# PROCESSING CAPABILITIES FOR THE ELIMINATION OF CONTAMINATED METAL SCRAPYARDS AT DOE/ORO-MANAGED SITES*

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## INTRODUCTION

Radioactively contaminated scrap metal inventories and processing capabilities were surveyed at facilities operating under contract with the U.S. Department of Energy and managed through the Oak Ridge Operations Office. Nearly 90,000 tons of nickel, aluminum, copper, and ferrous metals (steels) contaminated with low-enriched uranium and technetium-99 have accumulated primarily at the uranium enrichment facilities.[1] A site-by-site breakdown of the metals inventory is presented in Table I. The potential value of these metals on the scrap market could exceed $100 million. However, existing regulations forbid the release of materials contaminated with detectable quantities of low-enriched uranium for unlicensed use. Therefore, current handling practices include burial and above-ground storage for most of the scrap.

As the availability of suitable burial space decreases and burial costs increase, above-ground storage has been relied upon more heavily. Also, the Nuclear Regulatory Commission (NRC) has under consideration a rule change to permit unlicensed use of this material based on the trivial quantities of radiocontaminants present and the assessment of negligible health impacts.[2] This has heightened interest in potential resource recovery and encouraged material stockpiling. Figures 1 and 2 show the enrichment facility scrapyards at Oak Ridge, Tennessee, and Paducah, Kentucky, respectively.

The proposed NRC rule change refers only to residual contamination in smelted metals. Handling of the scrap "as is" by commercial dealers would still require licensing. Because of the presence of radiocontaminants, NRC licensing requirements, and the relatively small quantities of scrap involved (by industrial standards), commercial smelters have been reluctant to consider processing this material.[3] The cost of transporting contaminated scrap to commercial smelters is another deterrent. The purpose of this study was to assess the capabilities, deficiencies, and prospects of on-site smelting of contaminated metals.

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Table I. Breakdown of major contaminated metal stockpiles at sites managed by the Department of Energy Oak Ridge Operations

| Metal | Quantity (tons) | | | | |
|---|---|---|---|---|---|
| | Paducah Gaseous Diffusion Plant[a] | Oak Ridge Gaseous Diffusion Plant[b] | Goodyear Atomic Company[c] | National Lead Company of Ohio[d] | Totals |
| Steel | 15,350 | 23,551 | 29,000 | 3,250 | 71,151 |
| Nickel | 3,626 | 3,565 | 2,109 | 0 | 9,300 |
| Aluminum | 2,150 | 1,162 | 184 | 0 | 3,496 |
| Copper | 0 | 0 | 0 | 3,468 | 3,468 |
| TOTAL | 21,126 | 28,278 | 31,293 | 6,718 | 87,415 |

[a]Operator – Union Carbide Corporation Nuclear Division, Paducah, Ky.

[b]Operator – Union Carbide Corporation Nuclear Division, Oak Ridge, Tenn.

[c]Operator of the Portsmouth Uranium Enrichment Facility, Piketon, Ohio.

[d]Operator of the DOE Feed Materials and Production Center, Fernald, Ohio.

Fig. 1. Contaminated metal stockpile at the Oak Ridge, Tennessee, gaseous diffusion plant.

Fig. 2. Contaminated metal stockpile at the Paducah, Kentucky, gaseous diffusion plant.

## EXISTING CAPABILITIES

Smelting is used at several sites, primarily as a means of declassifying (from a security standpoint) shape-classified nickel and aluminum scrap. In addition, smelting provides volume reduction[4] and decontamination of most metals by slagging,[5–7] although decontamination of aluminum by slagging has been demonstrated only on a laboratory scale.[5] The remaining contaminants are dispersed throughout the metal. Accurate analysis is also possible by sampling the molten metal before ingot pouring to verify residual contamination levels. Smelting transforms scrapyard metal into rows of stacked ingots, which are then available for recycle or burial at significantly reduced costs. However, much of the scrap metal consists of large components, which require extensive size reduction before melting; thus smelting is labor as well as capital intensive.

