P.21 Nuclear Isotopic Dilution of Highly Enriched Uranium by Dry Blending via the RM-2 Mill Technology

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Abstract

DOE has initiated numerous activities to focus on identifying material management strategies to disposition various excess fissile materials. In particular the INEEL has stored 1,700 Kg of off-spec HEU at INTEC in CPP-651 vault facility. Currently, the proposed strategies for dispositioning are (a) aqueous dissolution and down blending to LEU via facilities at SRS followed by shipment of the liquid LEU to NFS for fabrication into LWR fuel for the TVA reactors and (b) dilution of the HEU to 0.9% for discard as a waste stream that would no longer have a criticality or proliferation risk without being processed through some type of enrichment system. Dispositioning this inventory as a waste stream via aqueous processing at SRS has been determined to be too costly. Thus, dry blending is the only proposed disposal process for the uranium oxide materials in the CPP-651 vault. The use of dry blending as a pre-conditioning step to transfer the HEU to an aqueous dilution facility may produce some significant advantages. However, evaluation of this concept for shipment to the SRS dilution facility (H-Canyon) did not yield advantages for their site specific processing conditions. Utilization of this pre-conditioning concept for another dilution center may produce different results especially if one assumes the grinding media is removed from each can prior to shipment to the dilution site. Given the availability, cost and lifetime of the proposed receiving facility (e.g., SRS canyons), the desire to place this material into the TVA program and to remove the inventory in the CPP-651 vault (to make it available for other missions or retire it from service), it follows that timely dispositioning of this off-spec HEU is a critical path issue.

Isotopic dilution of HEU to typically less than 20% by dry blending is the key to solving the dispositioning issue (i.e., proliferation) posed by HEU stored at INEEL. It reduces storage costs because it no longer requires Cat I and II safeguards and security (S&S) measures, promotes ALARA for shipper and receiver because the source term has been reduced and normalized, and most importantly could uncouple this material from the dispositioning schedule of the SRS processing facilities by allowing it to be processed at other HEU dilution sites.

A unique dry blending process has been developed at the University of Utah using a grinding mill called RM-2 mill. This mill has recently been identified as a potential irreversible dry blending process. In 1998 the RM-2 milling process was tested with surrogate materials (titanium dioxide and titanium mono-oxide) with different particle sizes, hardness and densities. These tests achieved complete and adequate blending and mixing (i.e., no methods were identified to easily separate and concentrate one titanium compound from the other) in remarkably short processing times.

The RM-2 milling technology will be tested thoroughly with the mixtures of natural uranium oxide (NU) and depleted uranium oxide (DU) stock to prove its performance with uranium oxide material. The effect of mill operating and design variables on the blending of NU/DU oxides will be evaluated with the intent to optimize the process. The blend achieved in a single grinding test will be characterized by spatial sampling of the mixture and analyzing for uniform ^{235}U concentration in each of the samples.

The RM-2 mill technology, if proven to be acceptable for dispositioning ^{235}U, could be a candidate technology for dispositioning other fissile material such as waste ^{233}U oxide, LWBR fuel pellets, waste forms of weapons grade Pu and other small quantities of fissile materials that may need some type of dry pretreatment, prior to grouting or immobilization in a glass waste form. The major advantages of RM-2 process are its: fast grinding time and simple but optimized design. These features make it significantly less costly than utilizing large-scale aqueous processes for disposal of HEU oxides. This process may be able to provide a pre-conditioning treatment that would reduce storage costs and possibly promote transfer to alternative HEU dilution sties that may be more cost effective to operate.