



PB94-203585

BUREAU OF MINES
INFORMATION CIRCULAR/1994

IC 9397

Recycling In The Major Metal Industries: Trends, Developments, and Regulatory Impacts

By Russell J. Foster



UNITED STATES DEPARTMENT OF THE INTERIOR

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
INFORMATION SERVICE
SPRINGFIELD, VA 22161

Library of Congress Cataloging in Publication Data:

Foster, Russell J.

Recycling in the major metal industries : trends, developments, and regulatory impacts / by Russell J. Foster.

p. cm. -- (Information circular; 9397)

Includes bibliographical references (p. 32).

1. Scrap metals--United States--Recycling. 2. Scrap metal industry--United States. 3. Environmental policy--United States. I. Title. II. Series: Information circular (United States. Bureau of Mines); 9397.

TN295.U4 [TS214] 622 s--dc20 [363.72'82] 93-50717 CIP



PB94-203585

REPORT DOCUMENTATION PAGE		1. REPORT NO. IC 9397	2.
4. Title and Subtitle RECYCLING IN THE MAJOR METAL INDUSTRIES: TRENDS, DEVELOPMENTS, AND REGULATORY IMPACTS			5. Report Date
7. Author(s) Russell J. Foster			6.
9. Performing Organization Name and Address Division of Regulatory and Policy Analysis U.S. Bureau of Mines 810 7th Street, NW Washington, DC 20241			8. Performing Organization Rept. No.
12. Sponsoring Organization Name and Address			10. Project/Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) (G)
			13. Type of Report & Period Covered Information Circular (IC)
15. Supplementary Notes			14.
16. Abstract (Limit: 200 words) Public awareness of, and involvement in, recycling has increased significantly in recent years. Nevertheless, recycling is generally perceived as a new development, and is familiar only in the context of municipal solid waste management. The actual magnitude and scope of metals recycling in the United States have gone virtually unnoticed. Over time, both the quantitative and qualitative aspects of secondary metals recovery and reuse have changed substantially, while the attendant regulations have become increasingly stringent. This U.S. Bureau of Mines report examines trends and developments in major metal demand and recycling, and analyzes the possible impacts of regulations with regard to recycling activities.			
17. Document Analysis a. Descriptors Recycling Iron and Steel Copper Zinc Regulations Aluminum Lead			
b. Identifiers/Open-Ended Terms			
c. COSATI Field/Group			
18. Availability Statement Release Unlimited		19. Security Class (This Report) Unclassified	21. No. of Pages 35
		20. Security Class (This Page) Unclassified	22. Price



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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT			
g	gram	lb	pound
gal	gallon	mt	metric ton
kmt	thousand metric ton	yr	year

RECYCLING IN THE MAJOR METAL INDUSTRIES: TRENDS, DEVELOPMENTS, AND REGULATORY IMPACTS

By Russell J. Foster¹

ABSTRACT

Public awareness of, and involvement in, recycling has increased significantly in recent years. Nevertheless, recycling is generally perceived as a new development, and is familiar only in the context of municipal solid waste management. The actual magnitude and scope of metals recycling in the United States have gone virtually unnoticed. Over time, both the quantitative and qualitative aspects of secondary metals recovery and reuse have changed substantially, while the attendant regulations have become increasingly stringent. This U.S. Bureau of Mines report examines trends and developments in major metal demand and recycling, and analyzes the possible impacts of regulations with regard to recycling activities.

¹Physical scientist, Division of Regulatory and Policy Analysis, U.S. Bureau of Mines, Washington, DC.

INTRODUCTION

During the past few years, the recycling ethic has become ingrained in the national consciousness. Yet, although recycling is being heralded as a vital aspect of environmental stewardship, public awareness stems largely from its role in municipal solid waste management—whereby metal, glass, and plastic containers, newspapers, and cardboard are separated from the household trash. In addition to this limited perspective, the layman also tends to view recycling as a somewhat novel concept.

As such, few people have an appreciation for the extent of materials recycling that actually takes place, and for the fact that recycling long has been a routine practice of the major metal industries. Not only are iron (predominantly in the form of steel), aluminum, copper, lead, and zinc the most extensively used metals, they are also the most extensively recycled, both in terms of quantity and

value. Indeed, the United States has the world's preeminent metals recycling system.

However, the system operates under several complex and controversial regulatory regimes. Currently, definitions and concepts associated with a number of existing regulations are being revisited, as part of the debate concerning reauthorization legislation and international agreements. Meanwhile, additional new legislation concerning various aspects of recycling continues to be introduced at the Federal, State, and local levels. Government, industry, and the environmental community are faced with the challenge of encouraging recycling while at the same time preserving the quality of the environment, and the health and safety of the general public and the work force.

This U.S. Bureau of Mines report is intended to focus attention on the full scope of metals recycling, and on the regulatory impacts affecting recycling activities.

RECYCLING

DEFINITIONS AND TERMINOLOGY (1-15)²

Recyclable materials themselves should not be considered as waste or trash. Initially they may be incorporated in a particular waste stream, but they can be removed for further use. Thus, recycling can be defined as the actions taken to divert or extract materials from a waste stream and reuse them. These actions encompass collection, separation, processing, marketing, and use in a new product or material.

Complete utilization of a starting material to produce a finished product is seldom realized. Also, things eventually wear out or become obsolete. The inevitable consequence of these circumstances is scrap. Scrap is generated at all stages of the material life cycle—during the initial production of the metal, the fabrication of intermediate forms, the manufacture of industrial and consumer products, and, ultimately, at the end of a product's useful life.

Scrap metals are initially categorized as ferrous or nonferrous. Ferrous scrap is simply iron and steel. Nonferrous scrap, therefore, is scrap metal other than iron and steel, such as aluminum, copper, lead, and zinc.

Both ferrous and nonferrous scrap are further described according to the stage of the metal life cycle at which they originate. New scrap is generated in the course of producing the metal itself, semifabricated products, and finished industrial and consumer items. New scrap is divided into home scrap and prompt scrap. Home scrap (also called

runaround, in-house, or revert scrap) results from production processes such as casting, and from fabricating intermediate forms (e.g., trimmings from new sheet, rod, wire, etc.). It is recycled by the company generating it, usually in the furnace on-site, and so does not enter the market. Prompt scrap includes trimmings, clippings, cuttings, borings, and turnings generated when consumer or industrial products are made; for example, the remains after an item is punched out of a sheet of metal, or a piece of metal is cut, or a hole is drilled. It is sold, or tolled,³ to scrap dealers, secondary smelters, or metal suppliers.⁴

Metal-containing processing residues (flue dusts, sludges, drosses, skimmings) can also be viewed as new scrap. They can be recycled directly to the early stages of the metal production process, or they can be sold to others for metal recovery. Some processing residues that are marketed in their original form (e.g., iron and steel slags and mill scale) are considered byproducts rather than scrap.

Old scrap consists of products that have been discarded because they are worn out, broken, obsolete, or rejected for other reasons. It includes automobile hulks, major appliances ("white goods"), beverage and food cans, batteries, wire and cable, and countless other items. Old ferrous scrap constitutes the predominant share of the scrap that has accumulated in the United States.

³Tolling is a practice whereby one company's material is processed by another for a fee. The original owner retains title to the end product.

⁴USBM data regarding new scrap refer to prompt scrap only. Data regarding home scrap, which is provided for ferrous scrap, are specifically designated as such.

²Italic numbers in parentheses refer to items in the list of references at the end of this report.

Collectively, prompt and old scrap are referred to as purchased scrap. Purchased outright from domestic and foreign sources, or processed on toll, it moves through a network of scrap processors back to the specific metal industry. Scrap (old and new) that requires minimal processing is commonly called direct melt or remelt scrap.

ENVIRONMENTAL HIERARCHY (16)

There is an established hierarchy of approaches for achieving environmental protection. The preferred approach is source reduction (i.e., pollution prevention). However, if pollution cannot be prevented, recycling is considered to be the next best means of protecting the environment. EPA holds that "...recycling... conducted in an environmentally sound manner shares many of the advantages of prevention..."

ADVANTAGES (2, 4-8, 17-20)

The benefits derived from recycling are considerable, and encompass technical, economic, and aesthetic values.

Determining their relative importance is subjective, and so prioritization depends on individual perspectives.

The recycling process provides...

- ...a significant savings in energy, compared with the production of refined metal from minerals. These energy savings have been quantified as follows: aluminum—95%; copper—85%; steel—74%; lead—65%; and zinc—60% (4-5).
- ...an alternative source of raw materials for refined metals production, thus extending nonrenewable mineral sources of metals supply (tables 1 and 2).
- ...substantial reductions in mining, manufacturing, and postconsumer wastes.
- ...additional space in landfills for nonrecyclable materials (at a time when available landfill capacity is declining).
- ...jobs to local and regional economies, and tax revenues for local, State, and Federal jurisdictions.
- ...improved balance of payments for the United States resulting from scrap exports (table 3). High levels of scrap exports also serve to enhance domestic recycling rates.

Table 1.—Major metal scrap recycled¹ in the United States, 1992

Commodity	Quantity			Value		
	(thousand mt)			(million dollars)		
	New scrap	Old scrap	Total scrap ²	New scrap	Old scrap	Total scrap
Iron and steel ³	NA	NA	41,764	NA	NA	22,187
Aluminum ⁴	1,145	1,612	2,757	1,452	2,044	3,496
Copper ⁵	722	554	1,276	1,711	1,312	3,023
Lead ⁶	55	861	917	30	466	496
Zinc ⁷	234	132	366	301	170	471
Total			47,080			29,673

NA Not available.

¹Recycled from purchased scrap.

²Data may not add to totals shown because of independent rounding.

³Value is based on average annual nominal finished steel base price at shipping mill.

⁴Value is estimated based on the average annual U.S. market price for primary aluminum metal.

⁵Recoverable copper values in scrap based on annual averages for refined copper.

⁶Transaction value estimated to be LME average cash value plus 6.5 cents/lb.

⁷Value based on average annual U.S. zinc metal price.

Table 2.—Major metals recovered from old scrap in the United States as a percent of apparent consumption,¹ 1992

Commodity	Metal recovered	Apparent consumption	Ratio
	(thousand metric tons)	(thousand metric tons)	(percent)
Aluminum ..	1,612	5,725	28
Copper	554	2,311	24
Lead	861	1,237	70
Zinc	132	1,276	10

¹Apparent consumption = primary production + recovery from old scrap + imports - exports + adjustments for Government and industry stock changes.

