

An Innovative Approach to Weapons Usable Nuclear Materials Minimization

The U.S. Department of Energy's National Nuclear Security Administration (DOE/NNSA) Office of Material Management and Minimization (M3) works to minimize civilian stocks of highly enriched uranium (HEU) and separated plutonium globally through the conversion of research reactors from HEU to low-enriched uranium (LEU) fuel and, when possible, removal or disposition of excess weapons-usable nuclear material (WUNM). The majority of uranium-based materials removed by M3 and its predecessor program, the Global Threat Reduction Initiative, have been unirradiated (fresh) uranium or irradiated (spent) uranium based on U-Al or U-ZrH fuel systems. To date, DOE/NNSA has removed or confirmed the disposition of approximately 3,520 kilograms (kg) of fresh HEU and 3,200 kg irradiated HEU.

Although significant progress has been made on HEU minimization, M3 estimates that large quantities of WUNM are still in civil commerce worldwide, much of which is excess to actual needs and is suitable for elimination. However, a large portion of these inventories is difficult to remove or otherwise disposition due to a number of constraints, including:

- Political: sending additional material to various receipt locations—whether in the United States or abroad—can conflict with U.S. or foreign partner priorities or policies;
- Technical: globally, there is limited, or in some cases no, infrastructure capability and/or capacity to eliminate certain types of WUNM; and
- Economic: given current capabilities and capacity, it can be more expensive to disposition certain materials than to pursue long-term storage options which do not result in permanent threat reduction.

To overcome these obstacles, M3 is developing a novel approach to work with foreign partners to eliminate difficult tranches of WUNM in an economic manner where they are located. M3 is developing a mobile platform for stabilizing excess WUNM and converting it into a stable, more proliferation resistant, low-attractiveness waste-form that can be readily disposed in a solid waste disposal facility. The process being developed by M3 builds on U.S. DOE's advances in the melt-dilute process originally developed for the treatment aluminum spent fuel materials to produce repository-acceptable waste forms. M3 has further adapted this process to cover wide ranging fuel and clad materials and is currently working to stage this process on a mobile platform. The prototype Mobile-Melt Consolidate (MMC) test system being developed leverages the melt processing technology and our understanding of metallurgical phase stability to develop customizable, stable waste forms to meet foreign partners' solid waste disposal facility performance envelopes. The MMC system aims to provide a new capability to eliminate small quantities of legacy WUNM in-country or in-region rather than commercial transport over long distances. M3 estimates that the MMC capability will be able to address approximately 20-50% of the known excess foreign tranches of WUNM.

This poster will review the issues and challenges associated with the elimination the diverse types of remaining, legacy WUNM and describe in detail the MMC concept and principles. The poster will also highlight the planned capabilities of the prototype MMC test system current being developed by M3 and the associated R&D validation and optimization studies. It will also describe the safety analysis and the regulatory framework for its design and operation. Finally, it will present a notional deployment model framework, highlighting the key points for discussion with foreign partners for its implementation.

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