INEL-95/0272

August 1995

RECEIVED
OCT 20 1995
OSTI

Lead Use And Recycling at the INEL

**S. J. Losinski
S. M. Thurmond**

MASTER

Lockheed
Idaho Technologies Company

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Lead Use And Recycling at the INEL

**S. J. Losinski
S. M. Thurmond**

Published August 1995

**Idaho National Engineering Laboratory
Lockheed Martin Idaho Technologies
Idaho Falls, Idaho 83415**

**Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-94ID13223**

MASTER

Lead Use And Recycling at the INEL

INTRODUCTION

As part of DOE's efforts to develop a Department-wide management strategy for the use, reuse, and recycle of lead, DOE has requested that each site provide site-specific management and use practices for lead, specifically management and use information that responds to four specific questions of interest. This report provides the Idaho National Engineering Laboratory's response to those areas of interest.

INEL RESPONSE

This report was compiled by personnel from the Waste Reduction Operations Complex Lead Management Project (LMP) and includes information gathered from facility managers, program managers, waste generators, lead facility operators, radiological control engineers, and others directly involved in the use, reuse, and recycle of lead. The report includes four sections, each of which addresses the specific areas of interest by DOE.

Question 1. What is the INEL doing related to reuse/recycle of clean and contaminated Pb within the site, DOE, and with private industry?

Reuse

Clean lead is reused within the site. The INEL's Clean Lead Facility (CLF) is located at the former Power Burst Facility. CLF operations coordinate the collection and storage of excess radiologically clean lead from INEL contractors and manage the storage and purchasing of new lead materials. CLF operations allow the following:

- Timely access of up to 131 tons of clean lead inventory for use in the event of a site emergency.
- Timely supply of clean lead to authorized site requestors.
- Timely collection of excess clean lead from site contractors.
- A lead procurement and usage approval process to minimize the need to purchase additional lead for on-site usage.

Clean lead has been transferred to other DOE complex facilities only occasionally. Recent examples are the "loan" of 5,000 lb of clean lead to the Hanford facility to be used for a weight test, and the transferral of cleaned lead blankets to Argonne National Laboratory-East.

In the past, some reuse of contaminated lead has taken place, e.g., individual facilities that used lead for shielding have reused their own low-level radiologically contaminated lead in other shielding applications where clean lead would have become contaminated. Recent examples of lead reuse within the INEL include the transferral of slightly contaminated lead shot from storage

at the Radioactive Waste Management Complex to Argonne National Laboratory-West, and to the Test Reactor Area.

Site-wide reuse of clean and radioactively contaminated lead is encouraged and promoted at the INEL. The INEL plans to maintain supplies of both clean lead and low-level radiologically contaminated lead at the CLF. The CLF will be renamed the "Lead Facility" if this is approved.

Radiologically contaminated lead can sometimes be decontaminated for on-site reuse. If the contamination is limited to the outside surface of the lead, various methods can be used to remove the contamination. The INEL has conducted research on decontamination methods such as CO₂ pellet blasting, and use of chelating agents in various mediums. In addition, the INEL has contracted with private industry to perform surface decontamination treatments on INEL lead, e.g., RUST has performed an acid etch treatment.

Recycling

A former INEL operation called the "Lead Shop" cast shielding lead for the INEL 20 to 40 years ago. The Lead Shop is no longer in operation. The INEL has no smelter nor does it have plans for one. Instead, the INEL has contracts in place with two private industry recyclers.

One of the recyclers, GNB of California, accepts essentially pure lead that is in the form of scrap lead and lead-acid batteries. The other recycler, Allied Precious Metals of Arizona, accepts less pure lead in the form of circuit boards and spent bullets.

To be eligible for recycle, lead must be non-radiologically contaminated, and the DOE hazardous waste shipping moratorium requirements met and documented via completion of Form-0919. Clean lead is staged at a warehouse at the Central Facilities Area until a sufficient amount has accumulated to comprise a truckload.

It is the intent of the INEL's Lead Management Project to reclassify contaminated waste lead currently stored in RCRA storage at the INEL, as a recyclable scrap material. This would allow the lead to be recovered by removal of the surface contamination and then recycled (released) to the private sector for unrestricted use. Lead brick, plate, blankets, and large solid lead shapes resulting from lead-bearing cask dismantlement are all candidates for surface decontamination.

For example, the lead lining from FY-94 dismantled shipping casks has undergone extensive testing and evaluation to enable its release to an off-site recycler. Cask lead with any indications of having surface contamination was thoroughly decontaminated. Cask lead with any indications of possibly being slightly volumetrically contaminated was disqualified as a candidate for recycle. Total weight of the remaining candidate lead for recycling is 50,375 lb. DOE-ID approval was obtained to allow the release of this clean lead as a special case.