Table 3.—U.S. major metal scrap trade, 1992

Commodity	Exports		Imports	
	Quantity	Value	Quantity	Value
	(thousand mt)	(million dollars)	(thousand mt)	(million dollars)
Iron and steel . .	9,262	1,100	1,316	148
Aluminum	295	300	265	267
Copper:				
Unalloyed . .	101	116	52	96
Alloyed	¹ 145	166	84	188
Lead	¹ 63	15	(²)	(²)
Zinc	82	48	43	23
Total		1,745		722

¹Gross weight.²Less than 1/2 unit.

A CHANGING PARADIGM (3, 7, 21-27)

As with any other competitive business enterprise, conventional recycling is grounded in the fundamentals of economic and technical feasibility. The extent to which various materials are recycled depends upon factors such as the magnitude and nature of the end uses, collection logistics, relative primary metal prices, processing costs, and available technology. More and more, however, the pragmatic aspects of recycling have been yielding to other considerations. Additional factors, such as the attitude of the citizenry, consumer preference, and Government regulations, have begun to influence which materials are, or are not, recycled, and are thus resulting in a changing paradigm.

For example, consumer preference for certain products now depends to some extent on the recyclability of the packaging. The plastics industry quickly recognized that plastic containers were being perceived as detrimental to the environment in comparison with other forms of packaging materials (metal, glass, and paper). The industry has regained a measure of public acceptance by instituting a coding system and by intensifying the development of processes to recycle their products. Further, although plastics have been a major factor in producing lighter weight automobiles to meet legislated fuel economy standards, their proliferation creates problems at the end of a vehicle's useful life. More utilization of plastics means greater quantities of "fluff"—a diverse mixture of non-metallic materials—at the shredder, which translates into higher waste disposal costs. The automotive and plastics industries are working on solutions—designing for disassembly; materials identification; limiting the variety of plastics used; and using plastics that are most compatible with recycling.

Traditionally, materials of low value, with small concentrations of the desired element, with bothersome trace elements, or of complex composition would normally not be considered for recycling. Now, some recycling of such materials occurs, even when their value is less than the treatment cost, if it results in avoidance of future environmental problems, or saves landfill space. On the other hand, recyclable materials with a "hazardous" stigma may be avoided by recyclers if they are faced with prohibitive regulatory compliance costs and the prospect of future liability.

Nowhere are the "new" priorities of recycling more evident than in the case of municipal solid waste (MSW), i.e., household, commercial, institutional, light industrial, and certain other wastes (from hospitals, laboratories, etc.). In many communities, MSW management is a major concern. Numerous landfills throughout the country are reaching capacity or cannot meet more stringent regulatory standards. The Office of Technology Assessment (OTA) has determined that 80% of existing landfills will therefore close within the next 20 years (24). New landfill development, and switching to alternatives such as incinerators, often face regulatory roadblocks and strong disapproval by the public.

In response, many local governments have instituted programs featuring curbside collection of recyclable materials. Ideally, the revenue that accrues from selling the recyclables gathered via curbside operations would be sufficient to offset the cost of the program. However, this is an elusive goal, and is seldom achieved. The actual costs of such programs invariably exceed revenues. Essentially, MSW recycling programs are being driven by the need to extend the life of existing landfills, and overall environmental concerns, rather than the likelihood of profitability.

THE SCRAP SYSTEM

HISTORICAL PERSPECTIVE (6, 9, 28)

Throughout the history of the United States, the utilization of scrap has been most visible when the Nation was at war, playing a vital role in sustaining production of war material. Nevertheless, scrap metal use came to America concomitant with the construction of the first iron furnace in Massachusetts in the mid-1600's. Peddlers ("junkmen") initially made a business out of supplying old scrap to the industry.

During the mid-1800's, the Industrial Revolution spurred the production of manufactured goods, increasing the supply of, and demand for, scrap. Collectors and dealers expanded the scope of their operations by obtaining new scrap from fabricators, and began preparing scrap to make it more compatible for use by consuming industries, thereby increasing its value. Quality control, densification, and standardization followed.

As the 20th century arrived, scrap handling and processing techniques were becoming more sophisticated. Much of this was large-scale and high-cost equipment, which characterizes the present scrap recycling system.

COMPONENTS (4-6, 8-9)

An efficient scrap infrastructure has been developed and nurtured by and for each of the major metal industries.

Scrap suppliers, whose operations number in the thousands, include collectors and small dealers, large dealer/processors, and brokers. Some handle all types of scrap, but most specialize. They range in size from small, family-run businesses to huge nationwide and worldwide corporations.

Dealers and dealer/processors purchase scrap from many different sources such as auto dismantlers, building demolition and dismantling operations, railroads, industrial plants, shipyards, airlines, Government facilities, utility companies, farms, and municipalities. Most processors tend to be specialized because of the different collection strategies, handling, and markets. The dealer/processor identifies the scrap components; sorts the scrap into grades (as per consumers' requirements); prepares the scrap (by cutting, shredding, etc.); and bales or packs the scrap for timely shipping to domestic and export markets. Brokers facilitate the flow of scrap by helping dealer/processors find appropriate scrap consumers, and by helping intermediate scrap consumers and scrap-consuming industries locate sources of supply.

The most important participant in the recycling loop is the industry that uses the recyclable material as input into its manufacturing process for its product. Without this demand, the collection and processing steps are of little consequence.

Intermediate scrap consumers consist of smelting and refining facilities that make refined metal and alloys of a specific form and composition. The downstream consuming industries are mills and foundries that utilize such intermediate forms, and/or processed scrap directly, to make new products.

MUNICIPAL SOLID WASTE (3, 7, 17)

Community MSW programs employ several different collection schemes. Curbside programs collect recyclables either commingled or separated. In some instances commingled recyclables are separated at the truck by the collector. Voluntary drop-off locations are more prevalent where curbside programs are not in place, such as in sparsely populated areas. Buyback centers are widely accessible, although their main interest is aluminum.

Marketing options for MSW recyclables can vary according to the magnitude of the program and the regional location of the community. In some areas, there are consuming industries (mills, foundries) or specific processing facilities (detinning plants) that will purchase materials directly. There may be intermediate alternatives available, such as regional material recovery facilities (MRF's), at which collected recyclables are physically separated and processed according to the specifications of the particular user. The private sector has decried the redundancy of Government-funded MRF's in communities where there are existing commercial facilities.

Fledgling MSW programs have been able to tap into the aluminum and steel scrap markets for the bulk of their revenues, but insufficient market demand for other MSW recyclables (paper, glass, plastics) has made the overall economics of MSW programs unfavorable.

MARKET CHARACTERISTICS (6-7, 9, 15)

The level of activity in the system depends not on the quantity of scrap that is being generated, but rather the quantity that is being purchased. Consuming industries establish the demand for the materials that the scrap processors provide. Thus, the scrap market is essentially demand driven.

There are many different types and grades of scrap for each of the major metals and their alloys. Relative to each other, they are priced according to quality and usefulness. Scrap dealers endeavor to sell scrap to consuming industries at prices that will recoup the costs of obtaining and processing the materials, plus realize a profit. However, the price of refined metal keys the price of scrap. As the differential between these prices narrows, processing becomes less economic. Thus, the status of refined metal prices usually influences the quantity of

scrap that becomes available. Scrap dealers may choose to hold onto their material when prices are too low, awaiting a more favorable market.

Prices respond quickly to market conditions, and also exhibit regional variations. Quotations for various kinds of metal scrap appear in daily and weekly trade publications.

Scrap is not only an important commodity in domestic commerce, but also in international markets as well. The United States is the world's largest exporter of major metal scrap collectively.

REGULATIONS, LEGISLATION, AND INTERNATIONAL AGREEMENTS

OVERVIEW (29-41)

Some environmental legislation and the accompanying regulatory regimes, such as those promulgated under the Clean Air Act (CAA) and Clean Water Act (CWA), are so comprehensive as to impact virtually all industries, and within the metal industries as to affect both primary and secondary production.

Air quality is regulated under CAA by National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP). NAAQS represent threshold levels of air pollution for six "criteria" air pollutants (including lead), below which no adverse effects will be experienced by humans or the environment. NSPS require the use of best demonstrated technology when stationary sources that emit or may emit any air pollutant are constructed or modified; NSPS have been promulgated for many source categories, including secondary lead smelters, lead-acid battery manufacturing plants, secondary brass and bronze production plants, and electric arc furnace (EAF) and basic oxygen furnace (BOF) steel plants. The NESHAP mandated by the 1990 Clean Air Act Amendments (CAAA) (to be promulgated over a 10-year period following enactment) are based on Maximum Achievable Control Technology (MACT) for source categories that emit one or more of the 189 substances defined in CAAA as hazardous. In July 1992, EPA published an initial list of categories, which includes secondary aluminum production, secondary lead smelting, lead-acid battery manufacturing, integrated iron and steel manufacturing, EAF steel manufacturing, iron foundries, and steel foundries. Standards that effect a 75%-90% reduction in emissions are anticipated (35).

The CWA was originally enacted as the Federal Water Pollution Control Act in 1972, and has been amended several times since. It addresses water pollution that can originate from either a point source, which is defined as

"any discernible, confined, and discrete conveyance from which pollutants are or may be discharged" (i.e., a pipe, ditch, channel, tunnel, conduit, etc.), or a nonpoint source. Among the "toxic pollutants" subject to effluent limitations under CWA are copper, lead, and zinc, and their compounds. National standards of performance govern sources within several categories, notably iron and steel manufacturing, ferroalloy manufacturing, and nonferrous metal manufacturing. Amendments to CWA mandate that EPA require a permit for stormwater discharges associated with industrial activity, and that stormwater runoff be regulated as a point source. The "scrap recycling industry" is specifically included under stormwater regulations. Thus, scrap that contains oils, polychlorinated biphenyls (PCB's), and heavy metals entails compliance problems for scrap processors, necessitating either modifications to on-site scrap management practices or avoidance of these kinds of scrap. Reauthorization of CWA is at the forefront of the regulatory agenda in the 103d Congress. Legislation introduced in the Senate proposes to revise portions of CWA concerning industrial toxic pollutant discharges (42). EPA would be granted new authority to incorporate source reduction practices, including changes in production processes, in its guidelines. Also, EPA would be required to develop a list of target pollutants, discharge of which would be prohibited within 5 years; and to identify not less than 20 pollutants that, if discharges were reduced, would benefit human health or the environment.⁵

⁵The House Committee on Public Works and Transportation listed 65 toxic pollutants or combinations of pollutants (including copper, lead, and zinc, and their compounds) pursuant to CWA legislation in 1977.

