# RADIOACTIVE SCRAP METAL RECYCLING: A DOE ASSESSMENT

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## ABSTRACT

This paper points up the importance of recycling in general in the Department of Energy's (DOE) Environmental Restoration (ER) Program and the recycling of radioactive scrap metal in particular. The substantial quantities of these metals currently on hand within the DOE complex and the large quantities expected to be generated by the ER program are discussed. Especially important is the opportunity for the DOE to realize a very substantial range of cost savings, with emphasis on long-term savings, through the decontamination and recycling of radioactive scrap metals. Also discussed is the critical impediment to achieving worthwhile recycling of these metals, which is the lack of establishment by the regulatory agencies of contamination standards that would allow the metals to be processed and released for unrestricted use. The current DOE activities in developing a recycling technology program are presented. Also noted are the concerns of the public and of the metals industry regarding safe levels of residual contamination.

## INTRODUCTION

Traditionally, we tend to think of waste disposal as burial, long-term storage, or destruction. Seldom is disposal thought of as getting rid of the unwanted material (the waste) by returning it to the stream of raw materials flowing into production processes, i.e., recycling. Yet doing so can solve several problems simultaneously. For example, it would get the waste materials off our hands, it would conserve natural resources, and it would reduce the demand for energy needed for processing the virgin materials that would be used if the recycled material were not available. For these reasons, as the Department of Energy's (DOE) Environmental Restoration (ER) Program grows, it is desirable that increasing attention be given to minimizing waste for disposal by recycling wherever and whenever possible.

## METAL RECYCLING CONSIDERATIONS

Where the DOE is concerned, nowhere is the potential for worthwhile recycling greater than in the recycling of radioactive scrap metals. Recycling these metals is especially desirable because they represent valuable commodities - assets - for which there is a ready marketplace. In particular, the scrap inventory at DOE sites includes five metals - nickel, copper, aluminum, steel, and lead - that routinely enjoy brisk markets, and scrap is a very important segment of those markets. To illustrate this factor, Table I(a) gives the U.S. production figures for these metals over a recent 5-year period, while Table I(b) lists the U.S. scrap consumption for the same five metals. Comparison of these data readily demonstrates the importance of scrap in the metals marketplace.

The magnitude of the metals recycling challenge to the DOE is evidenced by the estimates that there are approximately 1.5 million tons of radioactive scrap metal currently on hand at DOE facilities, and that the ER Program might produce another 1.0 million tons. Table I(c) provides a breakdown of the 1.5 million-ton inventory estimate. It needs to be noted that all these estimates are very preliminary and are expected to be refined over that next year.

A key problem with the estimates of current quantities is the lack of consistency in recording and reporting scrap inventories among the various DOE sites. While some sites report scrap metal quantities in pounds and tons, many sites record and report in units of cubic feet or cubic yards. Without some indication of density, the latter data are of very limited use. They are useful, however, in terms of planning for long-term storage or burial space, and illustrate the point noted earlier of the strong tendency to thin of disposal only in those terms. It should also be noted that scrap metal processing technologies, of which there are many, and scrap metal markets deal only in units of weight.

The metallurgical technologies for manufacturing steel, aluminum, copper, lead, nickel, and other metals, whether from virgin materials or from scrap, are well-known and widespread. It is most likely that successful processes for decontamination of radioactive metals (other than very shallow surface decontamination) will be extensions or adaptations of these existing metallurgical processes. A common complaint heard throughout the DOE complex is that decontaminating radioactive scrap metals is too expensive. The key technology need for DOE, then, is the capability to remove the contamination effectively and at reasonable cost.

## COST CONSIDERATIONS

The costs (both investment and operating costs) for such technology may not need to be as low as might be assumed at first glance. The reason is that the costs of acquiring and operating the technologies need to be compared to the total costs of not recycling the metals. These costs would include:

a. the immediate market price that could be obtained by selling decontaminated scrap in the open metals markets;

b. the value of natural resources conserved (i.e., saved) through not mining and processing the virgin materials that would be represented by the scrap metals; and

c. the costs that would be avoided by DOE not having to build disposal or long-term storage facilities for the scrap metals and for long-term surveillance and maintenance of those facilities.

