DOE/OSS).

If the requesting party is not a DOE facility, authorization is needed only to see the data of other facilities.

Tracking Special Requests

A NMMSS accounting form exists for special reports and it contains the following information: the name and organization of the requester, the date and time of request, the name of NMMSS employee who received the request, an estimate of the time needed to meet the request, the actual time required, a description of the request (the requesting party sometimes cannot formulate his requirements precisely enough), a report number (if a routine report is being requested) or a description of the information to be transmitted, the cost of request fulfillment routine, and how the information was transmitted (for example, SIMEX).

7.3 Inspection Packets

NMMSS receives requests for the compilation of inspection packets from the DOE and NRC inspection services. DOE and NRC inspectors do not need authorization to receive such packets. Requests for inspection packets are recorded. The NMMSS receives an average of eight to ten requests per month for inspection packets. The principal installations are inspected an average of once a year. [30]

Packets of four to five reports are usually requested, and they are fulfilled by the NMMSS as one assignment. They are completed quickly and inexpensively.

The inspectors compare the reports with the actual data at the installation. The installations sometimes request these reports themselves to prepare for an inspection.

Examples of the reports that are included in the inspection packets are:

- TJ-45—a detailed report on based form 742.
- TJ-8A—all transactions at the installation over a certain time period, with various recipient and supplier data.
- TJ-8B—only transactions with discrepancies in the shipper and supplier data.
- TJ-26—random samples.

7.4 Methods of Delivering Reports

Depending on the affiliation of the information user (DOE, NRC, or others), its level of available computer resources, whether or not it has automated data processing systems of the required types, and other factors, NMMSS reports may be transmitted in the following ways [22]: on the SIMEX network (DOE), over public communications lines, on magnetic media in various formats (DBF, Lotus, etc.) sent by mail, or in the form of a printed brochure sent by mail.

8. NMMSS Hardware and Software

8.1 Technical Characteristics of the Computer Hardware in the NMMSS Information Center

Fig. 8.1 shows a structural diagram of the computer hardware that is currently performing NMMSS tasks. The foundation of the hardware system is two file servers and seven personal computers linked to a LAN using Ethernet architecture. Three network laser printers [29] are connected to the local network.

All of the principal hardware is produced by Compaq.

Both Compaq ProLiant **file servers** (F/S1 and F/S2) have identical technical characteristics:

- 90-MHz Pentium processor.
- 96-MB RAM with an ECC system.
- Data transmission bus to external devices—SCSI-II.
- 14-GB external hard disk array, using RAID-5 technology consisting of eight 2-GB disks.
- An internal CD-ROM drive.
- Ethernet LAN adapter.
- VGA monitor.

High-capacity (up to 16 GB per magnetic tape cassette) **magnetic tape read/write devices are connected** to file server F/S1:

- TurboDAT Autoloader 4/16 GB.
- TurboDAT Tape 4/16 GB.

The **five workstations (WS3−7)** have the following technical parameters:

- 66-MHz Intel 486DX2 processor.
- 16-MB RAM—with an ECC control.
- 3.5-inch floppy drive, 1.44 MB.
- 5.25-inch floppy drive, 1.2 MB.
- Ethernet LAN adapter.
- VGA monitor.

Workstation (WS1):

- 100-MHz Intel 486DX4 Processor.
- 16-MB RAM—with an ECC control.
- 525-MB hard drive.
- 3.5-inch floppy drive, 1.44 MB.
- 5.25-inch floppy drive, 1.2 MB.
- Ethernet LAN Adapter.
- VGA monitor.