EPA's Toxics Release Inventory presently has reporting requirements for more than 300 toxic chemicals (including aluminum, copper, lead, and zinc, and their compounds).

EPA's current 33/50 Program has identified 17 priority chemicals (including lead and its compounds).

Other legislation and regulations may have a somewhat narrower focus, i.e., specifically targeting only recycling activities, or even individual sectors of the metal industries.

Numerous regulations impact the recycling of metals, but the two major regimes that have the most bearing on secondary metals recovery and reuse, and as a consequence are the subject of intense scrutiny and debate, stem from the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its amendments (SARA). Another area of concern is the prospect of further constraints on recycling arising from international agreements, in particular the Basel Convention.

Analysis of the ramifications of RCRA, CERCLA, and Basel follows next. The commodity-specific aspects of these and selected other regulations and legislation (principally at the Federal level) are discussed in subsequent sections that cover the individual major metals.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) (17, 43-53)

RCRA was passed in 1976, amending and completely revising the Solid Waste Disposal Act (SWDA). Its objectives are "...to promote the protection of health and the environment, and to conserve valuable material and energy resources." This would be accomplished by "...improved solid waste management techniques, new and improved methods of collection, separation, and recovery of solid waste, and the environmentally safe disposal of nonrecoverable residues," and "...minimizing the generation and land disposal of hazardous waste by encouraging process substitution, materials recovery, recycling and reuse, and treatment." State programs are based on Federal regulations and/or guidelines promulgated by EPA. Solid wastes are regulated under RCRA according to Subtitle C, which concerns hazardous waste, and Subtitle D, which covers nonhazardous solid waste.

Subtitle C required EPA to develop criteria for identifying the characteristics of, and for listing, particular hazardous wastes; and to establish standards applicable to generators and transporters of hazardous waste and to owners and operators of hazardous waste treatment, storage, and disposal facilities. "Characteristic" hazardous wastes are designated as such because they exhibit ignitability, corrosivity, reactivity, or toxicity. Lead is one of the materials for which toxicity levels have been established. "Listed" hazardous wastes are materials from certain nonspecific or specific sources, or discarded commercial chemical products. Included among the listed wastes from specific sources are EAF steelmaking dust

and secondary lead smelter emission-control dust/sludge. A "hazardous waste" is subject to substantial regulatory requirements, the impacts of which are reflected in higher costs associated with shipping, treatment, storage, and disposal.

Subtitle D calls for EPA to assist in developing and encouraging environmentally sound solid waste disposal methods that "...maximize the utilization of valuable resources including energy and materials which are recoverable from solid waste..." Specifically, among the minimum requirements for Federal approval of any solid waste management plan is that the State consider the use of resource recovery. Further, States with approved solid waste management plans can receive Federal grants to assist with the establishment of State or local recycling programs.

A metal recycling furnace itself is not regulated under RCRA so long as its operations are limited solely to metal recovery. Yet, if other waste materials are introduced into the furnace for their energy value, the process comes under Boiler and Industrial Furnace (BIF) regulations.

Mixture and Derived-From Rules

A major point of controversy within RCRA has been the "mixture" and "derived-from" rules, which were created in 1980 to prevent dilution of hazardous wastes and sham recycling (waste treatment practices that claim to be recycling). Basically, these rules mandated that any waste resulting from mixing a hazardous waste with any other solid waste, or any waste resulting from the treatment, storage, or disposal of a hazardous waste, was also a hazardous waste. The rules govern wastes that are to be disposed of, or used in a manner constituting disposal, or burned for their energy content.

In effect, these rules incorporated nonhazardous wastes into the hazardous waste regulatory program. Thus, facilities were at risk of incurring greater RCRA compliance costs, a significant disincentive to utilizing the resource potential that may be contained in any of the hazardous waste materials.

The courts vacated these rules in 1991. Nevertheless, EPA subsequently reinstated the unmodified rules as "interim final" rules. Also, most States had properly promulgated the rules in their authorized State hazardous waste programs.

EPA then proposed the Hazardous Waste Identification Rule (HWIR) offering two alternatives for removing low-risk wastes from RCRA Subtitle C regulation. One option, the Concentration-Based Exemption Criteria (CBEC), would have established requisite concentration levels of hazardous constituents. The other, the Expanded Characteristic Option (ECHO), would have replaced

hazardous waste listings with an expanded toxicity characteristic (TC) regulation. Neither alternative proved acceptable to both industry and the environmental community, so HWIR was abandoned. Subsequently, EPA brought together a task force of all interested parties for a series of discussions on the issue.

Applying Subtitle C regulations to low-risk materials generated in the course of a hazardous waste recycling process constitutes a major barrier to resource recovery.

Land Disposal and Storage Regulations

The Hazardous and Solid Waste Amendments (HSWA) to RCRA, enacted in November 1984, prohibit the land disposal of untreated hazardous wastes.⁶ HSWA requires EPA to set "...levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimized." Thus, treatment standards require that either the concentration of a hazardous constituent (or treatment residual) not exceed a prescribed level, or that a specified treatment technology be used, prior to disposal. Wastes subject to land disposal restrictions include EAF dust, secondary lead smelter dust/sludge, and characteristic lead wastes.

Land disposal is defined in HSWA to include "waste piles." Therefore, restricted hazardous wastes must be held in an approved structure (such as a "containment building"), which must be designed with costly emissions detection and control safeguards (effective May 8, 1994). Individual States differ over the necessity of a storage permit for recycling facilities. However, should a permit for storage of hazardous waste be required, additional regulations concerning comprehensive waste management and bonding provisions for closure ensue.

Definition of Solid Waste

HSWA contain provisions to restrict illegitimate or environmentally unsound recycling practices. Also, EPA was directed by Congress "...to examine the entire range of hazardous waste use, reuse, recycling, and reclamation activities in order to choose which should be regulated as necessary to protect human health and the environment." Concurrently, EPA put forth a rationale for imposing stricter controls on recycling by stating (in the preamble to

the proposed final rule on the definition of "solid waste") that wastes destined for recycling could endanger human health and the environment if managed improperly. Thus, EPA interpreted the term "solid waste" to include recyclable materials.

Indeed, the salient point of the recent debate concerning the reauthorization of RCRA has been the fact that, under RCRA, recyclable materials are generally viewed as "waste;" i.e., the current law equates recycling with disposal. Essentially, EPA regulates recycling as a waste management process, because "any discarded material" is a "solid waste."

By its own admission, EPA finds the current definition of solid waste "problematic" (51). EPA points out that solid waste is defined in the statute such that discard, not risk, is the basis for current regulations; recycling processes and recyclable materials are not specifically addressed; and EPA and the courts must implement operationally difficult statutory language. The circumstances have become so complex that the overall regulatory scheme has been characterized as "convoluted" (51). A recent RCRA Implementation Study (52) recommended that the definitions of solid and hazardous waste should be simplified, and should be changed to conform more closely to actual environmental risks and to reduce barriers to recycling. Therefore, it is safe to say that a great deal of uncertainty exists in the application of solid waste regulations to recyclable materials.

Although RCRA reauthorization was not accomplished in the 102d Congress, both the House and Senate bills had been amended to modify the meaning of the term "disposal," as defined in RCRA, so as to better accommodate recycling. EPA could then be tasked with promulgating regulations specifically tailored to recycling activities, in effect establishing a distinct regulatory regime.

Resolution of the problematic statutory language of RCRA in favor of recycling is key to a more favorable interpretation of Superfund liability as well, because CERCLA defers to SWDA (RCRA) for definitions of "disposal," "hazardous waste," and "treatment."

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA/"SUPERFUND") (2, 6, 48, 54-56)

Superfund was established "to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment, and the cleanup of inactive hazardous waste disposal sites." The debate over reauthorization of CERCLA is crucial because there are certain aspects pertaining to liability that are very troublesome for metal recyclers.

⁶EPA was required to evaluate at least one-third of wastes by August 8, 1988; at least two-thirds by June 8, 1989; and the "third third" wastes by May 8, 1990.

Potentially Responsible Parties

Superfund contains a provision that "potentially responsible parties" can be held liable for the cost of a Superfund site cleanup. Such parties include present and past owners or operators of the site; transporters of materials to the site; and generators who arranged, either directly with an owner/operator or indirectly with a transporter, for substances to be treated, or disposed of, at the site.

Strict, and Joint and Several Liability

Further, Superfund liability is "strict, and joint and several." Strict liability is liability without demonstrating fault. It need only be shown that some of a generator's hazardous materials came to be located at the site. Whether intentional or inadvertent negligence was involved, or whether there was knowledge that any actions were improper is irrelevant. For example, anyone who ships spent lead-acid batteries to a breaker/secondary smelter that handles them carelessly, could ultimately be held liable for cleanup costs. Also, Superfund places no time limit on liability. Therefore, liability extends to those tied to prior materials recycling or disposal activities conducted in ways that may have been entirely acceptable at the time they were performed, but are no longer in keeping with current environmental standards.

Joint and several liability means that responsible parties at a site can all be held liable together, or any one may be held liable alone for more than its share—up to the entire cost—of cleanup.

BASEL CONVENTION (57-60)

The Basel Convention is an international agreement dealing with the export and import of hazardous wastes. Negotiated over a period of 18 months, and completed at Basel, Switzerland, on March 22, 1989, the Basel Convention was signed by the United States on March 22, 1990. The Convention entered into force on May 5, 1992, 90 days after ratification by a total of 20 nations. As of September 1993, 46 nations had officially ratified the Basel Convention. Although the U.S. Senate ratified the Basel Convention on August 11, 1992, the Department of State is not delivering the instrument of ratification to the United Nations until implementing legislation, necessary for the United States to adhere to the Basel Convention, is passed by Congress. In July 1993, the Administration began an interagency process, led by EPA, of drafting new Basel-implementing legislation.

