

BUILDING NMMSS RESILIENCE IN RESPONSE TO GLOBAL NUCLEAR PROLIFERATION THREATS

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ABSTRACT

This paper describes the United States Nuclear Materials Management and Safeguards System (NMMSS) in its role to provide mission-critical data analytics and informational products and services to advance U.S. government policies/responses related to global nuclear proliferation threats. The sources of NMMSS data are from domestic facilities and foreign nations or organizations and these data are submitted under contractual requirements, government rules and regulations, and international agreements. NMMSS data have supported U.S. global non-proliferation initiatives since the 1970s. The interdependencies between domestic and international nuclear materials data uniquely enable NMMSS to provide services for other organizations such as: International Atomic Energy Agency (IAEA), National Nuclear Security Administration (NNSA), Office of Defense Nuclear Non-proliferation, Nuclear Regulatory Commission (NRC), Department of State, and the U.S. Congress. Due to these many interdependencies, the NMMSS program continues to adapt and change, to build and display resilience while prioritizing U.S. and community agency needs. This paper presents lessons learned, noteworthy practices, and recommendations of potential benefit for other IAEA member states using similar materials control and accounting systems.

INTRODUCTION

The *Atoms for Peace* program, initiated by President Eisenhower in 1953, marked the beginning of U.S. assistance to foreign countries for development of nuclear energy programs. The purpose of *Atoms for Peace* was to solve “the fearful atomic dilemma” by turning atomic energy into a benefit for all humankind. The inspiration was a vision of nuclear technology not only advancing medicine and agriculture, but also providing the world with power “too cheap to meter.” The program was administered by the Atomic Energy Commission (AEC) and was restricted to countries or international organizations bound by Agreements for Peaceful Nuclear Cooperation with the U.S. As part of *Atoms for Peace*, the AEC helped foreign countries purchase or lease special nuclear material necessary for approved programs; yet present-day nuclear proliferation risks are significantly heightened compared to those mid-20th-century nuclear cooperation agreements.

Since the Eisenhower administration, the U.S. has exported over 26 metric tons of nuclear-explosive material (highly enriched uranium and separated plutonium) worldwide—enough for more than 1000 nuclear weapons. Nuclear material was exported to more than 40 countries for

use as fuel or targets in civilian nuclear research and test reactors. The material was subject to control measures to prevent loss; it was shipped from the U.S. (either directly or indirectly using a third-country intermediary) to countries which were considered, at that time, to be non-proliferation partners. However, the U.S. remains concerned about not only states seeking to develop nuclear weapons, but also theft by subnational groups. In addition, concerns include both current location and current form of the nuclear material, and whether material was used for the stated intention or used for alternative purposes.

The U.S. regulates exports of nuclear-explosive material using three mechanisms: agreements for cooperation, export licenses, and subsequent arrangements made with other countries; the U.S. does not require foreign recipients of U.S. shipments to continue reporting on the material after acknowledging receipt and submitting required declarations to the IAEA. Agreement terms and conditions are not uniformly alike, owing to an evolving U.S. non-proliferation policy, and the U.S. government currently has no plans to increase reporting requirements for countries that possess U.S.-supplied nuclear material. Additional new inventory reconciliation procedures would force major changes in U.S. non-proliferation policy due to the reciprocal nature of these agreements.

Factors which have significantly strengthened requirements for nuclear material export reporting are: enhanced IAEA safeguards, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and changes in U.S. statutory requirements (including enactment of the Nuclear Non-Proliferation Act of 1978 and the Energy Policy Act of 2005). As a result, the NRC exporting licensure process has become increasingly more transparent and currently contains ever more detailed information about intended end-use of U.S.-supplied nuclear material.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

The IAEA was established as an autonomous organization in 1957 and it reports to both the United Nations General Assembly and Security Council. The IAEA's mission includes promoting the peaceful use of nuclear energy while inhibiting its use for any military purposes, including nuclear weapons. The IAEA maintains records of nuclear material transfers and performs verification actions to ensure that the exported nuclear materials are received and then used for civilian nuclear activities. Pursuant to the NPT, the U.S. voluntarily furnishes to the IAEA specific information related to exports including advanced notification of intended shipments of nuclear material, confirmation of actual quantities, composition, and date of shipment.

The U.S. government relies on the IAEA to maintain safeguards on the exported material as required by international law. Among other material control and accounting duties, the IAEA inspects facilities and locations containing nuclear materials as declared by each country to verify peaceful end use. The agency issues an annual report affirming that it was able to adequately safeguard nuclear material subject to various treaties. The IAEA does not have detailed enough information in order to identify quantities of nuclear material held by international facilities of U.S. origin, and therefore, subject to the terms of U.S. nuclear

cooperation agreements; IAEA inspections are not used to verify U.S.-exported nuclear materials.

