"ASSET OR WASTE" BENEFICIAL REUSE OF RADIOLOGICALLY ENCUMBERED LEAD STOCKS

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ABSTRACT

Underutilized and surplus lead stocks and leaded components are a common legacy environmental problem across much of the Department of Energy (DOE) Complex. While seeking to dispose of these items through its Environmental Management Program, DOE operational programs continue to require lead materials to pursue contemporary mission requirements such as the management and/or storage of radioactive isotopes. This paradox was identified in late 1999 through an examination of DOE scrap metal management policies. In January of 2000, the Secretary of Energy directed the National Center of Excellence for Materials Recycle (NMR) to develop and implement a comprehensive lead reuse program for all of DOE.

In response to Secretarial Direction, the NMR initiated a directed reuse pathway for radiologically encumbered lead. These methods have been successfully applied to lead stocks at DOE sites throughout the complex. In recognizing the success of this program, the Secretary endorsed NMR as "the Department's clearinghouse for DOE surplus lead and lead products." Since the program has gone nationwide, DOE has achieved a savings exceeding $4 million due to the reuse of over 780 tons of lead.

INTRODUCTION

With the prohibition on the unrestricted use of metal recovered from radiologically controlled areas, options for disposition of lead have been quite limited. Essentially, the only viable outlet has been compliant disposal. Lead compliant disposal requires macro encapsulation with several inches of plastic followed by burial. Cost for lead disposal has traditionally therefore been quite high, in many cases in excess of $4.50 per pound.

Further examination of the Department of Energy (DOE) procurements revealed that the department was purchasing new lead at the same time program elements were offering used lead for disposal. After considerable study, it was determined that old lead could be "reallocated" to new uses in support of nuclear shielding requirements at considerably less cost than disposal. By adopting this approach, DOE could save money while expressing outstanding environmental stewardship.

The pilot effort for lead recovery and recycling was conducted in a partnership between Flour Hanford and the DOE National Center for Materials Recycle (NMR) in Oak Ridge. The effort took lead recovered from Hanford's decontamination and decommissioning projects and

refabricated it into isotope storage casks. To do this, the lead was processed and verified to be compliant with release requirements and standards expressed in DOE Order 5400.5 *Radiation Protection of the Public.*

Since this pilot project, NMR has developed, according to DOE Order 5400.5 requirements, supplemental release limits for the directed reuse of lead in nuclear shielding applications. These limits are contained in *Supplemental Release Limits for Directed Reuse of Lead in Shielded Products by the Department of Energy,* October 2001. (ORNL TM-2001/36). This document specifies limits for radionuclide concentrations throughout the volume of lead to be offered for directed reuse. Application of supplemental limits has expanded the amount of lead eligible for recovery and reuse.

Since its establishment in early 2001, the Lead Reuse Program has secured the reuse of over 780 tons of lead coming from throughout the DOE complex.

FACTS AND BENEFITS

On July 13, 2000, the Secretary of Energy for the DOE established a policy that suspended releasing the Department's scrap metal from radiological areas into open commerce. This covered all metals regardless of whether they were free of radioactive contamination or if, as established by DOE Order 5400.5, they were stored in a radiological area as defined by 10 CFR 835 on or after that date. With this restriction of release into general commerce these metals were viewed as "administratively encumbered."

With shrinking budgets, increasing regulatory scrutiny, and the high cost of compliant disposal, the directed reuse of lead provides a viable, cost effective option that can expedite disposition of unwanted lead stocks. Recycling is not free, however. Generators of the lead are expected to pay up to $3.00 per pound to place their lead into the recycle pathway. To date, however, the highest cost for lead recycle into director use products has been less than $2.50 per pound with the mean price established at $2.00 per pound. This pressure on the cost of disposal has resulted in a downward adjustment to the cost of disposal of lead in bulk. In at least one case lead has been offered for disposal at about < $5000 per cubic meter – considerably less than the cost of recycling into competent products for shielding applications. Clearly, recycling and reuse are not a panacea from a cost perspective, but are nevertheless viable alternatives to disposal in many cases, especially for those sites with small amounts of radiologically contaminated lead or sites with special processing needs or requirements (e.g., destruction).