Provisions

The Basel Convention requires notification to, and written consent from, the government of a nation receiving hazardous wastes, as well as any transshipment nation, prior to shipment. It requires that governments prohibit exports of hazardous wastes if they have reason to believe that they will not be managed in an environmentally sound manner. U.S. regulations already require similar notice and consent from countries to which hazardous wastes are being exported. However, the concept of hazardous waste is far more inclusive in the context of Basel, compared with current practice in the United States, because some countries consider scrap metal to be a hazardous waste. Thus, Basel will impact currently recycled materials heretofore not subject to control. Traditionally, recyclables have been exported for reclamation and recovery, and the current level of major metal scrap exports by the United States exceeds \$1.7 billion (table 3). Also, trade in wastes between countries that have ratified the Convention and those that have not is prohibited. Other agreements entered into prior to May 5, 1992, remain in effect as long as those agreements "do not derogate from" environmentally sound management.

Previous Agreements

The United States already has bilateral agreements with Canada and with Mexico, and is a party to the Organization for Economic Cooperation and Development (OECD) Council Decision, approved March 30, 1992, which is binding on all parties that endorsed it at the OECD Council, and does not require U.S. Senate consent.

The OECD Council Decision applies to all wastes destined for recovery operations, and established a three-tier control scheme: green, amber, and red. The green list of wastes includes: metal and metal-alloy waste in metallic, nondispersible form; hard zinc spelter and zinc drosses; aluminum skimmings; slags from precious metal and copper refining; ironmaking and steelmaking slag; and slag from copper production. Green tier controls are simply the existing controls normally applied in commercial transactions. The amber list of wastes includes: dross, scale, ash, residue, skimmings, dust, sludge, and cake from metals production; lead-acid batteries; zinc slags; and galvanic sludges. Amber tier controls require a valid written contract, financial guarantees, tacit consent (30 days after notice) or written consent, and written pre-approval of specific recovery facilities. The red list of wastes includes lead anti-knock compound sludges. Red tier controls consist of a valid written contract, financial guarantees, and written acceptance from competent authority.

Further Deliberations

The first meeting of the Conference of the Parties (COP) to the Basel Convention was held November 30-December 4, 1992, in Uruguay. A discussion of basic implementation issues of the Basel Convention was superseded by a proposal calling for a ban on waste shipments (including recyclables) from OECD countries to developing countries. A compromise was negotiated in which the Conference "requested" that industrialized countries prohibit transboundary shipments of hazardous wastes for disposal to developing countries, and "requested" that

developing countries take steps to ban such imports. Waste shipments to developing countries for recycling and recovery would continue until a Technical Working Group studied the issue and made recommendations to the second meeting of the COP. This group was also tasked to undertake an analysis of the differing views and approaches regarding the identification of hazardous wastes that are recyclable materials, and to develop control procedures necessary to ensure safe management of recyclable wastes, including protocols on liability and compensation. The findings will be reported at the second meeting of the COP, scheduled for March 1994.

THE MAJOR METAL INDUSTRIES

IRON AND STEEL

Demand (61-64)

Consumption of steel in the United States has declined by about one-fourth from the record level set in 1973, as manufacturers have modified design and manufacturing techniques, and have moved to higher strength steels and substitute materials. All three leading end-use sectors—construction, transportation, and machinery—have experienced declines (fig. 1). The greatest reduction has been in transportation, because the need to produce more energy-efficient vehicles has resulted in smaller vehicle size and increased substitution with aluminum and plastics. By the 1980's, construction had replaced transportation as the principal end-use sector of steel. The declining demand overall, along with increased competition from imports, has caused domestic steel production to drop by an even greater extent over the same period. Nevertheless, imports of steel and steel products (e.g., automobiles) do represent an eventual domestic resource of old scrap for the U.S. steel industry.

Industry Structure (10, 61-64)

The U.S. iron and steel industry is made up of companies that produce steel mill products and iron and steel castings. Steel mills cast relatively simple steel shapes that are formed into finished products such as sheet, bar, or structural shapes. Steel mills can be integrated mills, which produce pig iron from ore and refine the pig iron, along with some scrap, into steel; or nonintegrated mills (minimills and specialty mills), which use scrap almost exclusively as their raw material. Foundries pour molten iron or steel into molds to produce castings that approximate the shapes of the final products.

Recycling (3-4, 6-7, 9-10, 18-19, 61-70)

Steel is the most widely used metal alloy, and is the Nation's most recycled material. In 1992, the quantity of iron and steel recycled in the United States from purchased scrap nearly equaled that of all other materials (nonferrous metals, paper, glass, and plastics) combined (fig. 2). Exports of ferrous scrap for recycling are also impressive

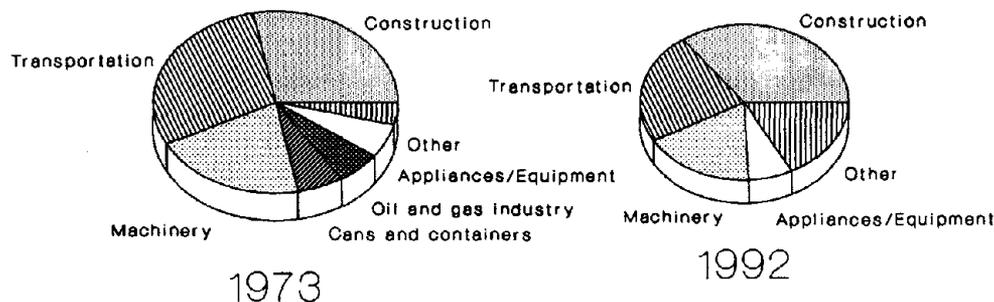


Figure 1.—Consumption of iron and steel, by end use.

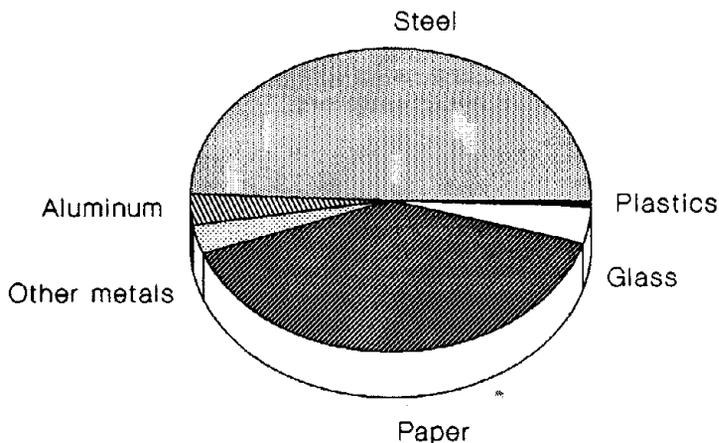


Figure 2.—Materials recycled from purchased scrap in 1992.

(table 3). The enormity of the domestic steel market, and the advantage afforded by magnetic separation, enable ferrous scrap to be collected and processed on a broad scale, encompassing about 5,000 establishments. Steel is completely recyclable and is an extremely versatile raw material for making other steel products. Nevertheless, the product ultimately dictates the appropriate level of residual elements, so the makeup of the scrap charge is determined accordingly.

The evolution of steelmaking technology in the United States has had a major impact on the utilization of ferrous scrap. The Bessemer process, which could accommodate only about 10% scrap, was overtaken by open hearth steelmaking in the early 1900's. The open hearth process had the capability to use 50% or more scrap. In the 1950's,

the basic oxygen process changed steelmaking technology again. The BOF uses a smaller percentage (at best, less than 30%) of scrap iron and steel per "heat" (71). However, the subsequent rise in EAF steelmaking, a process that can use virtually 100% scrap as a starting material (depending on the availability of suitable scrap), has offset the lesser use of scrap in BOF's (fig. 3).

Steel production accounts for about three-fourths of domestic ferrous scrap consumption; the ferrous castings industry consumes about one-fourth of the total. Relatively small quantities of scrap are used for producing ferroalloys, for the precipitation of copper, and by the chemical industry.

Production of steel mill products and ferrous castings creates home scrap. In a BOF plant, the quantity of home

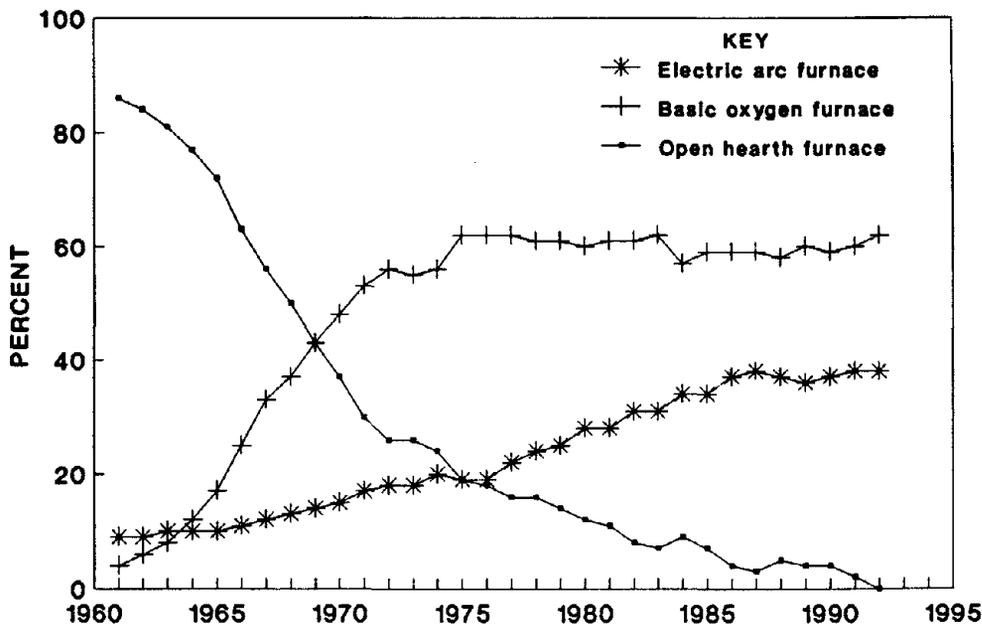


Figure 3.—Steel production, by type of furnace.

scrap generated is such that little purchased scrap is needed; at most, about 14% of a BOF charge would consist of purchased scrap (71). Iron and steel foundries typically require up to 30%-40% purchased scrap. EAF steelmaking, on the other hand, uses a quantity of purchased scrap approximately equal to the weight of product leaving the plant.