As part of a process demonstration activity, approximately 40,000 lb of surface-contaminated lead bricks were decontaminated using an acid etch process by RUST Environmental Services for reuse/recycle at the INEL. The total cost associated with the decontamination demonstration (including the RUST subcontract and INEL support) was between \$7.00 and \$8.00/lb of lead.

Costs of private sector production recycling of surface decontaminated lead brick are expected to be between \$4.00 and \$5.00/lb.

Because there are no established radiological levels under which a volume-contaminated item would qualify as radiologically "clean," and because of the INEL's lack of melting capability, the INEL has not attempted to decontaminate volume-contaminated items. Instead, volume-contaminated lead is ordinarily retained in storage at RCRA-permitted site facilities (such as the Mixed Waste Storage Facility or the Radioactive Waste Management Complex) until an appropriate treatment is devised.

Under the current constraints and environmental regulations, an approved RCRA treatment for volume-contaminated lead waste would be to size it into manageable pieces if necessary, then microencapsulate the pieces for disposal. However, disposing of a hazardous but useful material to a landfill may not be as environmentally and economically sound as cleaning and recycling the material. Furthermore, even volume-contaminated lead is still a useful material for radiation shielding purposes and could be used internally within the DOE complex without decontamination. One logical use for volume-contaminated lead would be to use it in place of clean lead presently in the INEL's emergency reserve.

Question 2. What definitions are being used by the site for clean, contaminated, and activated lead?

Clean

Lead (Pb) is considered clean at the INEL based on the following criteria:

- Lead and lead-bearing components received from an outside-source vendor in the form of a product (batteries, instrument shielding, bullets, lead wool, printed circuit boards, etc.) are considered clean.
- On-site in-process or emergency reserve lead is considered clean if it surveys clean to the requirements of the INEL Radiological Controls Manual. (This lead is not available for non-DOE use and is not considered a waste.)
- On-site waste lead is considered clean when a waste generator certifies the lead to be clean via Form EG&G-0919, "Hazardous Waste/Material Non-Radioactive Certification." Certification is based on process knowledge and available records associated with the waste. The requirements include (a) that the lead has not been used or stored in an area where the potential exists for contamination due to unconfined radioactive material, (b) that the lead has not been exposed to particle sources including neutrons and protons capable of causing activation, and (c) that the lead passes surface survey release criteria as specified in the INEL Radiological Controls Manual.

The INEL Radiological Controls Manual surface release limits (Table 2.2) are in all cases at least as stringent as the surface release criteria specified in DOE Order 5400.5. In addition, the INEL Radiological Control Manual contains specific limits for alpha contamination that are not specified in DOE Order 5400.5.

Virtually all lead that has been stored or used in an area where the potential exists for contamination due to unconfined radioactive material is considered contaminated, even if no measurable contamination is observed. However, a small number of "special case" situations have occurred in which lead exposed to such an environment was deemed clean and released for external recycling. In these cases, exhaustive radiological testing was performed, and extensive knowledge of the use of the lead in the contaminated environment was available. In all cases, the lead was protected from contamination by a significant mechanical barrier.

Contaminated

Lead (Pb) is considered contaminated at the INEL when:

- There is measurable surface radionuclide contamination that exceeds the surface limits of the INEL Radiological Controls Manual.
- There is any measurable volume contamination.
- Lead has been stored or used in an area where the potential exists for contamination due to unconfined radioactive material [in a Radioactive Materials Management Area, even if no measurable contamination is observed]. If the lead is not in use, it is stored as contaminated.
- There is a lack of process knowledge about the lead. The INEL has large quantities of lead for which it is impossible to determine where at the site it has been used, and therefore is considered contaminated.

Activated

Lead (Pb) is considered activated at the INEL when:

- There are measurable activation products observed. However, for all practical purposes, the INEL does not distinguish between activated or contaminated lead.
- Lead will be considered potentially activated at the INEL [after approval of the Hazardous Waste Shipping Moratorium (HWSM) submittal] when it has been in a neutron radiation field greater than 5 mrem/hr from the neutrons (there are no other activating fields at the INEL). If potentially activated, a survey would be conducted and the results evaluated as outlined in the HWSM submittal; generally, levels detectable at the 1-pci/gm level would result in it being considered activated.

Two noteworthy technical analyses at the INEL should be cited regarding activation of lead. A draft analysis by N. Rohrig^a has shown that material could be exposed to levels up to 1 rem/hr and the activation would generally not be detectable using the above criteria, but using the higher dose rate criteria has not been pursued because of potential conflict with the spirit of the HWSM. And G. Beitel,¹ in a draft Engineering Design File examines the most probable activation products that would be observed in lead, based on elemental contamination levels for various grades of lead.

Question 3. What issues or barriers at the site level are impeding progress in recycling/reuse (e.g., regulatory issues, uncertain ownership, moratorium)

Several issues and barriers are significantly affecting the INEL's ability to recycle/reuse lead.