From a regulatory perspective, recycling is also beneficial. If the lead is programmed for recycling rather than waste disposal, some relief from RCRA storage requirements can be expected. Lead is considered an "intermediate" in an industrial process and is exempt from RCRA regulations for the most part. This does not exempt the generator from proper and prudent handling, but does offer relief in the type and location of storage space used to manage the lead prior to its shipment for recycle. In addition, USEPA's charter firmly establishes recycle and reuse as the preferred disposition pathways for unwanted materials – especially those with inherent toxicity such as lead. Cooperation with local and federal regulators can be expected for bona fide recycle projects such as DOE Lead Recycle Program.

Typical Lead Products

To date the Lead Recycle Program has secured the manufacture of isotope storage casks for the Pacific Northwest National Laboratory, spent fuel transfer casks for Southern California Edison and Pacific Gas & Electric, shielded 55 gallon drum overpacks, lead shielded waste containers, x-ray shields, lead bricks, crane test weights, and lead shielded walls. Figures 1, 2 and 3 depict the various types of lead products utilized by the program.

Fig. 1 Lead bricks sent to NASA for shielding

Fig. 2 Lead shielded waste container

Fig. 3 This 55 gallon shielded container can be used for waste storage and disposal

Within the last year, discussions with the Waste Isolation Pilot Plant (WIPP) have identified lead shielded waste disposal containers as a product of considerable interest. Use of these containers at the site generating WIPP qualified waste would make remote handling unnecessary. Costs to manage this material once packaged would be considerably less and the risk of any work related exposures to WIPP employees receiving the waste would be considerably lessened. The current concept is to manufacture 55 gallon shielded containers and distribute them to generator sites for immediate use. 80 and 110 gallon versions are presently being evaluated for use as well, although both of these sizes will require regulatory approval prior to use. Transport of the 55 gallon containers would be through the use of existing casks approved for highway transport. Once at WIPP the containers would be managed as contact handled waste and would be suitable for disposal in less costly underground vaults rather than in specially constructed boreholes for high surface activity wastes. Total savings to WIPP associated with this approach has been estimated by some to top $300 million. If fully developed, it has been estimated that up to 9,000 shielded containers would ultimately be required to support the WIPP application.

Virtually any product requiring lead for shielding applications can be fabricated or, in the case of lead bricks and some sheet, be directly reused. To date manufacturing costs for these products has ranged from $0.50 to $2.50 per pound burdened entirely on the lead content of the item. With compliant disposal costs running $4.50 per pound and up, many generators find it financially advantageous to recycle rather than to dispose.

Lead Recycle Business Practices

Currently, the generator of the lead is burdened with the cost of dispositioning through recycling and reuse – currently up to $2.50 per pound depending on the amount and character of the lead

offered. These funds are used to pay for shell fabrication and lead processing (including remelting) to cycle the lead into a reuse pathway. Typically, NMR secures an outlet for lead prior to accepting it into the program. When lead is transferred, funds are also transferred through internal DOE financial transfer mechanisms. NMR uses up to the amount authorized and returns any residual funding to the generator.

Processing services for lead requiring decontamination is secured through NMR's Asset Recovery Basic Ordering Agreement (BOA). This is a competitive vehicle that is held by pre-qualified vendors. Each vendor has a radioactive materials license that permits possession, handling, processing, and release of materials from radiological control. The license is granted either by the NRC or NRC Agreement state. All processing is done off site of DOE facilities.

Current DOE Lead Reuse Policy

On January 19, 2001, the Secretary of Energy established the current DOE policy regarding lead reuse. This policy requires programs to seek lead reuse rather than purchase additional lead from commercial suppliers. It also requires generators of unwanted lead to preferentially seek disposition of this material through recycle and reuse pathways that involve the placement of lead in nuclear shielding applications. This policy is not only consistent with previous policy directives regarding release of metals from radiological areas into general commerce, but also with a host of Executive Orders mandating "green" procurement and management practices for federal agencies. A summery level diagram is presented in figure 4 of NMR's lead reuse process.