For illustration of the first type of cost savings above, a recent price for good scrap aluminum was about $600.00 per

**TABLE I(a)**

U.S. Production of Selected Metals
(Metric Tons Unless Otherwise Noted)

| Metal | Year | | | | |
|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 |
| Aluminum (Primary) | 3,499,765 | 3,038,673 | 3,346,874 | 3,944,528 | 4,442,502 |
| Copper (Crude) (Short Tons) | 1,386,500 | 1,322,800 | 1,308,300 | 1,527,000 | 1,554,500 |
| Lead | 1,053,600 | 931,800 | 1,042,000 | 1,090,500 | 1,180,000 |
| Nickel (Refined) | 33,000 | 1,500 | -- | -- | 300 |
| Steel (Short Tons) | 88,259,455 | 81,606,233 | 89,151,148 | 99,327,586 | 97,943,000 |

**TABLE I(b)**

U.S. Consumption of Scrap
(Metric Tons Unless Otherwise Noted)

| Metal | Year | | | | |
|---|---|---|---|---|---|
| | 1985 | 1986 | 1987 | 1988 | 1989 |
| Aluminum | -- | 1,882,555 | 2,096,071 | 2,234,812 | 2,173,989 |
| Copper | 1,402,075 | 1,490,032 | 1,581,854 | 1,605,841 | 1,616,759 |
| Lead* | 615,695 | 624,769 | 710,067 | 736,401 | 808,589 |
| Nickel* (Short Tons) | 53,645 | 43,724 | 46,657 | 63,309 | 62,381 |
| Steel (Short Tons) | 70,493,000 | 65,856,000 | 68,303,000 | 76,822,000 | 72,209,000 |

* Recovery from Scrap

**TABLE I(c)**

Estimated Quantities of Radioactive Scrap Metals in DOE Inventory
(Metric Tons)*

| Aluminum | Copper | Lead | Nickel | Steel |
|---|---|---|---|---|
| 161,700 | 32,400 | 2,400 | 204,150 | 1,093,800 |

* These 5 metals represent approximately 99 percent of the total DOE Radioactive Scrap Metals Inventory

ton. Assuming for the moment that the DOE inventory given by Table I(c) is correct, this market price would represent a gross return to the Department of some $97,000,000. For steel, a recent market price was $107.00 per ton, which would represent a gross return to DOE of over $117,000,000.

Aluminum also provides an example of the savings available through conservation of natural resources. About four tons of bauxite ore are required to produce one ton of aluminum. These 4 tons of bauxite were recently valued at about $20.00 per ton (as mined). At that price, the DOE's scrap aluminum inventory (Table I(c)) would represent a conservation savings of 646,800 tons of bauxite, or about $12,936,000. Beyond the savings in ore value, there is also a very significant energy savings when new aluminum is produced from scrap instead of ore, because making "new" aluminum from scrap requires only 5% of the energy that is required when aluminum is made from bauxite. According to the Aluminum Associate, some 15,000 kilowatt-hours (Kwh) of electricity are required to produce a ton of aluminum from bauxite. The use of scrap would save 14,250 Kwh per ton. Thus, the scrap aluminum in the DOE inventory would represent a very substantial dollar savings in energy (e.g., $23,000,000 at $0.01 per Kwh).

As substantial as they are, the savings outlined above could be dwarfed by the third type, especially the potential savings in surveillance and maintenance (S&M) costs. The S&M costs avoided would be particularly important because of the very long term involved, i.e., 100-200 years. If S&M costs for a disposal facility were to be $100,000 this year (1992), for example, at a steady 3% per year escalation rate, in the 100th year that annual cost would become $1,860,000. Further, the cumulative costs at that time would be some $58,800,000. If the escalation rate were to be a steady 5% per year, that $100,000 today would rise to $12,523,000 in the year 100 and the cumulative costs through year 100 would be $261,000,000 (see Table II). So, before we say that decontaminating radioactive scrap metals would be too expensive, we must consider the cost burden we would be imposing on the taxpayer in the future.

**TABLE II**

Projected Surveillance and Maintenance Costs
(Based on 1992 Dollars)

| (a) At 3% Per Year Escalation Rate | | |
|---|---|---|
| Year | Annual S&M Costs | Cumulative Costs |
| 1 (1992) | $ 100,000 | $ 100,000 |
| 10 | 130,477 | 1,146,387 |
| 20 | 175,351 | 2,687,037 |
| The Year 2019* | 222,129 | 4,293,091 |
| 100 | 1,865,880 | 58,825,789 |
| (b) At 5% Per Year Escalation | | |
| Year | Annual S&M Costs | Cumulative Costs |
| 1 (1992) | $ 100,000 | $ 100,000 |
| 10 | 155,133 | 1,257,890 |
| 20 | 252,695 | 3,306,696 |
| The Year 2019* | 373,345 | 5,859,957 |
| 100 | 12,523,908 | 261,001,461 |

* The Year 2019 is highlighted because it has been given as the nominal end-year of the DOE environmental restoration program.

## TECHNOLOGY CONSIDERATIONS

While some promising radioactive scrap metal decontamination technology work has been done within DOE, notably at Oak Ridge and the Idaho National Engineering Laboratory (INEL), no concerted program has been established to date. That, however, is changing.