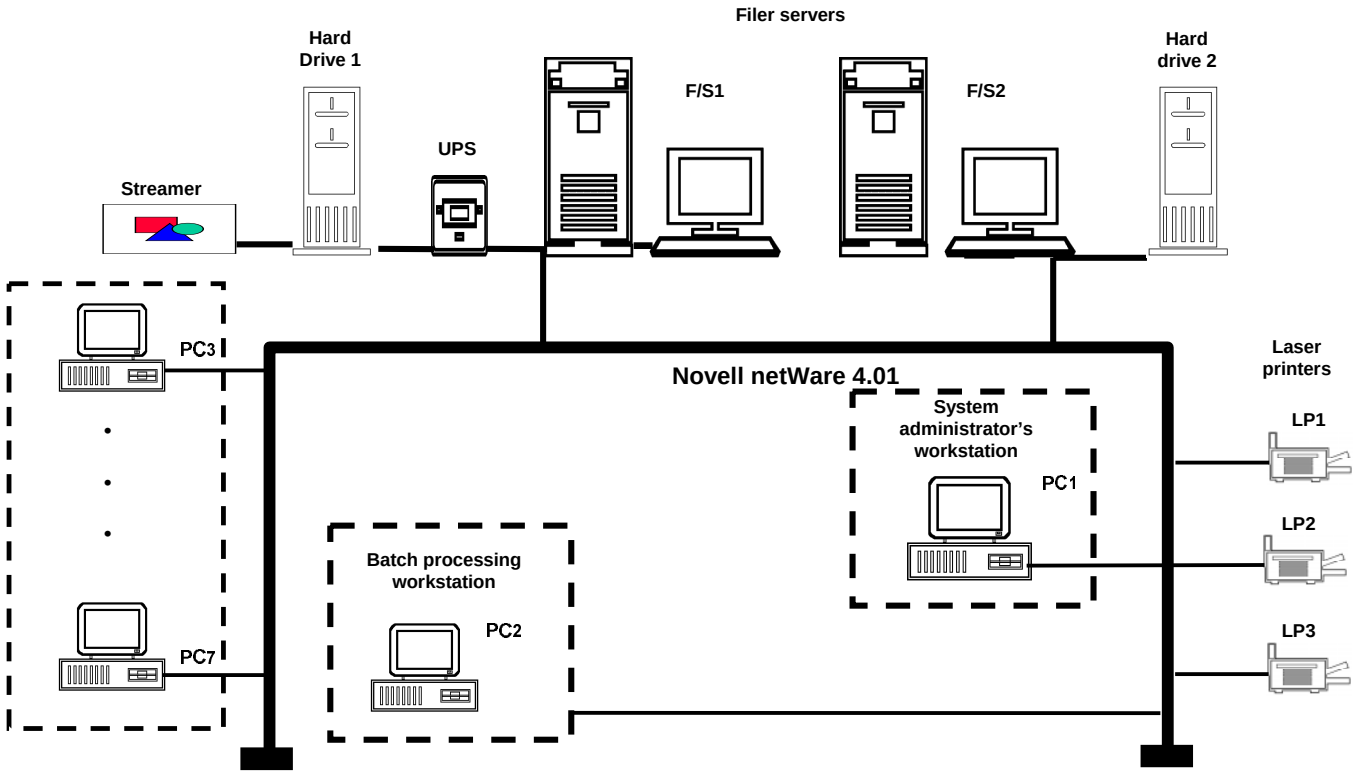


Figure 8.1. Diagram of the NMMSS LAN.

Workstation (WS2):

- 66-MHz Pentium Processor.
- 16-MB RAM with an ECC system.
- 525-MB hard drive.
- 3.5-inch floppy drive, 1.44 MB.
- 5.25-inch floppy drive, 1.2 MB.
- Ethernet LAN adapter.
- VGA monitor.

Three network laser printers:

- HP LJ-4Si LAN printer.
- A4 paper format.
- 600-DPI resolution.
- 16 pages/minute print speed.

- 2-MB working memory.
- Two 500-sheet feeders.

Uninterrupted power supply device:

- UPS2000.

The LAN bus is a fiber-optic cable. Personal computers and printers are connected through concentrators/converters.

The network operating system is Novell NetWare 4.02; it supports 25 users.

The workstation operating system is MS-DOS v. 6.22.

8.2 Functional Structure of the Computer Hardware

The foundation of the hardware system for the NAC Information Center is two file servers. The first is the so-called production file server on which NMMSS tasks are performed in normal mode; it also stores the updated NMMSS database. [29] The second file server is, on the one hand, a back-up in the event of a failure of the "production" server, and, on the other hand, a "test" server, since it is used by programmers to debug and test newly created software using the actual database.

Operator use one of five identical workstations (WS3 to WS7) when they manually enter information into the database from reports not submitted electronically and when they make corrections to information. The WS2 workstation is used to enter information received on magnetic media. The WS1 workstation is used to control the operation of the entire system.

The laser printers are used to print output reports.

The 14-GB disk array, configured using RAID-5 technology, is intended to accommodate the entire NMMSS database. The RAID-5 technology supports: presentation of the set of physical disks to the user as one large virtual disk; distribution of data over all the physical disks; the capability of recovering data in the event of a crash of one or several disks, ensured by the availability of surplus disk space volume; and the capability of replacing a faulty storage device during operation.

Tape storage devices make it possible to perform database back-ups. The storage devices can accommodate up to 16 GB of information on a single magnetic tape cassette in operating mode with four-fold compression.

A UPS2000 uninterrupted power supply protects the central kernel of the system against random electric power supply failures and, in the event the power supply is disabled, makes it possible to maintain system operability for 15 to 20 minutes. This provides an opportunity to complete all operations at the workstations without the risk of losing information.

8.3 NMMSS Communications

Various types of communications are used for exchanging information among contractors, users, and the NMMSS Information Center. [11, 12, 17]

Most DOE contractors use the secure SIMEX network. SIMEX is a system structured on the UNIX information distribution platform that supports reliable identification, transmission error checking, recording, and the retrieval and transmission of messages. This telecommunications network links facilities that belong to the DOE. The SIMEX network is constructed using a star architecture with its

center co-located with the network center of the Department of Defense in Maryland. A correcting code is used to transmit information within the system via distributed telephone lines. The network stores and transmits information (both classified and unclassified) without monitoring its content. Information received through the SIMEX network is recorded on magnetic media for subsequent entry into NMMSS and, conversely, information from NMMSS is transmitted to the SIMEX network on magnetic media.

STU-III, a third-generation secure telephone installation, is used for transmitting information. Communication is accomplished by two remote computer operators using special telephones connected to the computers with a physical key. Information obtained using this system is also transmitted to the NMMSS by magnetic media.

Some contractors transmit information using modem communications between their computers and an electronic bulletin board (BBS).

The U.S. Postal Service is used when information (both classified and unclassified) is sent in hard copy or diskettes.