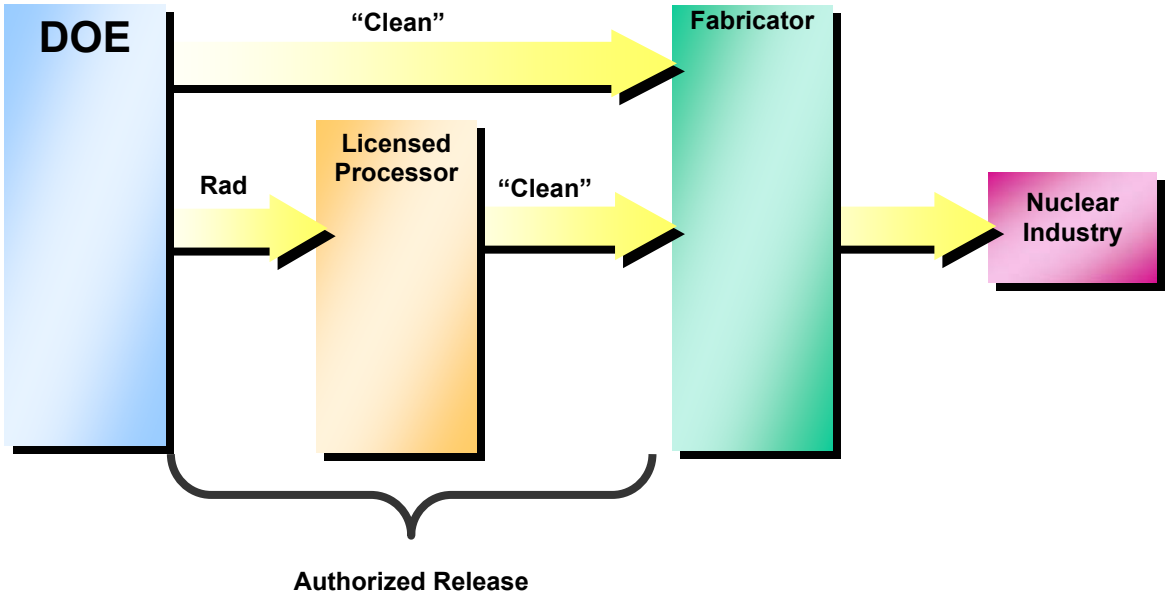

Fig. 4 NMR's lead reuse process

In fact, DOE's policy is that the reuse of lead metal and lead products will take precedent over the purchase of new lead metal and lead products. DOE is required to give first consideration to the reuse of existing lead inventories prior to the procurement of any new lead metal or lead products.

If you do have an inventory of lead, or need lead products, the policy is that you will coordinate your lead reuse efforts with the DOE NMR.

Lead Recycling Works

The process that has been developed for lead reuse and recycling is a sound business practice. The system was built with careful consideration for not only the costs and benefits of lead recycle and the products produced from this lead, but for the costs of compliant disposal. Qualitative externalities such as the environmental benefits of less mining of lead ore, etc., were deliberately not considered to simplify the economic decision between recycling and disposal.

Key to the success of this new business center has been our ability to make use of commercial resources. The vendors on the lead recycling BOA have been extremely active in the competitive procurements issued by NMR to secure the processing and reuse of over 700 tons of lead. Through the use of our BOA, we are also inducing additional firms to compete for lead recycling projects. Through the BOA, DOE is able to reduce the administrative burden on qualified firms by consolidating qualification audits on these facilities.

Significance

This lead recycling initiative exceeds the Secretary of Energy's goals by creating a closed-loop program for restricted reuse of volumetrically contaminated material. In addition, it does so in a way that redefines the existing DOE inventory of excess lead as a valuable commodity rather than a liability. Table I is a summary of the cost factors associated with the lead recycle/reuse program.

