

The United States Department of Energy Nuclear Materials Loan Program

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ABSTRACT

The Atomic Energy Act, as amended, authorizes the United States (U.S.) Department of Energy (DOE) and its predecessor agencies to distribute nuclear materials to U.S. universities and other educational institutes for the purposes of research, development, and education. DOE's authority to loan nuclear materials is extremely limited and is generally only used with U.S. educational institutes, Nuclear Regulatory Commission (NRC) licensees and/or other U.S. government federal agencies. Since the Atoms for Peace initiative in the 1950s, nuclear materials have been distributed to educational institutions by multiple DOE offices and their predecessor agencies. Due to reorganizations and the elimination of offices, in some cases, DOE program responsibility for loaned nuclear materials has become uncertain and documentation of loaned nuclear materials is inconsistent. In addition, DOE has received an increasing number of inquiries from institutions possessing DOE owned nuclear materials that are interested in returning DOE loaned materials to government custody. To improve and facilitate management of DOE loaned nuclear materials, the DOE is establishing a Lead Materials Management Organization to manage government-owned material on loan. The LMMO will provide a single point of contact within DOE for loan inquiries and return of loaned nuclear materials. The LMMO will manage the inventory of nuclear materials retained by NRC licensees and other U.S. federal agencies through verification and continued tracking, facilitate return or disposition and evaluate risk and prioritize requests to return and/or remove government owned nuclear materials, and establish and maintain loan agreements with the institutions. This paper will provide an overview of the history, status, and improvements underway associated with DOE nuclear materials loans.

INTRODUCTION

The Atomic Energy Act of 1954 (AEA), as amended, authorizes the United States (U.S.) Department of Energy (DOE) and its predecessor agencies to distribute nuclear materials to public and private U.S. institutions for the purposes of education as well as research and development (R&D).^A The AEA also specifies provisions governing the distribution of source, special nuclear materials, and byproduct materials, as defined in Section 11 of the AEA.^B Beginning in the 1950s, the Atomic Energy Commission (AEC) loaned or leased nuclear materials to public and private institutions.

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As part of the Energy Reorganization Act of 1974, the AEC was split into two new agencies: the NRC and the Energy Research and Development Administration (ERDA). The responsibility of loaning government-owned nuclear materials to public and private institutions for educational uses and R&D was transferred to the ERDA. The Department of Energy Organization Act of 1977 established DOE, abolished ERDA, and transferred ERDA's AEA authorities and responsibilities to DOE. Since DOE's inception, responsibility for the management of nuclear material loans for R&D purposes has fallen to multiple program offices depending on the nature and purpose of the activity. Over time, departmental and program re-organizations have left many nuclear material loans without an obvious DOE program sponsor.

The majority of the loaned nuclear materials are still in use by educational institutes; however, some loaned materials have been reported as excess to a university's need and must either be returned to DOE custody or disposed of. To improve management of DOE-loaned nuclear materials, the DOE Office of Nuclear Materials Integration (ONMI) established a Nuclear Materials Loan Program (NMLP) Lead Material Management Organization in March 2021 pursuant to DOE Order 410.2 Admin Chg. 1, *Management of Nuclear Materials*. The NMLP LMMO charter outlines the approach for managing nuclear material loans under the cognizance of the NMLP and is further discussed in this paper. For the purposes of the NMLP LMMO, nuclear materials are those considered to be accountable per DOE Order 410.2, Admin Chg. 1, *Management of Nuclear Materials*. They are: americium-241, americium-243, californium, curium, deuterium, enriched lithium, neptunium-237, plutonium-238, plutonium-239–241, plutonium-242, thorium, tritium, depleted uranium, normal uranium, highly enriched uranium, low enriched uranium, and uranium-233.

APPROACH

Organizational Responsibilities

Management of the NMLP LMMO was assigned to the Y-12 National Security Complex Management and Operating contractor (Y-12). The DOE NMLP LMMO will serve as a central point of contact for nuclear material loan inquiries, inventory management, and returns to DOE. The NMLP LMMO will receive inquiries, research, identify, notify the program office having primary responsibility for the loaned materials, if possible, and coordinate with the responsible program office in recovery and disposition of previously loaned materials. For loaned materials without a clear program sponsor, the NMLP LMMO will collaborate with the possessing entity to document the chemical and physical characteristics of the material in support of transportation and disposition then use subject matter expertise to recommend a disposition path. The NMLP LMMO will work to re-establish contemporary loan agreements for legacy accountable nuclear materials without a clear programmatic sponsor.

Inventory Analysis

As an initial step, the NMLP LMMO is actively examining Nuclear Materials Management and Safeguards System (NMMSS) records for government-owned nuclear materials loaned to NRC institutions in the U.S. This effort includes confirming the status and location of government-owned nuclear materials, verifying the status of loan agreements, identifying the sponsoring

program office or successor program office, if possible, and if necessary, coordinating inventory verification and status of loan agreements with the sponsoring program office.