By far, the most significant barrier to recycle lead is the DOE Shipping Moratorium. The INEL has generated many iterations of Performance Objective Plans (POPs) to address the salient issues of the Moratorium and, to date, none of them have been approved. The lack of an approved POP has directly affected the INEL Lead Management Project's (LMP's) ability to recycle lead from 20 shipping casks dismantled in FY-94. Other lead objects, such as decontaminated lead bricks, have also been prevented from being recycled.

From the LMP perspective, the most elusive issue associated with relief from the Shipping Moratorium has been, and is, the interpretation of the "volume no-rad-added" release criteria. The INEL LMP has generated proposed free release criteria, and developed associated instrumentation to support the proposed criteria, but this work is of little use unless the POP is approved. To further exasperate this issue, DOE sites that have had their POPs approved have vastly differing release criteria.

There are also significant issues associated with reuse of lead at the INEL. Because of the requirements of RCRA, a lead object must be classified as a waste, scrap metal, or product. Each category imparts specific handling, sampling, storage, transportation, and inventory control practices. Reuse of lead often requires reclassification of a lead object, and the rules, documentation, and protocol to do this are unclear. Unfortunately, once a lead object is declared waste it is very hard to move (transport). In many cases, the costs of completing compliance documentation, and the associated sampling and analysis costs, far exceed the intrinsic value of the lead.

Several administrative issues at the INEL also impede recycle/reuse of lead.

There is not a defined method of cost sharing associated with recycle of lead. In a recent example, a proposed dry fuel storage facility could easily have used contaminated lead as a shielding material. However, the cost of installing contaminated lead in the facility would be more expensive than the cost of installing an alternate material. If the costs associated with storage and disposal of the lead could be applied toward offsetting the increased costs of using

a. Rohrig, N.D., Personal Communication, June 1995.

the contaminated lead, then a net savings to the DOE would result. Cost transfers between different programs is rare.

Another administrative issue, closely aligned with the cost sharing, is that the generator of a lead waste does not bear disposal cost. This practice results in a lack of incentive for the generator of a lead waste to find a legitimate reuse/recycle mechanism.

Question 4. What are the costs, in general terms, related to reuse/recycling (e.g., decontamination, smelting, reforming, shipping, purchase of new Pb)?

Costs for reforming lead cannot be accurately reported since this activity has not been performed at the INEL for decades. As previously mentioned, the INEL does not have the equipment to perform smelting and reforming. In addition, substantial quantities of new lead have not been purchased in INEL's recent past. One supplier, Seafab Metal Corp. of Seattle, Washington, quoted a price of \$0.59/lb for lead bricks.

In the INEL's experience, shipping costs are typically relatively small. The present cost to ship scrap lead from the INEL to a recycler in Arizona is \$2,400/truckload (approximately 40,000 lb).

Decontamination costs and associated sampling and analysis costs are substantial. The cost to perform surface decontamination and the cost of sampling and analysis to verify adequacy of the cleanup are roughly equivalent, and are each in the range of \$2 to \$6/lb. In many cases, it is not cost effective to recycle or reuse lead because of the high costs of sampling and analysis and of decontamination. In one instance, the retrieval and characterization costs alone (decontamination was not even performed) were equivalent to the cost of purchasing new lead. At the INEL, the use of lead has recently often been replaced with alternate shielding materials (such as concrete) to avoid the high costs associated with generating a mixed waste.

Three decontamination methods were investigated and the life cycle costs were estimated to employ them on surface-contaminated lead.² (The following cost estimates have been updated based on more current information than that available when Reference 8 was written). The CO₂-pellet-blasting process was determined to have a life cycle cost of \$5.00 to \$6.00 lb of lead treated. The acid etching process is expected to result in a life cycle cost of \$4.00 to \$7.00/lb of lead treated. The melt refining process was determined to be infeasible at this time. Only a few foundries in the U.S. are permitted to treat radiologically contaminated metal, but none are permitted to treat contaminated lead.

The life cycle cost to keep 584,300 lb of lead in indefinite storage in the INEL's Mixed Waste Storage Facility was determined to be about \$5.00/lb. This was calculated from the annual cost of storing the lead in the Mixed Waste Storage Facility, about \$0.35/lb-yr.²

INEL Experience and Related Work

The INEL LMP strongly supports DOE's efforts to develop a Department-wide plan for use and management of MIN lead. The INEL has long been an advocate of the safe handling, and recycle/reuse of lead as indicated by the numerous design files and reports on the subject.¹⁻²⁹ It is believed that many of the management practices and recycling/reuse methods employed at the INEL are applicable to the Department-wide plan. The INEL LMP will gladly assist the DOE with both management and technical expertise in developing the Department-wide plan.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