Shipments from domestic nonintegrated steel mills have grown from a 10%-15% share of finished product output in the 1960's to nearly 40% of the present total. Minimills initially were limited to making bars, wire rod, or light structural shapes, but now they produce a wide range of products. In addition to this increased reliance on EAF's, steel producers have expanded their utilization of continuous casting (fig. 4), a process that achieves much higher product yields than ingot casting. Both of these developments have necessitated a greater dependence on purchased scrap, especially old scrap. Whereas home scrap represented about 60% of the total ferrous scrap consumed by U.S. steel mills in 1970, that share had been more than halved by 1990 (fig. 5). This trend should continue because it is expected that EAF's will account for about 50% of new steel production by the year 2000.

Although traditional sources of old ferrous scrap—automobiles, demolished structures, railroads, large appliances, machinery, etc.—have continued to provide a significant share of ferrous scrap supply over the years, steelmakers have been exploring other sources of steel scrap. Notably, demand for steel products recovered from MSW is increasing. The post-consumer steel portion of MSW is generally estimated at approximately 5%-10% (exclusive of large steel items such as automobiles and building construction materials).

In most communities, 2%-4% of MSW by weight will consist of steel cans. Curbside collection is a major source of post-consumer steel cans. Steel cans account for more than 90% of the food can market, and more than 100 million steel cans are used in the United States every day. Every steel food and beverage can is recyclable by the steel industry, including bimetal cans—those with steel bodies and aluminum ends. Aluminum actually benefits the steel recycling process by supplying additional energy. General line steel cans (e.g., paint and aerosol cans) are recyclable also.

Thus far, however, steel cans are being recycled at a much lower rate than aluminum cans. Nevertheless, there has been steady improvement. From 1988 through 1992, the annual steel can recycling rate improved from 15% to 41% (fig. 6), reflecting the broadened scope of many recycling programs as well as the steady growth of curbside collection programs throughout the United States. The disaggregated recycling rates in 1992 were 50% for steel beverage cans, 44% for food cans, and 15% for general line cans.

Steel food and beverage cans are coated with tin to safeguard their contents (hence, the term "tin can"). Steel-making processes can accommodate modest levels of tin, so, to a limited extent, tinned steel cans may be included directly in the scrap feedstock. Where tin-free scrap is preferred or required, steel cans may still be utilized after processing at certain detinning plants to remove the layer of tin. About 11% of the steel cans collected are detinned (72).

In addition to cans, scrap consumers continue to investigate other sources of iron units as well. An EAF steel producer located in California has pioneered the use of

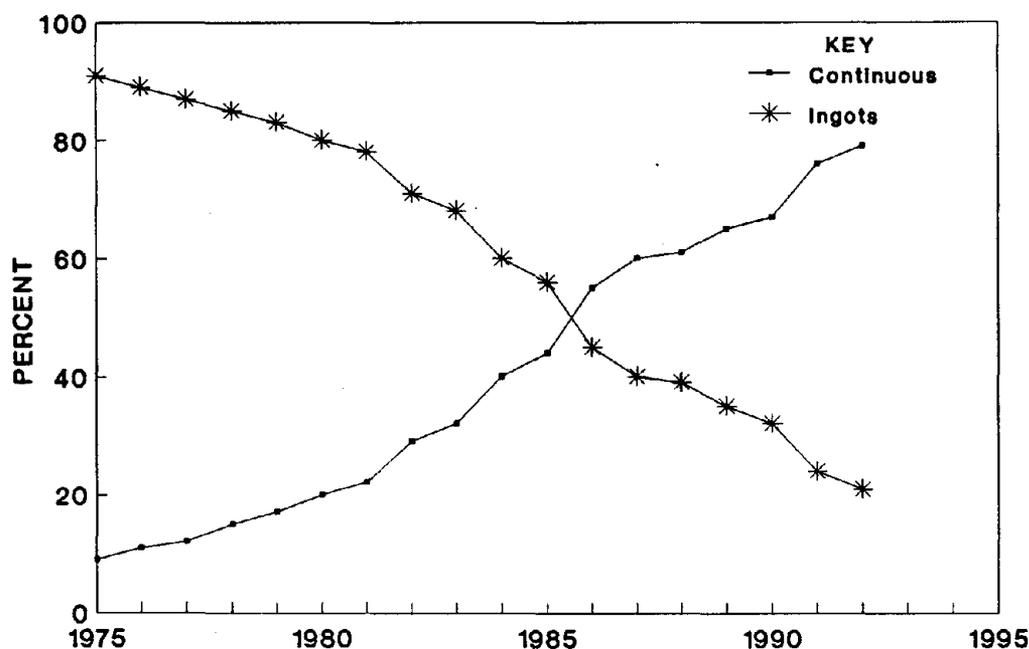


Figure 4.—Steel production, by type cast.

used oil filters and steel belts from wornout tires as novel forms of ferrous scrap. The company is also considering the possibility of utilizing spent household batteries that have steel casings (i.e., alkaline and nickel-cadmium cells), at such a time when mercury-free formulations are standard (73-74). EAF steel producers' familiarity with utilizing or capturing elements such as nickel, cadmium, and zinc would indicate that this may be a beneficial way of dealing with the household battery disposal problem.

Regulations and Legislation

EAF Dust Treatment (75-77)⁷

When scrap is melted in an EAF, some of the nonferrous metal additives, such as zinc, lead, and cadmium, are captured in a baghouse as constituents of EAF dust.

⁷See also the Zinc section of this report.

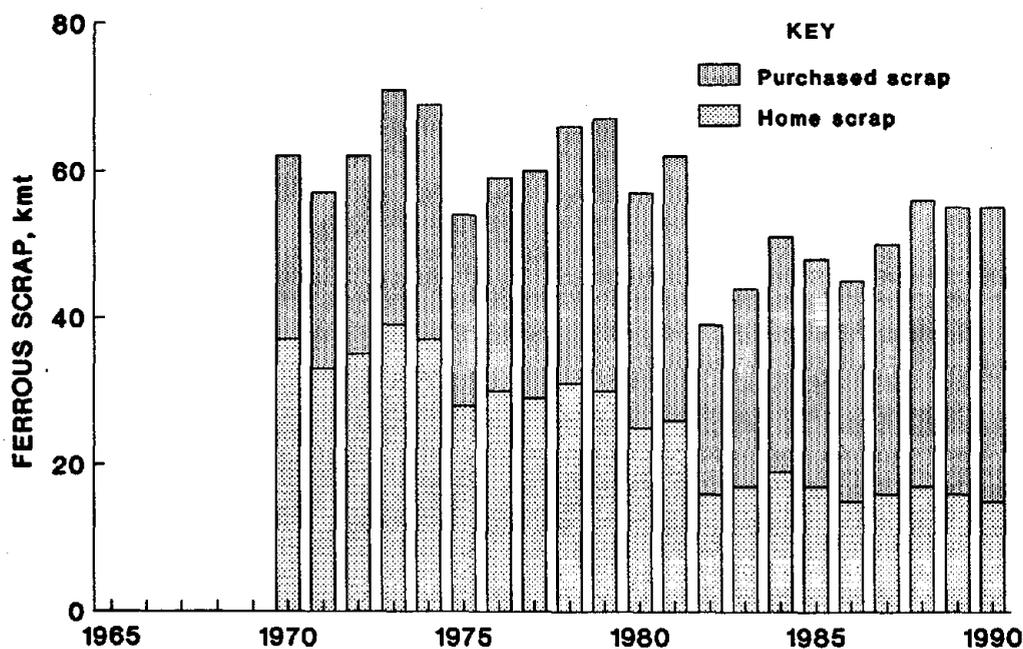


Figure 5.—Consumption of home and purchased ferrous scrap.

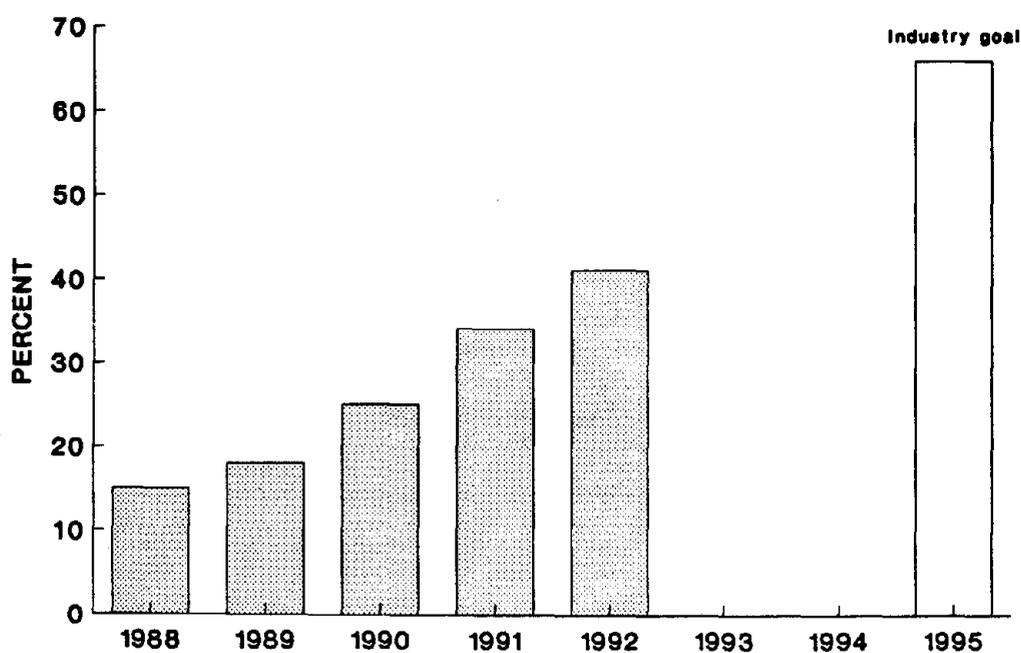


Figure 6.—Steel can recycling rates.

More than 500,000 mt of EAF dust is generated annually by U.S. minimills. EPA has listed EAF dust as hazardous waste (designated K061) and has issued land disposal regulations requiring that, after August 8, 1991, dust containing 15% or more zinc be processed using high-temperature metals recovery (HTMR), which was determined to be the best demonstrated available technology (BDAT). Dust with less than 15% zinc was required to be treated via either HTMR or a stabilization process before disposal.