Other types of communications, for example satellite transmissions, are currently not used in the NMMSS.

Figs. 8.2 and 8.3 show the principal lines of communication used by the NMMSS Information Center to send and receive information.

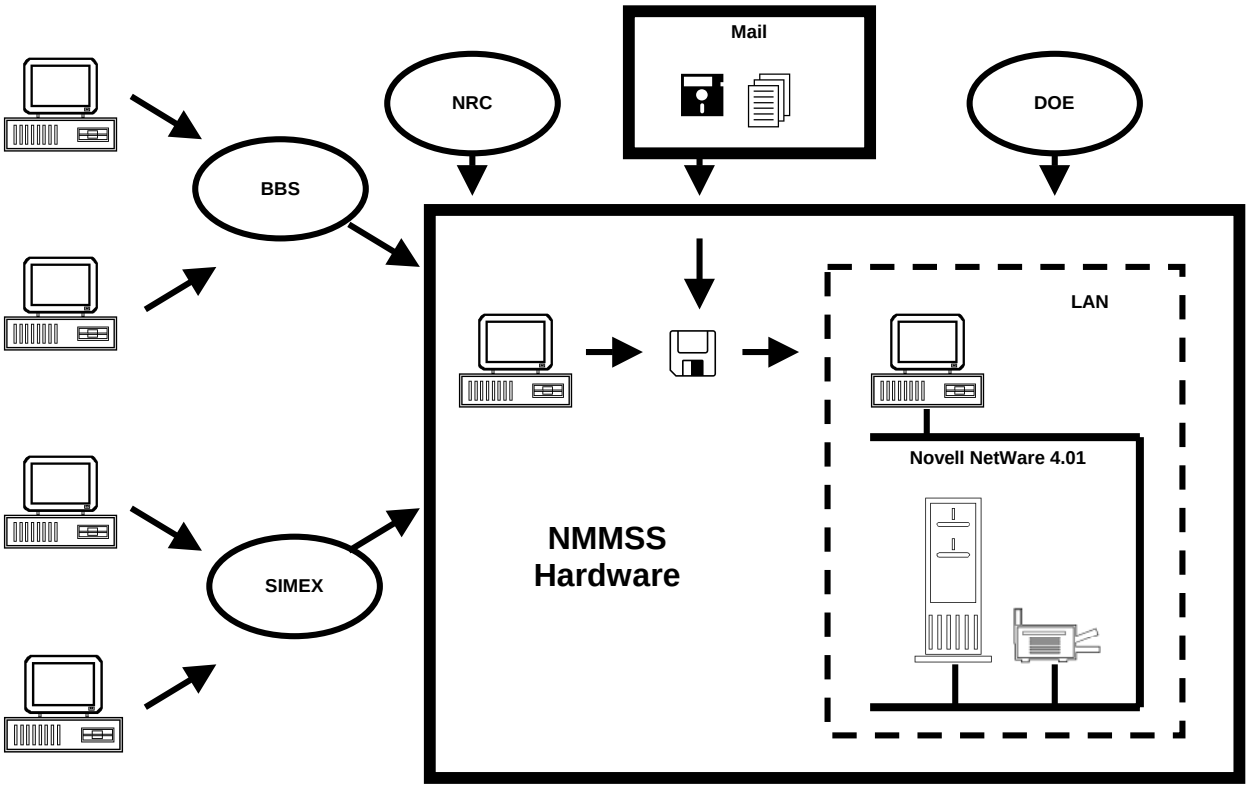


Figure 8.2. Information receipt methods.