NUCLEAR MATERIALS MANAGEMENT AND SAFEGUARDS SYSTEM (NMMSS)

The NPT resulted in NMMSS serving as the U.S.' official national accounting and control system for nuclear materials, performing a series of mission-critical functions to directly support IAEA safeguards and international treaties. Activities involving export and import data for U.S.-supplied nuclear material are recorded and maintained by NMMSS. During the 1960s NMMSS' mission and functions were delineated by the DOE (and its precursor, the AEC); the system began work in 1966, inaugurated the computerized system in 1968, and added facility and international reporting in the 1970s with the International Nuclear Materials Tracking System (INMITS). INMITS contains data on non-domestic nuclear materials transactions, foreign contracts, import/export licensees, and authorizations to retransfer U.S.-supplied material between foreign countries.

NMMSS accomplishes its mission by:

1. Collecting both domestic and international data relative to nuclear materials;
2. Processing the data; and,
3. Issuing reports to support the safeguards and management needs of DOE, NRC, and other government organizations—including those associated with international treaties and organizations.

NMMSS receives records that identify all U.S. civilian nuclear material exports upon shipment, and a monthly report of these shipments is provided to the IAEA. However, after the U.S. ships nuclear material, the recipient nation is not obligated to report subsequent updates to NMMSS regarding actual location and use of the nuclear material, or changes to the quantity of the material due to usage, burn-up, and decay. For example, exports by the U.S. pursuant to a peaceful nuclear cooperation agreement may subsequently be moved among facilities within the receiving nation (intra-country transfer) or moved from one EURATOM country to another with no attendant reporting obligation to the U.S. [EURATOM (European Atomic Energy Community) nations are treated as one common regulatory reporting control zone.] U.S. treaties do not account three categories of U.S.-supplied material as reportable transactions:

1. Facility-to-facility movement within one nation;
2. Country-to-country movement within EURATOM; and,
3. Alterations to U.S.-shipped material.

Because the above categories, by definition, are not considered to be retransfers, they are consequently not reportable to the U.S. via NMMSS.

NMMSS is the most comprehensive U.S. transaction-based system available for both domestic and international commerce of nuclear material; nevertheless, there are limitations in tracking U.S.-shipped materials abroad. These limitations reflect not only incomplete historic data related

to the status and locations of U.S.-supplied nuclear materials internationally (GAO 1994), but also agreements for cooperation which do not require countries to report data on current locations of U.S.-supplied nuclear material (GAO 1982, 1985). Consequently, the U.S. uses other resources to estimate specific information about U.S.-shipped nuclear materials inventoried by other countries.

NMMSS' INTERNATIONAL REPORTING LIMITATIONS

NMMSS' user organizations (Congress, Department of State, NRC) have acknowledged that NMMSS' international transaction and inventory data are often inaccurate, incomplete, or lacking sufficient clarifying detail; therefore, the user organization community cannot rely solely on NMMSS for international information. Due to the intrinsic limitations of these international data, the DOE agrees with this assessment. Since its 1960s inception, NMMSS has continued making efforts to improve international data accuracy. For example, in 1982, a "backfit" project incorporated more than 1100 historical export records into NMMSS. However, the export data were never reconciled to corresponding foreign governmental data; their completeness and accuracy are unresolved. As a result, it remains difficult to determine unequivocally whether NMMSS transactional data are completely accurate. This NMMSS historical accuracy problem will persist, at least until an accounting reconciliation exercise with complete data resolution has been conducted.

There have been attempts at inventory reconciliation in order to discover what happened to the material shipped from the U.S.; yet these efforts were generally fragmented, and outcomes lacked sufficient detail to be documented to NMMSS. Reconciliations were attempted directly with some foreign facilities receiving U.S. nuclear material, but results produced neither official documentation nor foreign regulatory body concurrence and the results could not be placed within NMMSS.

The most important test of accuracy for NMMSS international nuclear materials inventory is whether two countries' records agree. Achieving accuracy and completeness regarding international data will require both additional source documentation and eventual country-by-country reconciliation.

The impetus for improvement to NMMSS international data is attributed to the 2018 DOE Report to Congress titled *Maintenance and Expansion of the Nuclear Materials Management Safeguards System*. The 2018 Congressional report recognized that the information in NMMSS is an important national resource that must be available to key decision makers and stakeholders in the U.S. Government. However, changing treaty requirements retroactively by adding new reporting burdens to data submitters is clearly not within the NMMSS scope of organizational responsibilities; however, there are some very practical steps NMMSS recently undertook to improve the accuracy of international data. These NMMSS initiated improvements consisted of:

1. Organizational realignment to refocus NMMSS goals in order to meet current changing international environments;

2. Defining/validating user requirements for international data and exploring design alternatives to satisfy these informational needs; and,
3. Updating the NMMSS/INMTS software.

