

Highly Enriched Uranium Radiation Signature Training Device (RSTD)

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 from falling into the hands of non-state actors by minimizing and, when possible, eliminating the civilian use of weapons-usable nuclear material (WUNM).

Over the last decade, DOE's Oak Ridge National Laboratory (ORNL) has developed and fabricated units known as Radiological Signature Training Devices (RSTDs) in various iterations. An RSTD is a device that can emulate the radiation signature of larger masses of Special Nuclear Material (SNM), while using relatively small amounts of the material. This is technically feasible to do because large, solid SNM metal objects shield most of the gamma rays produced.

Specifically, for an HEU RSTD, an equivalent isotropic gamma flux is produced by the use of a small quantity of HEU in a low-density matrix in the shape of icosahedron shell. An RSTD that emulates a 25-kg solid metal sphere composed of 90% ²³⁵U consists of 80 HEU triangular source tiles assembled into an icosahedron frame. Each individual titanium source is loaded with HEU material before being welded closed, decontaminated, and leak tested. The 186 keV gamma ray peak from the assembled unit matches that of solid metal sphere of 25-kg of 90% HEU within 10%. The overall unit contains approximately only 240 g of ²³⁵U. In addition to the HEU shell, a 1 kg depleted uranium metal source centered in the unit offsets the higher energy gamma emissions. Characterization of the HEU RSTD by gamma spectra measurements at every face and vertex of the assembled icosahedron has shown the unit to be isotropic with very low variability in gamma flux. The modularity of the overall design allows for varied reduced masses of material to be emulated simply by assembling a number of the triangular sources in a different sized frame and/or geometry. The ability to subdivide the sources allows for them to be shipped in five small drums by commercial carrier, making transport substantial easier than movement of a monolithic source.

In the last few years, M3's Nuclear Material Removal Program has been working cooperatively with ORNL to investigate the technical options for deploying an HEU RSTD to an international partner for its operational use in lieu of using larger quantities of HEU. The technical and operational efficacy of an HEU RSTD has been demonstrated, and M3 and ORNL will continue to find opportunities to leverage the RSTD's capabilities of emulating HEU, while using very small amounts of SNM. This furthers the shared objectives of furthering HEU minimization policies globally.

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