

Closing the Transport Gap: Mobile Conversion of HEU-UF₆ into Legally Shippable Forms

The safe recovery and transport of highly enriched uranium hexafluoride (HEU-UF₆) remains a critical challenge for nuclear security operations. At present, there are no legal means to ship large quantities of HEU-UF₆ in its native volatile form, creating both regulatory and safety barriers to international material removal. To address this issue, Oak Ridge National Laboratory (ORNL) developed a system for the U.S. Department of Energy's National Nuclear Security Administration's Mobile Uranium Facility (MUF) to convert HEU-UF₆ into uranyl fluoride (UO₂F₂), a chemically stable solid compatible with U.S. Department of Transportation-certified ES-3100 shipping containers. This process enables secure, regulation-compliant transport of material previously considered unshippable.

The MUF's system uses activated γ-alumina to adsorb UF₆ vapors under negative pressure, converting them into UO₂F₂ and hydrogen fluoride (HF). Both products are immobilized within the alumina matrix, yielding a stable, nonvolatile form suitable for packaging. The system, contained within a single CONEX unit, features four adsorption traps operated in series or parallel to maximize capacity. Once saturated, uranium-bearing alumina is HEPA-vacuum-transferred into Teflon bottles and then into an ES-3100 qualified container for shipment.

A phased testing program demonstrated readiness for field deployment. Bench-scale studies confirmed alumina's loading capacity of ~50% by weight. A half-scale two-trap system using HEU-UF₆ validated materials compatibility and process scalability, while full-scale demonstrations with water vapor surrogates provided operator training and confirmed heat-of-reaction monitoring and sorption kinetics. Together, these results confirm that the MUF can safely process a full 5A (~25 kg) HEU-UF₆ cylinder.

By converting volatile HEU-UF₆ into a legally shippable solid, the MUF eliminates a long-standing regulatory gap, enhances transportation security, and provides a mobile capability supporting international nuclear material removal missions.

Country or International Organization

Instructions

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