The cost of dealing with EAF dust has risen dramatically as a result of the hazardous waste listing and the subsequent land disposal restrictions. Almost all of the domestic capacity to handle K061 is at a few offsite locations, and generators must pay to have their dust transported and treated. Contributing to the high cost of dust treatment is regulation of the recycled products under the current "derived-from" rule, whereby, despite certain exemptions granted by EPA, marketing of "hazardous" HTMR slag, whose uses include road base and cement aggregate, is proving to be difficult.

EAF Dust Exports (76-77)

EPA and the Government of Mexico permit several U.S. steelmakers to export EAF dust for treatment at a facility in Mexico. Mexican law provides that wastes may be imported for recycling purposes, but importing wastes for land disposal is prohibited. The plant reportedly is in full compliance with Mexico's environmental regulations. However, in the United States support has been evident for legislation requiring foreign facilities to adhere to RCRA standards, including certain financial assurance and liability provisions. Imposing such an obligation in this instance could effectively eliminate a convenient and cost-effective EAF-dust-treatment option for some domestic steelmakers.

Household Batteries (78)

EPA's proposed "special collection system," which would ease RCRA Subtitle C regulations for collecting and handling common post-consumer hazardous wastes ("universal" wastes), could make more used household batteries available for recycling.

Air Quality (32)

NESHAP are scheduled to be promulgated for EAF steel manufacturing in November 1997; and for integrated iron and steel manufacturing, and iron and steel foundries in November 2000.

Shredder Residue (31, 41, 79-82)

The proliferation of scrap shredders over the past 30 years has been a major factor in maximizing the

utilization of discarded automobiles and large appliances as steelmaking feedstock. However, concern about the disposal of shredder residue ("fluff") generated at metal salvage and recycling facilities prompted EPA to conduct a seven-site pilot study in 1991 on the hazardous material content of fluff. Three separate material categories were evaluated—automobiles only, appliances ("white goods") only, and mixed input. PCB's were found in all, and lead and cadmium in most, of the fluff samples. Also, virtually all of the PCB content of the original scrap appears in the fluff. Yet the findings suggest that only lead seems likely to leach from the fluff at higher than acceptable levels.

Subsequently, "metal shredding (recycling)" was included on EPA's preliminary draft list of categories of sources that emit hazardous air pollutants, which was a precursor to the possible development of a NESHAP under the 1990 CAAA. However, ferrous scrap processors were able to dissuade EPA from pursuing NESHAP regulation of metal shredding; it was not on the revised list of categories of sources that EPA published in July 1992.

Shredding operations have also been forced to contend with increasing regulatory pressure regarding the removal of PCB's and chlorofluorocarbons (CFC's) from scrapped appliances.

Steel Can Recycling (72, 83)

The steel industry holds that so-called "rates and dates" legislation⁸ mandating specific recycling goals is not essential to accomplish higher levels of steel can recycling. There is particular concern about requirements for "recycled content," especially because BOF products are inherently limited to less than 30% scrap feedstock. As noted previously, the availability of home scrap is diminishing, so the industry is actively engaged in helping to facilitate and sustain the inclusion of steel cans in community recycling programs.

ALUMINUM

Demand (84-85)

There has been remarkable growth in domestic aluminum consumption over the years (fig. 7), to the point where it is exceeded only by iron. The packaging, transportation, construction, and electrical sectors have come to rely on aluminum for its high strength-to-weight ratio, corrosion resistance, and conductivity. By 1980, packaging had surpassed the other major end-use categories as the principal domestic end use for aluminum. This is attributable mostly to the phenomenal success of the aluminum beverage can, a development that has dramatically influenced aluminum recycling as well.

⁸See also the Aluminum section of this report.

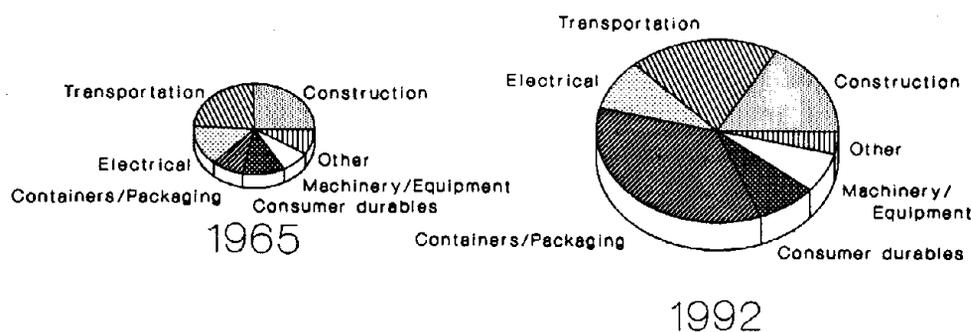


Figure 7.—Consumption of aluminum, by end use.

Industry Structure (11, 84-86)

Integrated aluminum companies and secondary smelters are the major consumers of scrap. Aluminum scrap is also utilized by nearly every other segment of the domestic aluminum industry as well, including independent mill fabricators, foundries, and chemical producers.

Secondary aluminum smelters use scrap to produce alloys for the diecasting industry, which in turn supplies the automobile and appliance manufacturing sectors. Secondary smelters also produce deoxidizers for the steel industry.

Integrated aluminum producers use both primary raw materials (alumina derived from bauxite) and scrap to make aluminum ingots and sheets. Integrated producers tend to be more selective than the secondary smelters with regard to the types of scrap they process, with used beverage cans (UBC's) being the predominant source. These companies maintain UBC recycling programs, and either operate their own can recycling plants or have the cans toll smelted at independent recycling plants. The bulk of the remainder of scrap processed by integrated aluminum companies is new scrap, which they frequently purchase from their industrial customers or obtain on a contract conversion basis.

Independent mill fabricators (extruders and rolling mills), foundries, and others often supplement their primary ingot supplies with scrap similar to the grades used by the integrated aluminum companies.

Recycling (8, 11, 20, 66, 84-91)

The emergence of secondary aluminum recovery occurred just prior to World War I, as aluminum scrap became more abundant. However, it was not until World War II that aluminum recycling exhibited truly dramatic growth, based to a great extent on the need to process aircraft scrap for the war effort. Today, various types of aluminum scrap are utilized by virtually all segments of the industry.

The quantity of aluminum recovered from scrap has increased by an order of magnitude since 1950 (fig. 8). Recovery from old scrap has been especially remarkable, rising from a mere 69,000 mt in 1950 to more than 1.6 million mt in 1992. This is equivalent to about 28% of apparent consumption (fig. 9), as opposed to being about 8% of metal demand in 1950. Aluminum recovery from old scrap surpassed that from new scrap for the first time in 1990; in 1992, 58% of secondary aluminum was from old scrap.

New scrap (borings and turnings from aluminum fabrication and manufacturing, and residues, skimmings, and drosses from aluminum metal production) is recycled rapidly, but the recycle time for old scrap varies considerably depending on its form and end use. Aluminum products used in the construction, transportation, and electrical sectors usually have a considerable lifespan (10 to 30 years) before they become scrap. However, UBC's may return to the production stream in just a few weeks or months after their manufacture.

The present UBC recycling system is the outgrowth of an experiment started by Reynolds Metals Co. in Miami in 1967, whereby people were urged to donate used aluminum cans to a charitable organization which in turn sold them to Reynolds. The limited success of this program led to a different approach—in March 1968, in Los Angeles, a permanent recycling facility was established by Reynolds, offering cash payment to any individual or organization for aluminum cans or other clean household aluminum. Aluminum Co. of America (Alcoa) instituted recycling programs in California and Texas in 1970.

The buyback concept was the key to developing an economically feasible consumer-oriented business. Today, the consumer system consists of about 10,000 aluminum can buyback centers nationwide, and includes company-operated sites, automated "reverse vending" machines, and independent and contract recyclers. Public endorsement of this system is evidenced by the fact that about 80% of the aluminum UBC's that are recycled pass through buyback operations, whereas around 15% result from deposit

laws, and the remaining 5% come from curbside programs. Thus, the recognized value of aluminum UBC scrap and the availability of a widespread collection network both encourage and facilitate recycling.

The value of the recoverable aluminum makes it of special interest in determining the economic feasibility of MSW processing systems. Reportedly, aluminum generates 40%-70% of the revenue, despite representing only

3%-6% of the volume, and 1%-2% of the weight, of the recyclable material collected.

In 1968, Reynolds' total was 1 million lb of cans. In 1972, the first year nationwide data were kept, 1.2 billion cans were recycled, which represented about 15% of aluminum beverage cans shipped. By 1984, the recycling rate had grown to 53%, and in 1992 almost 68% of aluminum UBC's were recycled, totaling nearly 63 billion

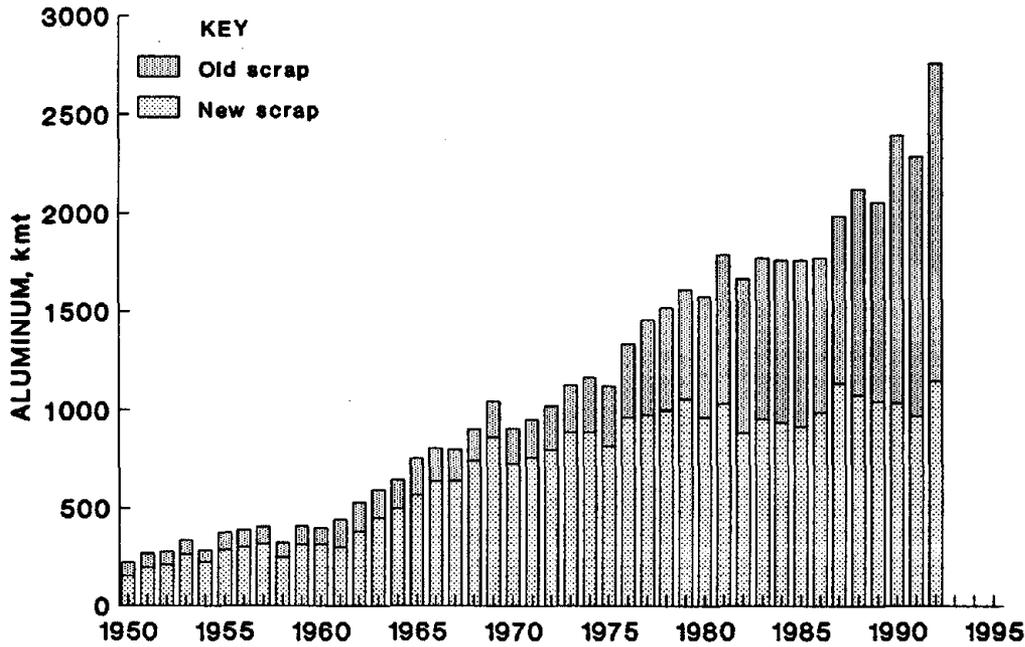


Figure 8.—Consumption of purchased new and old aluminum scrap.