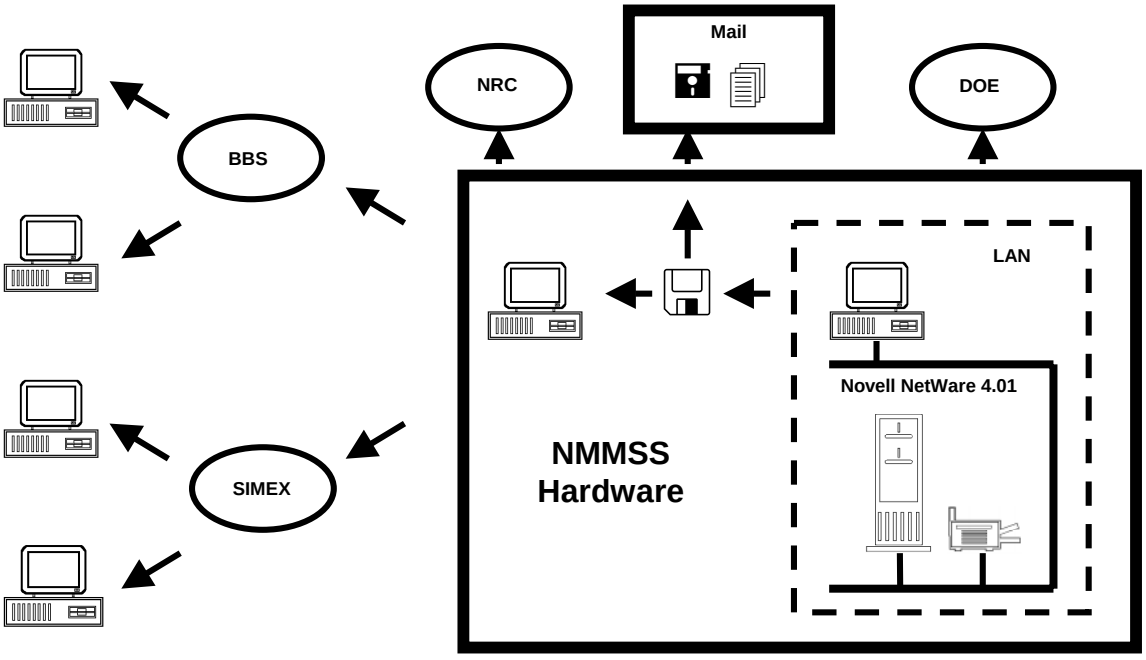


Figure 8.3. Information transmission methods.

8.4 Information Processing Technology at the NMMSS Information Center

The technological process of information processing at the NMMSS Information Center is designed to execute major NMMSS tasks. [29]

- Collecting data coming in from the facilities, and checking, editing, and entering into the NMMSS database.
- Servicing and upgrading the NMMSS database.
- Preparing routine and special reports for NMMSS facilities (users), DOE operations departments, regional divisions of the NRC, and NMMSS program clients (the DOE and NRC, the USEC, and the IAEA). Three groups have been created at the NAC for this purpose: the system administrator, which includes the programmers; nuclear materials operators working with American users; and nuclear materials operators working with international organizations.

The system administrator and the nuclear materials operators are engaged directly in the operation of the system.

The principal duties of nuclear materials operators include entering data in hard copy, processing (and editing, when necessary) all incoming reports, as well as providing consultative assistance for system users.

Data received from the facilities on magnetic media are entered into the system daily from the batch processing workstation. Data arriving in hard copy is entered by a nuclear materials operator from an operator's workstation. The data is then checked for errors during initial processing. Data containing errors is automatically entered into an errors file, which is analyzed daily by a nuclear materials operator.

In order to correct errors, the nuclear materials operator contacts the facilities whose data contained the errors. The nuclear materials operator, after receiving corrected data, enters it into the system for processing. The editing and correction process continues until the information is error-free. Only after all errors have been eliminated is the data entered into the NMMSS working database.

The nuclear materials operator generates a material balance report from the system for each facility based on the inventory and transaction data received. The nuclear materials operator also handles special requests, generating various types of routine report formats with the aid of the system software.

In the event a required report form is not available, the nuclear materials operator sends a request for the development of the necessary type of report to the programmers.

All of the report types are generated from the system on magnetic media or in hard copy.

The nuclear materials operator uses the appropriate references, instruction manuals, and standards documents of the DOE and NRC in order to complete the reports correctly.

9. Components of NMMSS Quality and Reliability

The quality of the NMMSS information system is defined from the standpoint of its users by the accuracy, completeness, and timeliness of the presentation of information and the convenience of its use. However, the presentation of information in a form convenient for the users depends mostly on the degree of mutual understanding between NMMSS personnel and the users. Quality assurance for the remaining indicators entails a great deal of organizational and technical work.

Information security is another indicator of quality besides those reflecting the interests of the users of information that in turn reflects the interests of the state.

System security and reliability [24, 29, 31, 32] are key factors in every stage of NMMSS design, development, and operation.

9.1 Standards and Procedures

Standards and procedures are the most important factors in ensuring the quality and reliability of NMMSS operations. NMMSS standards and procedures relate to every activity NMMSS performs. The standards and procedures are based on DOE orders:

- 1000.3B Internal Control Systems.
- 5639.6A Classified Automated Information System Security.
- 1360.2B Unclassified Computer Security Program.
- 5500.7B Emergency Operating Records Protection Program.
- 1330.1D Software Management.

NMMSS standards and procedures developed concurrently with, or on the basis of these orders, encompass the following:

- Assurance of quality control (in the broad sense).
- Requirements for the observance of operating procedures.
- Guidance for new personnel.
- A plan for the restoration of system operations after an accident.
- Configuration management.
- NMMSS security requirements (internal requirements reflecting external requirements).

The completeness of the scope, detail, and thoroughness of the study of standards and procedures and how well they are documented are among the most important components in ensuring the quality and reliability of the NMMSS.

9.2 Personnel and Users

The qualifications of personnel, the quality of their training, and a responsible attitude toward their duties are components of the reliability of any system and cannot be overestimated. [24, 32]

NMMSS employees must follow the standard and qualification procedure for every activity that they perform. The standard procedure includes both the production duties of the employees.

Training of NMMSS personnel begins at the system development stage and continues as long as they work within the system. A special system of training exists for newly hired personnel (procedure: Guidance for New Personnel). New NMMSS employees are trained during work hours in accordance with the standard procedure. This includes the mandatory involvement of the new employee in various sections of the production cycle so that they can experience and understand the entire system.

The NMMSS takes advantage of every opportunity to expand the knowledge and experience of its employees on issues connected with system operation. NMMSS employees, for example, are members of various associations (associations of users of information technologies, associations of program users, international associations of users by functional areas).