REFERENCES

1. Beitel, G.A., *Activation Products of Various Commercial Grades of Lead*, Draft EDF, March 1995.
2. Losinski, S.J., *Development of Free Release Criteria for INEL Lead*, EDF Serial Number WROC-EDF-237, June 1994.
3. Feldman, E.M., *Free Release of Lead Retrieved from Dismantlement of Cask HS-101*, EDF Serial Number WROC-EDF-278, June 1995.
4. Beitel, G.A. and S. Mott, *Comparison of the Radiological and Chemical Toxicity of Lead*, INEL-95/00095, Idaho National Engineering Laboratory March 1995.
5. Ledford, W., *Survey, Sampling and Radioassay of Lead Removed from Shipping Casks*, EDF Serial Number WROC-EDF-264, March 1995.
6. Miller, G.K., *Lead Overpack Storage Containers*, EDF Serial Number WROC-EDF-276, May 1995.
7. Gehrke, R.J. et al., *Volumetric Radioassay of Lead Bricks Being Considered for Unrestricted Release*, INEL-95/0001, Idaho National Engineering Laboratory January 1995.
8. Walsh, P.M., *INEL Lead Use -- Life Cycle Cost Study*, EDF Serial Number WROC-EDF-236, May 1994.
9. Vandel, D.S., *Scoping Study of Radioactive Lead Treatment Methods*, EDF Serial Number WROC-EDF-235, May 1994.
10. Thiesen, T.J., *Application of the "RCRA Recycling Exemption for Radioactively Contaminated Lead*, EDF Serial Number WROC-EDF-200, March 1994.
11. Thiesen, T.J., *Recycling Approach for Lead*, EDF Serial Number WROC-EDF-200, March 1994.
12. Thiesen, T.J., *Recycling of Lead Casks*, EDF Serial Number WROC-EDF-207, March 1994.
13. Brown, R.W., *FY-1994 Lead Brick Cleaning Demonstration at WINCO ICPP at INEL*, EDF Serial Number WROC-EDF-215, January 1994.
14. DeHaan, M.S. and S. J. Losinski, *Statistical Derivation of Lead Free Release Criteria*, EDF Serial Number WROC-EDF-205, October 1993.
15. Taylor, D.N. and R.W. Brower, *Condition of Lead Shielding Material Recovered from HS-101 Shipping Cask*, EDF Serial Number WROC-EDF-204, September 1993.

16. Losinski, S.J., *Lead Waste Minimization Site Survey and Literature Search*, EDF Serial Number WROC-EDF-154, January 1993.
17. Adler-Flitton, M.K., *Lead Inventory Database Requirements and Specifications*, EDF Serial Number WROC-EDF-149, November 1992.
18. Miyasaki, D.H. and D.P. Thiesen, *Conceptual Design Report for the Treatment Process for Radioactively-Contaminated Lead*, EGG-WM-10497, October 1992.
19. Thiesen, B.P., *Size, Thermal and Energy Requirements for Lead Treatment Facility Thermal Unit*, EDF Serial Number WROC-EDF-136, September 1992.
20. Neupauer, R.M., *Materials Handling Approach and Design Concepts for the Lead Treatment Facility Microencapsulation Unit*, EDF Serial Number WROC-EDF-140, September 1992.
21. Miyasaki, D.H., *Power, Time, Size and Space Requirements for the Lead Treatment Facility Acid Decontamination Unit*, EDF Serial Number WROC-EDF-141, October 1992.
22. Thiesen, B.P., *Facility Design and Cost Options for Lead Treatment Process*, EDF Serial Number WROC-EDF-144, October 1992.
23. Tyson, D.R., *LDR Treatment Options Study of Lead Waste Generated from TRA*, EDF Serial Number WROC-EDF-124, March 1992.
24. Tyson, D.R., *LDR Treatment Options Study of Lead Waste Generated from CPP*, EDF Serial Number WROC-EDF-125, March 1992.
25. Tyson, D.R., *LDR Treatment Options Study of Lead Dross Waste Generated from WERF*, EDF Serial Number WROC-EDF-117, March 1992.
26. Neupauer, R.M. and J.F. Zukauskas, *Recommendations of Treatment Technologies for Radioactively Contaminated Lead at the Idaho National Engineering Laboratory*, EGG-WM-10146, EG&G Idaho Inc., March 1992.
27. Davis, M.V., *Pilot Scale Testing of Refining Process For Decontaminating Lead*, EGG-WED-8961, EG&G Idaho, Inc., April 1990.
28. Davis, M.V., *Lead Management at the INEL*, EGG-WED-8342, EG&G Idaho Inc., January 1989.
29. Davis, M.V., *Decontamination of Lead by Refining, Bench Scale Testing*, EGG-WED-8216, EG&G Idaho, Inc., September 1988.