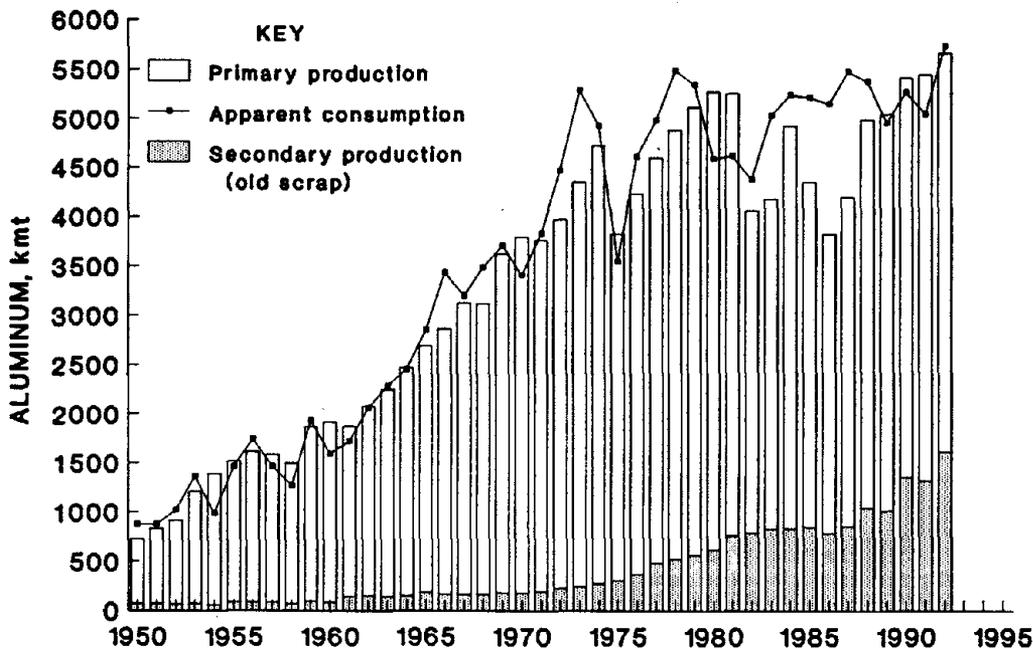


Figure 9.—Primary and secondary aluminum production as a share of apparent consumption.

cans. It marked the 21st consecutive year that the number of recycled aluminum beverage cans increased, and was the 4th consecutive year that the recycling rate for aluminum beverage cans in the United States exceeded 60% (fig. 10).

UBC's have been the largest single source of old aluminum scrap beginning in 1981, and accounted for 60% of the total old scrap consumed in 1992 (fig. 11). Nevertheless, many other common products are recycled also—automotive engine and body parts (currently approaching 200 lb/car on the average) (92), wire and cable, residential siding, storm door and window frames, lawn-chair tubing, appliances, cooking utensils, formed containers, and foil wrap.

The industry has begun actively promoting increased recycling of formed aluminum containers (those used for frozen food trays, bakery items, deli trays, etc.) and household foil. In 1991, the buyback and processing centers affiliated with Alcoa began accepting clean, dry, and separated containers. In addition, Alcoa initiated two pilot curbside programs. Also in 1991, Reynolds began a collection program, including school participation, in five test market areas; this was expanded to more than 60 metropolitan areas in 1992.

Regulations and Legislation

Packaging (92-99)

The present regulatory agenda concerning packaging is in the context of MSW. The Council of Northeastern Governors (CONEG), a regional organization that deals with solid waste issues, and includes representatives from government, industry, and the environmental community, is in the forefront of activities at the State level. CONEG has focused on eliminating the use of heavy metals in packaging, and on lessening the contribution of packaging to MSW. CONEG is endeavoring to ban lead, hexavalent chromium, mercury, and cadmium from packaging by requiring packagers to certify that their materials, including ink, are free of those metals. CONEG-developed model legislation proposes a 15% reduction (relative to 1988 levels) in the weight of solid waste by 1996, and 30% by the year 2000.

So-called "rates and dates" legislation is viewed with caution by the industry. Aluminum companies feel that it is unfair to arbitrarily mandate increased recycling rates without considering aluminum's position relative to that of other forms of packaging.

Another of the domestic aluminum industry's main legislative concerns is that governments should not mandate "flow control" restrictions on solid waste, whereby governments require that solid waste be collected and/or disposed of as they designate, thus restricting the handling

and sale of recyclable materials. The industry views flow control as undue interference in the economics and competitiveness of the marketplace, and wants to ensure that the system that it has established will not be jeopardized.

The process used to produce can sheet is very sensitive to impurities. Therefore, aluminum UBC scrap consumers are concerned about the presence of contaminants such as plastics, glass, dirt, sand, etc., which may be introduced in UBC scrap by inadequate and/or careless materials separation in MSW curbside programs. The industry would like to see these programs structured so as to minimize the contamination problem.

Processing (100-101)

Dross (a scum that forms on the surface of molten metals because of oxidation or the presence of impurities) is generated in all molten aluminum processes, including the melting of scrap. Its aluminum content (20%-80%) warrants treatment for metal recovery. However, aluminum producers are coming under increased scrutiny from regulators concerning disposal of the salt slags that result from rotary furnace processing of dross. Companies have been developing alternative methods for treating aluminum dross and for processing the slag in an effort to eliminate possible disposal problems.

Air Quality (32)

NESHAP are scheduled to be promulgated for primary and secondary aluminum production in November 1997.

COPPER

Demand (102-103)

Copper stands third, behind iron and aluminum, in terms of domestic consumption of metals. Apparent consumption of copper in the United States reached its highest level in 1979; although since 1964, annual demand has been fairly steady. Copper demand growth has been deterred because of substitution by aluminum in overhead high-voltage power transmission lines and in automobile radiators, by plastics in plumbing pipe and tubing, by fiberoptics in telecommunications, and by zinc in coinage; downsizing in the automotive industry; and the use of thinner gauge and narrower bore copper.

Since 1960, the electrical and electronic end-use sector has steadily increased its share of domestic copper consumption, so that currently it accounts for close to three-fourths of the copper used (fig. 12). Construction represents 14% of consumption, followed by machinery, and transportation, both with 5% of the total.

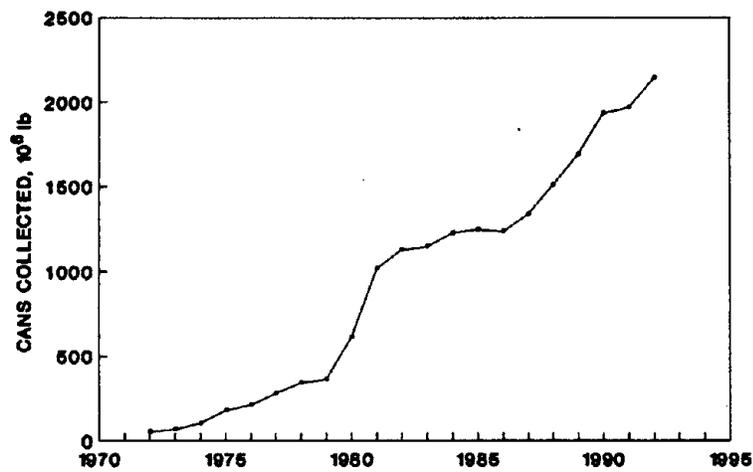
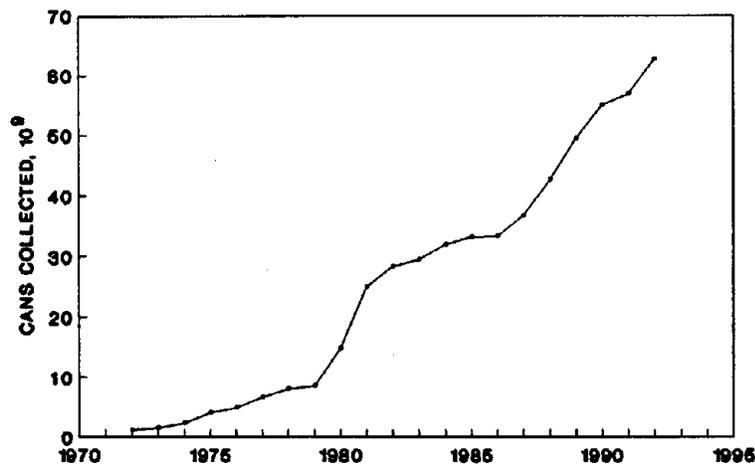
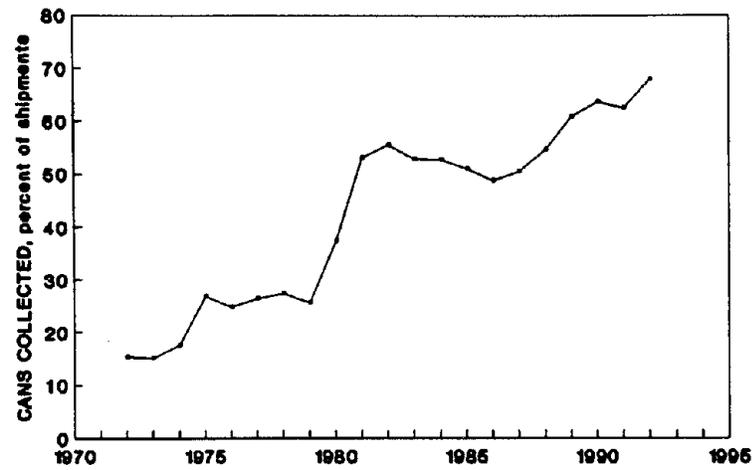


Figure 10.—Aluminum can recycling, by percent, quantity, and weight.