### Paducah Gaseous Diffusion Plant (PGDP)

Of all the ORO-managed sites, smelting is used most extensively at PGDP, primarily as a means of destroying the identity of security-classified nickel and aluminum components. Much of this material was uncontaminated scrap from fabrication operations. The material is declassified by melting and cast into 1-ton ingots. Since it is clean, it has been offered for resale to commercial scrap dealers. To date, the Paducah smelting operations have returned nearly $30 million to the U.S. Treasury from these sales.

Smelting capabilities at PGDP consist of a 6-ton Brown-Boveri induction furnace, a reverberatory furnace, and a direct-fired drip melter. The latter two are used basically for aluminum melting. The drip melter, in particular, is used for selective melting of aluminum from uncontaminated composite scrap metal components.

The induction furnace can handle both ferrous and nonferrous scrap. It has been used for production runs of nickel, aluminum, Monel, cobalt, and (most recently) nickel-plated steel. The scrap is melted and cast into 1-ton ingots directly from the furnace by a hydraulic tilt-pour mechanism (Fig. 3) at a rate of one or two ingots per hour. Ingots are dumped from the molds when cooled and then stored outside the building on concrete pads.

The induction melter is scheduled for melting the estimated 9300 tons of classified nickel scrap currently stockpiled at all three enrichment facilities. Because of limited classified storage space at PGDP, the nickel is currently stored compactly in drums at each site. This type of packaging, unique to the nickel and several aluminum components, facilitates material handling and transport by federal courier. Shipments will be made periodically to PGDP throughout the nickel campaign, which is expected to be completed in FY 1985.

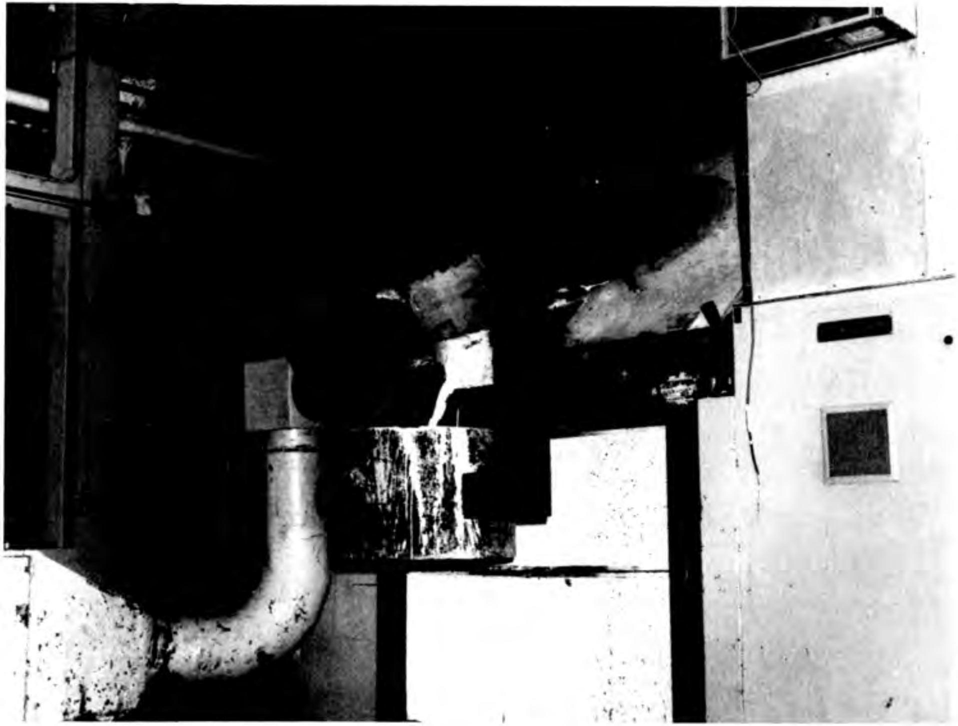

Fig. 3. Pouring of molten Monel from the 6-ton induction melter at the gaseous diffusion plant in Paducah, Kentucky.