Much attention is devoted to working with the system users. The timely receipt and accuracy of information from the installations are critical to the successful operation of the NMMSS, and depends, to a significant degree, on the understanding of the users (DOE, NRC, and the installations, among others). Users must be knowledgeable of their job requirements and the importance and responsibility of their role in the process of nuclear material control and accounting.

The NMMSS organizes regular workshops and yearly conferences for users so they can interact directly with NMMSS employees and with each other, clarifying issues of interest and increasing skills. Information from these conferences is included in the newsletter, which is available to all on request.

9.3 Accuracy of the Data

The NMMSS was created to manage nuclear materials control and accounting data. The data is the principal asset of the system and much attention is paid to ensuring its accuracy. One of the procedures focused on increasing the accuracy of the data, as was noted in the previous section, is working with the users—the source of the data. An increase in the quality of the reports received makes it possible to reduce the amount of effort needed to check the data, although errors cannot be eliminated entirely. The accuracy of NMMSS data is ensured by database management technology, which requires repeatedly checking data for correctness at various stages of data processing.

All report information from the installations is subject to verification at the data entry stage for completeness of submission, the presence of errors in elements of the data, and accessibility of the logical combinations of symbols in accordance with the verification algorithm. Input check programs use information from the reference tables to check the correctness of coding particulars. Only correct data is entered into the NMMSS database.

The data received from the suppliers and the users is compared at the data processing stage. Only compatible transactions will be entered into the database according to NMMSS technology.

The data from the inventory calculated by the NMMSS is compared with the inventory data from the installations in the inventory processing stage.

Errors detected in data processing are analyzed and edited. Editing results are reflected in reports that the NMMSS sends back to the installations. The installations then check their reporting procedures against the noted errors.

And, finally, the accuracy of data is checked during the routine semi-annual reconciliation process.

The method of repeated comparison between NMMSS data and installation data over the course of the procedural cycle makes it possible to ensure the integrity of the database, and, consequently, the reliability of NMMSS output data. [32]

9.4 Data Protection

The data received by NMMSS and stored in its database is the property of the state and constitutes a state secret. Receipt of this data by hostile forces could cause significant harm, as well as the irreversible loss of that data.

The NMMSS security system is a set of organizational measures, hardware, and software that simultaneously provides access to data and ensures its protection.

Date protection means, first and foremost, determining the individuals authorized to access the data and their specific rights in working with the data, i.e., examination, alteration, and deletion. Every person who works with the data needs official authorization to perform a specific type of activity.

The NMMSS database has a multilevel security system. The NMMSS Information Center is located in special accommodations with highly restricted access. The LAN bus consists of fiber-optic cable that does not emit electromagnetic radiation. The development and performance of tasks are physically separated in the NMMSS. Each is performed on autonomous LAN busses (see Sec. 8). NMMSS operators work at non-disk workstations that do not allow information screens to be copied.

The NetWare operating system has a streamlined security system. It distinguishes five categories of protection within the network: registration protection using a password system, protection by sponsorship, protection by rights, protection by succession of rights, and protection by effective rights.

NMMSS data are protected against possible outside access because data entry and data transmission can be accomplished only through an intermediate medium (diskettes, reports in paper form). NMMSS has no direct link between the LAN and communication lines.

Additional classified hardware and software protection undoubtedly exist. The primary functions of this protection are monitoring and limiting access, logging all data activity, reporting prohibited activities, and encoding data where necessary.

Maintaining a back-up copy of the NMMSS database protects against physical loss.

9.5 Technical Reliability

One of the primary links in the functional reliability of the NMMSS is the operational reliability of the computer hardware in the Information Center. The technical reliability of NMMSS is achieved through the following measures:

- Redundancy of computer equipment. The system uses two file servers with identical technical characteristics: one is the primary, the second a back-up. Identical disk arrays structured using RAID-5 technology are connected to the servers, providing highly reliable information storage and recovery—even when a disk drive is disabled. The average run time to failure of such a disk array is on the order of 40 to 50 million hours. There are redundant laser printers as well.
- File archiving for magnetic tape.
- The use of uninterrupted power sources. The electric power for the principal elements of the LAN is provided from an uninterrupted power source.

– Territorial redundancy. An identical computer center containing a copy of the NMMSS database is located in a different city.

The computer equipment used provides a high degree of data preservation. A plan has been developed for recovery operations in the event of unforeseen situations that makes it possible to preserve the database and ensure uninterrupted operation. [29]

9.6 Software Reliability

The correctness of the engineering decisions adopted in the design process has an impact on the reliability of the program system. But beyond that its reliability is defined almost entirely by the careful execution of strategically correct testing procedures. A unique testing strategy is selected in each specific instance. Much attention was devoted to software testing during the process of transferring NMMSS from Oak Ridge to Atlanta.

Transferring a system to a new technical base in a new program environment is actually a new elaboration, but with more explicitly pronounced requirements toward its results. Testing software under development and testing the system as a whole should be performed as often as possible.