The NMLP LMMO has identified 62 U.S. educational and research facilities holding approximately 56 metric tons (MT) of DOE-loaned nuclear materials. The majority of nuclear material loaned, almost 48 MT, is in natural uranium (NU) fuel slugs used in training reactors. Types of loaned nuclear materials include fuel, fission chambers, sources, and other nuclear materials needed for nuclear energy educational purposes and training and research reactor operations including but not limited to:

- Uranium [U] hydride in stainless steel (e.g., Training, Research, Isotopes, General Atomics fuel, referred to as “TRIGA”)
- Uranium aluminides (UAl_x)
- U₃O₈- Al (uranium-aluminum dispersion fuel)
- UO₂-Polyethylene (e.g., Aerojet General Nucleonics fuel)
- UO₂ in stainless steel
- U-molybdenum (Mo) fuel
- Highly enriched uranium (HEU) fission detectors
- NU slugs and rods
- Depleted uranium (DU)
- Deuterium (e.g., D₂O in heavy water)
- Plutonium (Pu)-beryllium sources
- Pu-238
- Pu-239 sources
- DU-Pu mixed oxide (MOX) fuel
- Pu pins/foils
- Other

The NMLP LMMO is in the process of sending questionnaires to these NRC licensees possessing DOE-owned nuclear materials requesting the licensee to confirm quantities and characteristics of each DOE owned nuclear material. The questionnaires request the following information:

Loan agreement number	Container condition
Licensee name	Number of items
Material loaned (by item)	Retain for use or excess
Total element (weight)	Intended purpose for continued use
Total isotope (weight)	Project year for continued use/excess
Physical description	Material no longer needed
Condition of material	Historical information
Chemical form	Characterization data
Material container	Photos

As of June 2021, 56 surveys have been sent and 27 responses received. Five facilities reported excess nuclear materials. Responses from the NRC licensees will support development of an initial report of government-owned nuclear materials without a current sponsor or under

management by a current program on loan to a NRC licensee based on NMMSS entries. The NMLP LMMO will update this report annually to ensure continued stewardship of loaned government-owned nuclear materials.

Disposition Options

The NMLP LMMO will evaluate excess nuclear materials loaned to educational facilities and make recommendations for disposition options and scheduling removals. Unwanted material may be dispositioned by return to DOE for storage or recovery, return to DOE commercial contractor for processing, transfer to another authorized facility for reuse, or direct disposal as waste.

The NMLP LMMO developed a Nuclear Material Return Request Ranking Tool (NMRRT) to prioritize the removal of excess nuclear material from NRC licensees. The NMRRT calculates a “Return Ranking Score” based on material condition, security, and importance of need to return.

NMLP LMMO will facilitate returns in cooperation with existing DOE programs including the Central Scrap Management Office for Uranium (CSMO), the Off-Site Source Recovery Program (OSRP), and the Research Reactor Infrastructure Program (RRIP) as applicable. During the startup phase of the NMLP, from 2019–2021, loaned nuclear materials were removed from the following facilities:

- Heavy water shipped from the University of Florida to Y-12.
- Low enriched uranium (LEU) shipped from the University of Texas-Austin to Y-12.
- Heavy water shipped from Columbia University to the Oak Ridge National Laboratory.
- HEU, LEU, and DU loaned to the Department of Homeland Security (DHS) shipped from Sensor Concepts to Y-12.
- Lithium-6 carbonate transferred from the Armed Forces Radiobiology Research Institute to Silverside Detectors Inc.
- Deuterium transferred from the Armed Forces Radiobiology Research Institute to Pennsylvania State.
- LEU foils shipped from the Missouri University Research Reactor to Y-12.
- NU and DU loaned to DHS transferred from Passport Systems to Massachusetts Institute of Technology.
- Title to DU on loan to the National Aeronautics and Space Administration (NASA) transferred from DOE to NASA.

The NMLP LMMO is currently evaluating feasibility of processing options to remove the aluminum coating from NU fuel slugs versus waste. If determined feasible, excess NU slugs stored at universities could potentially be directly shipped to a DOE commercial contractor to process the NU for reuse in DOE programs. The NMLP LMMO is also considering options for removal of excess enriched uranium fission chambers stored at the Armed Forces Radiobiological Research Institute. Specifically, the NMLP LMMO is working with the CSMO to add these fission chambers to an effort underway at Y-12 that will disassemble a significant number of fission chambers and prepare the uranium for disposition and/or reuse.

SUMMARY AND CONCLUSIONS

The DOE NMLP is improving management of DOE-loaned nuclear materials by standing up the NMLP LMMO, integrating with other programs managing DOE loans and returns, assessing risk and priorities, and responding to facilities holding DOE-loaned nuclear materials declared excess in a timely manner thereby reducing overall environmental, safety, health, and security risks and storage or other facility burden. When materials are ready to be returned for disposition, the NMLP LMMO will coordinate its efforts with other active DOE programs like CSMO, OSRP, and RRIP and will facilitate safe and secure transportation, storage, recycle, or other disposition of DOE-loaned excess nuclear materials.

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REFERENCES

Atomic Energy Act, 42 U.S.C. § 2011–2259.

Meehan, R. 7 April 2021. *Charter for Nuclear Materials Loan Program Lead Material Management Organization*. Memorandum to DOE distribution.

Meehan, R. 24 March 2021. *Charter, Nuclear Materials Loan Program (NMLP), Lead Materials Management Organization (LMMO)*.

DOE National Nuclear Security Administration [NNSA] Office of Nuclear Materials Integration. 10 April 2014. *DOE Order 410.2 Admin Chg 1, Management of Nuclear Materials*.

DOE Office of Inspector General, Office of Audit Services. February 2009. *Audit Report: The Department's Management of Nuclear Materials Provided to Domestic Licensees*, DOE/IG-0813.

^A The term DOE includes DOE and its predecessor Government organizations, i.e., the U.S. Army Corps of Engineers Manhattan Engineer District, the Atomic Energy Commission, and the Energy Research and Development Administration.

^B See AEA section 11.e, 42 U.S.C. 2014.e, (definition of byproduct material); AEA section 11.z, 42 U.S.C. 2014.z, (definition of source material); and AEA section 11.aa, 42 U.S.C. 2014.aa, (definition of special nuclear material).

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