The aluminum melters are oil-fired furnaces capable of melting about 100 tons per month. As with the nickel, the form of the classified aluminum facilitates material handling and furnace charging. Aluminum is cast into ingots of about 450 kg (1000 lb) each. Because of the high cost of fuel oil, these furnaces are more expensive to operate than the induction melter. Therefore, aluminum is melted in the induction melter whenever scheduling permits. Aluminum is melted on a 3 to 6 month campaign basis, as required, to reduce classified inventories.

Goodyear Atomic Company (GAT)

Smelting capabilities at the Portsmouth uranium enrichment facility, operated by GAT, consist solely of a 5-ton, direct oil-fired aluminum melter. The melter has a pump discharge and filters the molten aluminum to screen out unmelted metals. Half-ton ingots can be cast at a 10 ton/d capacity. However, the short life of the submersible pumps and the filtration requirement reduce production capability to 70 to 100 tons per month. As at PGDP, the melter is operated on a campaign basis, as required.

National Lead Company of Ohio (NLO)

At the DOE Feed Materials and Production Center, operated by NLO near Cincinnati, Ohio, a bank of vacuum induction melters typically used for uranium conversion were made available for the decontamination and size reduction of contaminated copper. The copper scrap was generated during upgrading of motors used in the diffusion process. Copper motor windings were shredded, granulated, and air classified to remove insulation. This also removed much of the contamination. The copper was then loaded into an induction furnace along with about 1 wt % crushed glass, which forms a slag and decontaminates the metal. In production-scale experiments, about 120 tons of copper were processed into 225-kg (500-lb) ingots, which are currently stored at the FMPC. Over 60% of the ingots met existing requirements for resale. This was probably due to removal of much of the low-enriched uranium and trace $^{99}Tc$ with the wire insulation. Total uranium content was below 5 ppm in 99% of the ingots (493 out of 498). Funding to consolidate the remaining 3000 tons of copper has been requested.

## CONCLUSIONS AND RECOMMENDATIONS

Capabilities exist for reducing all the contaminated nickel, aluminum, and copper scrap to ingot form by smelting. Processing these metals at existing facilities could be completed in about 5 or 6 years. However, these metals represent only about 20% of the total metal inventories currently on hand at the DOE/ORO-managed sites as shown in Table I. No provisions have been made for the ferrous scrap. Most of the ferrous scrap is unclassified and does not require secured storage. Also, the potential resale value of the ferrous scrap at about $100 per ton is very low in comparison. Consequently, this scrap has been allowed to accumulate.

With several modifications and equipment additions, the induction melter at PGDP could begin processing ferrous scrap after its commitment to nickel and aluminum. The PGDP smelter is a retrofit installation, and annual throughput capabilities are limited. Processing of the existing ferrous scrap inventories would not be completed until the FY 1995–2000 time frame.

An alternative proposal has been the installation of induction melters at the other two enrichment facilities. Conceptual design of a generic metal smelting facility is under way. The design study includes capital and operating costs for scrap preparation through ingot storage at an annual throughput of 10,000 tons per year. Facility design includes an induction melter with the capability of melting both ferrous and nonferrous metals. After three years of operation with scrapyard feed, the smelter would have excess capacity to support on-site decontamination and decomissioning projects or upgrading programs. The metal smelting facility has been proposed for FY 1984 line item funding with start-up operations in FY 1986.

An assessment of potential recycle applications for trace-contaminated metals has been initiated. Preliminary investigations have identified several areas of interest, such as structural steels for construction projects within the Department of Energy or Department of Defense communities. Recovered material could meet the substantial requirements for steels in thermal shielding base plates and thick-walled canisters proposed for use in the disposal of solidified high-level waste. Potential uses for specific components in uranium mining operations have also been identified. Economic trade-offs including alloying requirements, product demand, market impact, and fabrication costs will be evaluated.

In addition to the obvious benefit of volume reduction, smelting of contaminated metals effectively decontaminates the metal to the part per million level. Radiocontaminants are concentrated in the low-volume slag. Residual contamination is homogeneously dispersed throughout the metal matrix, permitting representative sampling for verification of contamination levels simply by tapping the melt or drilling the ingot. Furthermore, this resource can be recycled back into the government or commercial economies only after the contamination level uncertainties of the scrap metal in the yard have been overcome by smelting.

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