NAC employees performed various types of tests in the process of transferring NMMSS. Internal functional software testing was performed in 1994, before the start of NAC/LMES parallel processing. The transfer of the historical database from Oak Ridge to the NAC took place in August and September 1994. Many changes were made in the data entry support software at that stage. The heart of the system is the process of checking the input data (there are about 250 steps performed to check the input data for errors). Data with errors are rechecked. Rewriting of the data from Oak Ridge with the performance of these verification procedures was testimony to the operability of the NAC programs. The NAC started working with the installations, obtaining “raw” data from them, as of November 1994. The NAC, by working with the users, checked and rechecked the information and compared its own data with that of the Oak Ridge reference standard, thereby checking out its own software as well.

NAC Specialists conducted special testing along with the “trial and error” testing method based on the Oak Ridge reference described above. The first testing project developed was declined. Specialists from the Lawrence Livermore National Laboratory took part in the second testing project. [29, 33] Some 37 tests were devised in all (in accordance with IEEE standards). The following system functions were tested during the testing process: data receipt, data processing and entry into database, report generation and distribution, and data protection.

Thirty-three tests were performed in August 1995. The remaining four tests were completed over the period from September 1995 through March 1996. The last four tests, and 16 of the first 33 tests were repeated.

Acceptance testing was performed by a Commission whose composition included representatives of the U.S. Government and a number of independent specialists.

A report was issued on the results of the testing. [29]

9.7 Recovery Operations After an Accident

NMMSS developed an information recovery plan in accordance with the requirements of DOE (5637.1). The goal of this plan was to ensure the uninterrupted processing of data in nuclear materials control and accounting coming from the installations and the distribution of the output reports to the users of

the information. NMMSS developed a detailed procedure, in addition to the plan for information recovery, that governed the sequence and content of the actions that an emergency team performed.

The plan was reviewed annually. The system was checked using the back-up computer system. A "fictional accident" was set up, and complete recovery of the system was practiced every two years. Partial recoveries were practiced between complete recoveries. Test results were evaluated and, if necessary, the plan was modified.

Members of the system recovery team were changed each year, so that all NMMSS employees obtained the necessary skills. [32]

10. Conclusions: Experience in the Development and Operation of the NMMSS

In the concluding lecture of the course given to the Russian specialists, specialists from NMMSS/Oak Ridge gave the following recommendations based on their own experience in the development and operation of the system [34]:

1. The system should be open and flexible, and should not be self-limiting. The possibility of upgrading must be inherent in the system at the design engineering stage, and one should try and foresee what it will be in ten years. Rigid data structures should not be inherent in the system.

   Examples of bottlenecks in NMMSS given were:

   – Adherence to 80 column formatting of input data.

   – Allotting only two characters for the "year" field—this proved insufficient.

   – Not enough space allowed in the "country control number" field in the NMMSS evolution process.

   – Other problems.

   The lack of space in which to input information into a field leads to the decision to temporarily use other fields for that information, e.g, the introduction of "patches" into the system. This occurred at NMMSS/ Oak Ridge.

2. NMMSS personnel and users must work together in order to ensure that the consequences of the decisions reached for current and future demands are identically understood. In order to avoid expensive revisions in the future, the user must pay close attention to the perspective of NMMSS personnel, who are obligated to inform the user of potential problems.

3. Significant attention must be paid to the training of NMMSS personnel and users. The better prepared the system personnel and users are, the more effectively the system operates. Funds for these purposes should not be removed from the budget of the control and accounting system.

4. Constant liaison with the users is very important. It was essential, on the one hand, to have a constant awareness of whether the system meets the requirements of the users; on the other hand, these requirements must be understood so as to react to the truly necessary ones and substantiate the necessity of system modifications to the sponsors (DOE, NRC, USEC).

   Everything possible must be done so that users feel they have an impact on the results achieved through operation of the system.

   Various types of interaction with users were practiced at NMMSS/Oak Ridge.

   – *User surveys*. A survey on the extent to which routine NMMSS reports were used made it possible to reduce considerably the volume of material distributed.

   – *The organization of meetings and workshops* with the participation of users to familiarize them with the NMMSS and discuss issues of mutual interest.

   – *Publication of the newsletter*.

5. The system should have clearly set procedures and be well documented. All regulations pertaining to nuclear materials control and accounting in the United States were assembled at NMMSS in summarized form. The documentation is kept up-to-date, and regulations represented by their latest

versions. NMMSS procedures included all the requirements of DOE orders and NRC mechanisms. All NMMSS procedures, techniques, and instructions were well documented. They stipulate explicit and unequivocal actions by NMMSS personnel in the process of system operation. The availability of high-quality documentation was important not only in the process of system operation, but also to train new NMMSS employees, as well as during audits. NMMSS personnel were always prepared for audits, owing to the high-quality documentation.

6. A mechanism for internal verification should be built into the system. NMMSS envisages the generation of routine reports for the verification of other reports. An “in-house” report was printed every six months. The test reports were also used for checking the database.

7. Drawbacks you have noted in the system cannot be ignored even when its operation is entirely normal. These drawbacks could manifest themselves entirely unexpectedly and, as a rule, at a critical moment.

8. You must consider your activity to be just one of many constituent parts of the whole, and take advantage of the experience of others.

   NMMSS took advantage of any opportunity available to it to expand the outlook of its employees on issues connected with system operation. NMMSS employees, for example, were members of various special interest groups—associations of users of information technologies, associations of program users, and international associations of users by functional areas.

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Appendix

Full expansions of the headings in the forms presented in the system description.