The DOE Office of Environmental Restoration (EM-40) has entered into an Interagency Agreement (IAG) with the Environmental Protection Agency (EPA) for a joint project that will get underway this year (1992). This project will be managed by the EPA and the field work will be performed by a contractor. The project will consist of two phases. In Phase 1, a broad-based study of DOE radioactive scrap metals will be conducted that will cover the following efforts:

- Development of a summary of contaminated metal inventories at individual DOE sites.
- Development of a summary of the radionuclide contaminants and levels, and the types of contamination (surface, bulk).
- Projection of future quantities of radioactive scrap metals expected to be generated at DOE sites through the ER Program.
- Identification of the technology available for metals decontamination and recycling.
- Compilation of the total life-cycle costs involved in scrap metal decontamination and recycling.
- Development of models for estimating radiological risk.
- Summary of the radiological risks and environmental impacts of radioactive scrap metals recycling.
- Analysis of the costs and benefits of metals recycling.

Phase 2 of the project will consist of demonstrations of selected technologies, identified in Phase 1 as holding the greatest promise. It will conclude with a thorough analysis of the results, identification of further research and development needs, and an evaluation of whether DOE should develop in-house decontamination and recycling facilities.

In another DOE initiative, the Office of Technology Development (EM-50) is also preparing plans to sponsor demonstration projects in radioactive scrap metal decontamination. Further, it is anticipated that both the Office of Environmental Restoration and the Office of Technology Development will be actively seeking ideas for additional recycling demonstration projects.

## REGULATORY CONSIDERATIONS: THE KEY TO SUCCESS

The most critical need in radioactive scrap metal recycling is for resolution of the regulatory issues that currently make for an unsettled situation. At present, the lack of contamination standards from the regulators, i.e., the EPA and the Nuclear Regulatory Commission (NRC), poses a very real barrier to radioactive scrap metal recycling. Needed are answers to questions such as:

- Should the metal show no detectable contamination in order to be released for unrestricted use?;
- Will decontaminating the metal to background level qualify it for release for unrestricted use?;
- How should we define "background level" in this case?;
- Can we employ dilution processes to achieve desired/required contamination levels without the need

for any prior decontamination of the metals, i.e., before they enter the processes?

While DOE has established guidelines for surface decontamination that can be applied to scrap metals (DOE Order 5400.5), there are no volumetric contamination guidelines that could be applied. Both the EPA and NRC have considered the establishment of standards that could be applied to scrap metals and have suggested potential levels, but neither agency has as yet actually promulgated any standards. In fact, the two agencies are currently in disagreement not only on the issue of standard levels, but also on the issue of which agency should have the lead in regulatory radioactive contamination.

On the international level, radioactive scrap metal recycling is being pursued by a number of other countries and has been the subject of attention by the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA). A meeting of the OECD/NEA's Technical Advisory Group on Decommissioning is planned for March 1992 to collaborate on strategies for developing unrestricted release criteria to be used in materials recycling. Mr. William Murphie of the Office of Environmental Restoration will be representing DOE in this effort.

These difficulties are further compounded when the public and the metals industry are considered. Confronted by such uncertainty and disagreement on the part of government, the public's perception is that no one knows what constitutes safe levels of contamination. Thus, the public tends to disbelieve that any level of radioactive contamination is safe. The metals industry and the manufacturers whose products would contain the contaminated (at some level) metals are likely to be very willing to trade and use them. They will do so, however, only when they can be assured by government that as long as they satisfy regulatory requirements, they will not be held liable for any adverse effects that might be perceived to be caused by the presence of the radioactive contamination.

There appear to be two principal elements in the need for resolution of the issues confronting the recycling of radioactive scrap metals. They are:

- A "Below Regulatory Concern" level of contamination, i.e., a level below which the metals can be released for unrestricted use without the need for tracking or further recordkeeping after the original survey measurements are completed; and
- Provision for utilizing dilution to achieve unrestricted use level, i.e., allowing the mixing of radioactive scrap metal with uncontaminated metal (new or scrap) in melts, to reduce the final contamination level of the melt to the unrestricted use level. No records would be kept after the melt contamination level has been verified.

Favorable resolution of these two key elements could quickly lead to a strong, on-going program of decontaminating and recycling DOE's radioactive scrap metals.

## CONCLUSION

The DOE has an excellent opportunity to decontaminate and recycle its large and continuing inventories of radioactive scrap metals. While some technology development will be required and existing technology is not inexpensive, recycling scrap metal nevertheless holds excellent payoff potential for the ER Program as well as for the nation in general. The lack of established regulatory standards specifically defining contamination levels that would qualify the metals for release for unrestricted use is a critical barrier to an effective recycling program. Despite this shortcoming, the DOE intends to promote development of recycling technology, and is working with EPA for resolution of the regulatory issues.