Table I Cost-savings from Lead Recycle Program

Cost of standard disposal per pound	~ $4.5 per lb.
Cost of recycle disposition costs	~ $2.4 per lb.
Amount of lead recycled to date	789 tons
Savings to DOE	> $4 million

The cost-savings from this program accrue to both the lead generator and the packaging or shielding user. For example, in cases where the lead is being recycled into shielding for a standard B-25 box, the lead generator pays only for fabrication of the box, which can be as low as 25% of treatment and burial costs. The packaging user pays only for transportation of the container to their site. In the case of a standard B-25 box, this saves the packaging user approximately $6,000 per container as opposed to purchasing a container made from clean lead. Packaging users may also specify that the lead lining be integrated into custom containers.

In fact, because the container user only incurs the cost of delivery, the lead-lined products are far less expensive than non-shielded products. Because of the low product cost and high availability, DOE sites are more likely to use shielded products to meet their goals for ensuring that exposure rates are as low as reasonable achievable (ALARA). The users of other lead shielding products, such as shielding walls, refueling components, and bricks see similar benefits. Regardless of the final product, use of recycled lead shielding will greatly reduce occupational exposures and other indirect costs related to high-exposure materials handling in the field.

Costs associated with storage of radiologically impacted lead are also avoided by directed reuse. DOE programs must provide facilities for, and costly maintenance of stockpiled lead. The directed reuse option greatly reduces or eliminates those stockpiles, it is likely to be completed much more slowly than directed reuse because of the cost of burial is significantly greater, thereby extending the duration of programmatic support required for waste storage and maintenance.

Broader impacts to resources, energy use, and the environment are evident in this program as well. Recycling radioactively contaminated lead reduce the need for new supplies of raw lead, thus avoiding energy costs in mining, refining, and transporting new sources of commercially available lead. Reusing rather than burying the lead as a waste eliminates the prospect that eventually even the best disposal practice may result in some environmental releases.

KEYS TO CONTINUED SUCCESS

The directed reuse of impacted lead is gaining momentum and becoming a real success. Between NMR, DOE contractors, and the private sector, a strong, viable industry has evolved around the concept of directed reuse of impacted lead. There is a great fit that is helping make generators, end users, and regulators winners. Also, the existence of a viable lead recycling alternative to disposal has resulted in considerable downward pressure on disposal costs. Maintaining this avenue of disposition is vital to preserve this competitive pressure on disposal prices.

As viable products are made available and are satisfactorily used in DOE as well as the nuclear industry, it is expected that the consumers of these valuable products will share in the cost of manufacture of these items – thereby driving down the cost of lead disposition to the generators. A recently completed market study by NMR has indicated a cost to consumers of $500 - $1000 per container is not unreasonable considering the value of a competing container. This translates to a potential discount of approximately $0.25 – $0.50 per pound for disposition "payable" to the generator.

A synergy is developing that is perpetuating the conventional recycle loop. Generators now have options for dispositioning lead and users of cost effective lead products available, and regulators at all levels appear comfortable with the direction this new industry is headed. NMR is continuing to identify new and novel approaches to cost effective dispositioning. As the industry matures, we should see an increase in the value for all parties.

CONCLUSION

Lead recycle and reuse is a viable disposition alternative to disposal. In most cases it has proven to be more cost effective even when the value of the resulting product is not taken into account. With compliant disposal costs of $4.50 per pound and above in some cases, recycling of lead has been found to be traditionally more financially advantageous than disposal. The value of the products made from this material represents an additional bonus to DOE. Further, as opposed to disposal, recycling offers generators an opportunity to uncomplicate the problem of lead storage as long as the material is "in the queue" for recycling and recovery. Lastly, competing with disposal has forced disposal costs lower – drastically in some cases. Without a viable competitor such as

recycling, it is doubtful that such costs would have been lowered. Continued viability of lead recycling will keep disposal costs in check through the forces of competition.

Lead recycling, as presented in this paper, is not only compliant with current DOE policy regarding the release of scrap metals from radiological areas but represents the preferred dispositioning pathway for DOE lead stocks. Recycling offers advantages to generators in the form of exemption from RCRA storage requirements because lead earmarked for recycle is not considered a waste. Generators must take care to insure their lead is programmed for recycle to assure themselves of environmental compliance.