DOE/NRC form 742C (Figure 5.3)

Physical Inventory Listing

1.	Facility address and name
2.	Whether form 740M DOE/NRC is attached. Indicate—Yes/No
3.	Inventory date
4.	Facility reporting identification symbol (RIS)
5.	License number(s)
6.	Batch Data
6a.	Material type
6b.	Composition code
6c.	Element mass
6d.	Isotope mass
6e.	DOE project number
6f.	Scrap program
6g.	Mass % isotope
6h.	Owner code
6i.	Sequence number
6j.	Batch name
6k.	Number of items
6l.	Key measurement point
6m.	Measurement code:
	Measurement basis
	Other measurement points
	Measurement method
6n.	Entry code (in reactors, spent fuel pools, in the fuel fabrication process, etc.)
7.	Totals [specifies the total value of the element mass (6c), the fissile isotope mass (6d), and the number of items (6k)]
8.	Signature
9.	Name, title, and initials of authorized operator
10.	Date

DOE form DP-733 (Figure 5.4)

Physical Inventory Report
(Computer Form)

Item No.	Field name
1	Data type code
2–7	Inventory report date
8–11	Facility reporting identification symbol (RIS)
12–13	Material type code
14–17	Inventory composition code
18–30	Element mass
31–43	Isotope mass
44–53	DOE project number
54	Scrap program
55	Reserved
56–58	UESA category code
59–64	Mass % isotope
65	UESA production code
66	Owner code
67–74	Reserved

DOE form DP-733A (Figure 5.5)

Physical Inventory Report
(Computer Form for the IAEA)

Item No.	First segment field names
1	Data type code
2–7	Inventory report date
8–11	Facility reporting identification symbol (RIS)
12–13	Material type code
14–17	Inventory composition code
18–30	Element mass
31–43	Isotope mass
44–53	DOE project number
54	Scrap program
55	Reserved
56–58	UESA category code
59–64	Mass % isotope
65	UESA production code
66	Owner code
67–74	Reserved
75	Sequence number
Item No.	**First segment field names**
1	Data code
2–7	Inventory report date
8–11	Facility reporting identification symbol (RIS)
12–13	Material type code
14–17	Inventory composition code
18–33	Batch identification
34–37	Number of items
38-39	Key measurement point
40	Measurement basis
41–42	Other measurement points
43	Measurement method
44	Entry status
75–80	Sequence number

DOE/NRC form 741 (Figure 5.6)

Nuclear Material Transaction Report
(Inventory Change Report)

1.	Shipper's reporting identification symbol
2.	Receiver's reporting identification symbol
3.	Transaction number
4.	Correction number entered in the initial nuclear material transaction report
5.	Processing code ~~(only for the NRC commission)~~
6.	Reserved
7.	Action code or transaction type identifier: NM shipment or receipt, correction in the initial report (form 741)
8.	Data code
9a.	Name and address of shipper
9b.	License number
10a.	Name and address of receiver
10b.	License number
11.	Number of data lines
12.	Nature of transaction (possession of material in transaction)
13a.	Shipped for account of (specifies the three character code of the individual assuming financial responsibility for the shipped NM)
13b.	Specifies the reporting identification symbol of the entity releasing financial responsibility for the shipped NM
14a.	Shipped to the account of (specifies the three character code of the individual assuming financial responsibility for the NM being transferred)
14b.	Specifies the reporting identification symbol of the entity ~~assuming~~ releasing financial responsibility for the NM being transferred
15.	Transfer authority (contract number, project number, etc.)
16.	Export or import transfers
16a.	License number
16b.	Port entry/exit
17	Material type and description
18	Transportation profile
18a.	Trip segment
18b.	Carrier identification
18c.	Transfer point
19.	Package identification
19a.	Model ID
19b.	Number
20.	Action date
20a.	Shipment date
20b.	Date of shipper's correction or confirmation of NM shipping document
20c.	Receipt date
20d.	Receiver's measurement date
20e.	Date of receiver's correction or confirmation of NM receiving document

21.	Miscellaneous
21b.	Concise note attached by shipper (form 740M) (yes/no)
21c.	Concise note attached by receiver (form (740M) (yes/no)
22.	Total mass (gross). Specification by the pound.
23.	Total volume (waste transfers only)
24.	Shipper's data for each batch
24a.	Line number
24b.	Type of inventory change (29 codes available)
24c.	Identification (batch name)
24d.	Number of items
24e.	Project number
24f.	Material type
24g.	Inventory composition code
24h.	Production code
24i.	Owner code
24j.	Country control number
24k.	Key measurement point
24l.	Measurement identification
24m.	Gross mass
24n.	Net mass
24o.	Element mass
24p.	Element mass measurement limit of error
24q.	Mass % isotope
24r.	Isotope mass
24s.	Isotope mass measurement limit of error
24t.	Signature of official authorized by shipper
25	Receiver data
The receiver completes fields 25a–25t in the same manner as the shipper completes fields 24a–24t	

DOE/NRC form 741A (Figure 5.7)

Nuclear Material Transaction Report
(Continuation Page)

1.	Shipper's reporting identification symbol
2.	Receiver's reporting identification symbol
3.	Transaction number
4.	Correction number entered in the initial nuclear material transaction report

The number of the page continuation and the total number of pages in the report are specified in the upper right-hand corner.