Collectively, these three NMMSS initiatives will significantly improve the completeness, accuracy, and quality of NMMSS international data.

NMMSS ACTIONS TO IMPROVE INTERNATIONAL DATA

Organizational Realignment

Current NMMSS workforce consists of both generalists and specialists. Generalists have broad knowledge of the nuclear industry and focus on cross cutting issues to make true program integration possible. They concentrate on database operations, communicate daily with data submitters, and manage complex processes such as facility reporting requirements, resolving data discrepancies, and database reconciliation. Generalists are experts in both DOE and NRC regulations and guidance documents. They have broad-scope knowledge of the domestic nuclear industry and are responsible for all NMMSS inputs and outputs.

The international specialist positions, called Country Officers, were recently created in response to increased complexity and volume for NMMSS reporting. In contrast to generalists, Country Officers are treaty specialists, knowledgeable in specific nuclear material accounting and reporting provisions. Year by year, international updates to treaty content have resulted in highly detailed and more nuanced customer requirements. Organizational realignment has allowed NMMSS to be quicker, more accurate, and more responsive to requests for international data involving U.S. facilities and/or U.S.-supplied nuclear materials.

Validating User Requirements

The increased complexity in NMMSS international reporting is largely attributable to recent changes to U.S. international accounting requirements. The changes affect specific treaties that support nuclear nonproliferation while permitting the U.S. to engage in civilian nuclear cooperation with foreign countries. The changes also influence IAEA reporting and affect basic data structure and business rules to support NMMSS/INMTS international reporting. However, reporting changes are not uniformly applied across all facilities. For example, some U.S. facilities are now required to report isotopic weights for specific, but not all, natural uranium transactions. Additionally, for some selected transactions, element weights are reported in kilograms while isotopic weights are reported in grams. Under other conditions, facility reporting per regulations is kilograms, but NMMSS external reporting must be converted to grams.

Similar challenges exist in accounting for nuclear material for which not all international transfers are obligated; terms and conditions vary with trading partner, and the timing of treaty negotiations as agreements is strongly influenced by current world events.

As described, situational reporting can create major problems during country or facility reconciliation, material balance preparation, and NMMSS reporting. Consequently, NMMSS and

INMTS need to be updated. Establishing upgrade requirements necessitates both engaging internal/external stakeholders and implementing effective change control plans. NMMSS external stakeholders for international data are Congress, DOE/NNSA, DOS, the NRC; and internally, the NMMSS team itself. NMMSS is currently engaged in stakeholder consultations, reviewing existing requirements, and establishing documentation.

Updating NMMSS/INMTS Software

After requirements are confirmed, both NMMS and INMTS software will need to be updated. The contrasts between the two systems are: NMMSS data originate from U.S. facilities and are submitted to NMMSS according to regulations provided by either the DOE/NNSA or the NRC; INMTS data come from foreign sources and are provided according to country specific regulations. INMTS information historically has informed NMMSS of impending activities involving the U.S. including: confirmation of receipt of U.S. materials, planned shipments to the U.S., and foreign retransfers of U.S. materials to a third country.

Besides shipment, receipt, and retransfer information, INMTS can also be used to store data from annual/periodic reconciliations with trading partners on their holdings of U.S. nuclear materials. Documenting the results of country reconciliations in INMTS will compare national records against material transfer/retransfer data in order to account for material consumed or irradiated by reactors.

SUMMARY

The NMMSS provides mission-critical data analytics and informational products and services to advance U.S. government policies/responses related to global nuclear proliferation threats. The system continues to adapt and change, to build and display resilience while prioritizing U.S. and community agency needs.

Navigating the current complex nuclear material tracking and reporting environment has prompted NMMSS to enhance its international processes. This has been accomplished through organizational realignment, validating stakeholder requirements, and updating the NMMSS INMTS module.

1. **Organizational Realignment.** Increased complexity and volume for NMMSS international reporting was addressed by creating new international specialist positions. These specialists allow NMMSS to respond more quickly to informational requests for international data.
2. **Validating User Requirements.** Recent changes in U.S. international reporting commitments have necessitated a reexamination and validation of current system business rules and data structures. NMMSS is accomplishing this in consultation with U.S. governmental stakeholders including DOE/NNSA, DOS, and the NRC.

3. **Updating NMMSS/INMTS Software.** After the requirements validation phase is complete, NMMSS/INMTS software will be updated. Systems updates will adhere to generally accepted development practices including: generating clear, complete, and accurate documentation throughout the system development process; placing the software development under configuration management; and ensuring that the system successfully completes acceptance testing prior to becoming operational.