Shipper data and receiver data continues in accordance with fields 24a–24t and fields 25a–25t, respectively, of the chart presented above.

DOE form DP-740 (Figure 5.8)

Nuclear Material Transaction Journal
(Computer Form)

Major transaction identifiers are specified in the upper left-hand corner of the report.

Item No.	Field name
Transaction identification	
1–4	Shipper's reporting identification symbol
5–8	Receiver's reporting identification symbol
9–14	Transaction number
15	Correction number
16	Processing code
17	Reserved
18	Action code
General information	
19	Data code
20–21	Number of lines
22	~~Nature of transaction (possession of the material in transaction)~~ Financial or contractual activity
23–26	Shipper RIS for account
27–30	Receiver RIS to account
34–50	Contract number ~~or project number~~
70–75	Action date
80	Concise note indicator
Detailed information	
19	Data code
20–21	Line number
22–23	Type of inventory change
24–39	Identification (batch name)
40–43	Number of items
44–53	DOE project number
54–55	Material type code
56–59	Composition code
60	Production code
61	Ownership code
62–69	Country control number
70–71	Key measurement point
72–75	Measurement identification
72	Measurement basis
73–74	Other measurement points
75	Measurement method
Continuation of "detailed information"	
19	Data code
20–21	Line number
43–53	Element mass
54–58	Element measurement limit of error
59–64	Mass % isotope
65–75	Isotope mass
76–80	Isotope measurement limit of error

DOE/NRC form 740M (Figure 5.9)

Concise Note

1.	Facility name and address
2.	Specifies to which form the concise note is attached
2a.	Form 741 DOE/NRC (specify—Yes/No)
2b	Form 742 DOE/NRC (specify—Yes/No)
2c.	Form 742C DOE/NRC (specify—Yes/No)
3.	Facility reporting identification symbol
4.	Reporting period. Beginning/ending date.
5.	Transaction data
5a.	Shipper's reporting identification symbol
5b.	Receiver's reporting identification symbol
5c.	Transaction number
5d.	Correction number entered into the initial transaction report
5e.	Processing code
5f.	Action code or transaction type identification: NM shipping or receiving, correction in the initial report (form 741)
5g.	Data code
6.	Reporting date
7.	License numbers
8a.	Line number
8b.	Entry reference
8c.	Text of concise note
9	Signature of individual preparing the concise note
10	Title, name and initials of individual preparing the concise note
11	Date of the concise note

DOE/NRC form 742 (Figure 5.10)

Material Balance Report

1.	Facility name and address
2.	License number(s)
3.	Facility reporting identification symbol (RIS)
4	Reporting period. Beginning/ending date.
5	Material type
Section A. Material accounting	
7.	Indicate whether concise not is attached (form 740M DOE/NRC). Specify—Yes/No
A.	Element mass
B.	Isotope mass
8.	Beginning inventory—DOE owned
9.	Beginning inventory—not DOE owned
Receipts (increases)	
11.	Procurement from DOE. Specifies the amount of DOE owned material. This may be presented by listing specific receipts from each facility. Specifies the reporting identification symbol (RIS) for each facility.
13.	Procurement for the account of DOE
14.	DOE returns—use A
15.	DOE returns—use B
16.	DOE returns—other uses
21.	~~Procurement from~~ Production
22.	~~Receipts~~ From other materials (blending or crossovers)
30.	Other receipts reported in form 741 DOE/NRC (not presented above). This may be presented by listing specific receipts from each facility. Specifies the reporting identification symbol (RIS) of each facility.
34.	Receipts—miscellaneous
38.	Material donated from DOE to other organizations
39.	Material donated from other organizations to DOE
40	Total (specifies the total material from lines 8–30) 8–39
Removals (decreases)	
41.	Expended in space programs
42.	Sales ~~within~~ to DOE. This may be presented by listing specific sales and specifying the reporting identification symbol of each buyer
43.	Sales to other organizations
44.	~~Shipped~~ DOD—use A
45.	~~Shipped~~ DOD—use B
46.	~~Shipped~~ DOD—other uses
47.	Expended in tests
48.	Routine tests
49.	Shipper-receiver difference
51.	Other shipments reported in form 741 DOE/NRC (not presented above). This may be presented by listing specific shipments from each facility. Specifies the reporting identification symbol (RIS) of each facility.

54.	Shipments—miscellaneous
58.	Material donated by other departments to DOE
59.	Material donated by DOE to other organizations
65.	Rounding bias
71.	Degradation to other materials. (A change in the NM element category by blending/crossover)
72.	Decay
73.	Fission and Transmutation
74.	Normal operational losses/measured discards
75.	Accidental losses
76.	Approved write-offs
77.	Inventory difference
80.	Ending inventory—DOE owned
81.	Ending inventory—not DOE owned
82.	Total (specifies the total material from lines 41–81)
83	Bias adjustment
Section B. Country control number data	
1.	Country control number
2.	Element mass
3.	Isotope mass
4.	Total mass (specifies the total mass of the element and isotope for items 2 and 3 of this section. Total must agree with totals on line 80 or 81 or both.)
Section C. Certification	
Date, signature, and title of individual compiling the report	

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