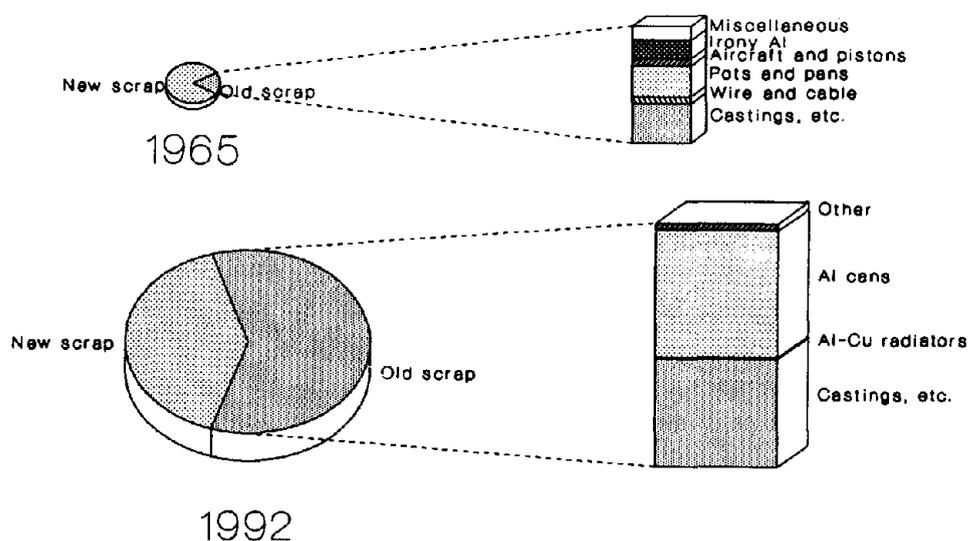


Figure 11.—Constituents of aluminum scrap, 1965 versus 1992.

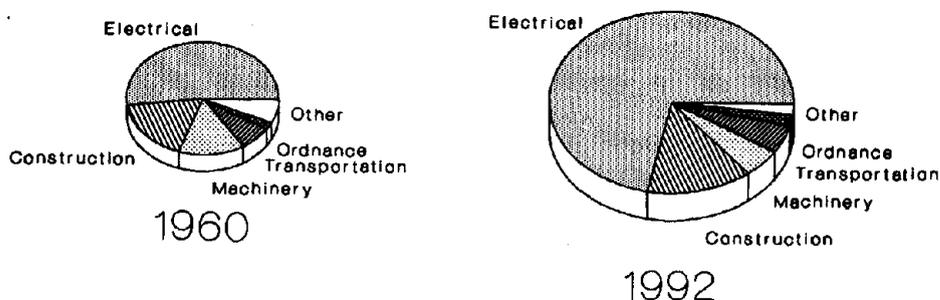


Figure 12.—Consumption of copper, by end use.

Industry Structure (12, 86, 102-103)

The classic depiction of the copper industry is that of a gigantic open pit mine whose sulfide ore is extracted, concentrated, smelted, and refined into pure copper. Primary copper is also produced by leaching and solvent extraction/electrowinning of oxide ores. Yet, as substantial as these primary sources are, a large share of U.S. copper supply is also derived from scrap. Pure copper scrap and copper alloy scrap are consumed in a wide variety of forms and grades by the various segments of the copper industry—brass, tube, and wire rod mills, secondary smelters and refineries, ingotmakers, foundries, and chemical plants.

Recycling (12, 66, 86, 88, 102-104)

Secondary copper is recovered mainly (57%) from new scrap, but a significant share (43%) is derived from old scrap as well. Copper scrap is consumed mostly by brass mills, smelters, and ingotmakers.

Although wire has become the predominant end use for copper, wire mills consume very little scrap directly. The increasing dominance of electrical applications, which require electrolytic grade copper, has led to a greater reliance on refined scrap. In 1941, only 8% of U.S. refined copper production was derived from scrap; in 1992, 20% originated from scrap.

Approximately 45% of the total copper scrap consumed (representing about half of the copper recovered) is utilized by brass mills. These facilities, together with tube mills, are the major users of No. 1 (greater than 99% Cu content) unalloyed copper scrap, cartridge cases, and yellow (30% Zn content) brass. Nearly 75% of new scrap goes to brass mills. There has been a substantial increase in the use of scrap relative to refined copper at brass mills.

Smelting and refining operations consume nearly 40% of all copper scrap (accounting for 35% of the recovered copper). Nearly 65% of old scrap is handled by secondary smelters.

Brass and bronze ingot manufacturers consume more than 10% of the total scrap consumed, including most of

the old scrap that does not go to refineries. Copper scrap is alloyed with zinc and tin, and other metals, in the form of ingots, which are usually sent to foundries.

Collectively, secondary smelters and ingotmakers process nearly all of the No. 2 unalloyed copper scrap (which requires refining before it can be consumed), automobile radiators, and red (less than 15% Zn content) brass.

Other facilities, such as foundries and chemical plants, use the remainder, which is evenly divided according to new and old scrap and according to unalloyed and alloyed scrap. Most copper chemicals and copper powders are produced from scrap.

Recovery of old scrap in the United States over the past 50 years has provided 19%-33% of annual apparent copper consumption (fig. 13). In 1992, old scrap converted to refined metal and alloys was equivalent to 24% of apparent consumption.

Regulations and Legislation

Impact of Lead Regulations⁹

EPA's lead exposure reduction strategy, plus various legislation directed at discouraging lead use, impact the manufacture and recycling of other materials as well, including many copper-bearing products that contain lead—copper alloy plumbing fittings, fixtures, and related solders, sheathing on copper cable, etc.

⁹See also the Lead section of this report.

Ingot makers and foundries that use certain lead-containing copper alloys are confronting problems related to compliance with tougher workplace exposure rules, and the possible reduction in lead content of plumbing products.

Workplace Standards (105-108)

The Occupational Safety and Health Administration (OSHA) has phased in more stringent workplace lead standards for secondary copper smelting, foundries, and brass and bronze ingot manufacture. Following several years of legal action, the regulations for foundries were implemented as a two-tiered system (based on the number of employees at the facility) to moderate the impact on small operations. Ingot makers are looking to negotiate a mutually acceptable worker exposure standard with OSHA in order to avoid the rulemaking process.

Plumbing Fittings (107-113)

Brass plumbing fittings typically have an 8% lead content, which provides improved machinability, better tolerance of fluctuations in temperature, pressure tightness and nonporosity, and corrosion resistance. These products are made out of recycled materials, predominantly automobile radiators, from which the lead originates.

The Safe Drinking Water Act (SDWA) already prohibits the use of lead pipes or lead solder in new drinking water systems, and defines "lead free" plumbing products

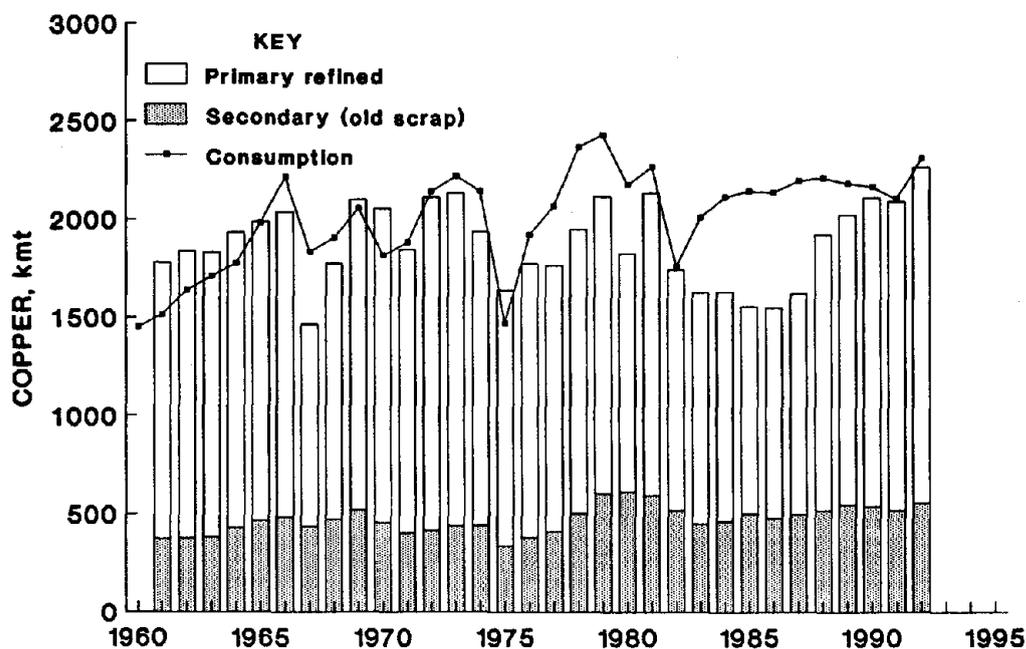


Figure 13.—Primary and secondary copper production as a share of apparent consumption.

as those having a lead content of 8% or less. Also, EPA promulgated a final rule in June 1991 establishing lead "action levels" at the tap and for the system.

Nevertheless, EPA and the Congress have been giving consideration to imposing either a performance-based standard or a prescriptive limit on the amount of lead in plumbing fittings. Also, in December 1992, lawsuits were filed against various faucet manufacturers in California State court, alleging contamination of drinking water by lead leaching from faucets. An injunction requiring faucet labeling was issued under California's toxics labeling law; further legal action seeks an injunction prohibiting the sale of faucets containing lead.

Faucet manufacturers and metals recyclers have been striving to develop a voluntary standard that will be acceptable to all concerned, while at the same time maintaining a viable recycling and manufacturing system. The industry asserts that the removal of lead from scrap is currently not feasible; that lead-free copper scrap is not readily available because of high demand for it in other markets; and that the utilization of alternative alloys would have several technical and economic drawbacks. In addition, any prescriptive standard mandating lower lead content for plumbing products would reduce recycling accordingly; for example, a 2% limit on lead content in plumbing fittings, compared with the present 8% level, would result in a 75% decline in demand for scrap radiators.

LEAD

Demand (114-115)

Apparent consumption of lead is virtually equivalent to zinc as fourth highest among the major metals, although the demand for each is only half as much as for copper. The pattern of lead consumption has changed dramatically since the 1970's (fig. 14). The incremental adoption of regulations limiting the quantity of lead in gasoline¹⁰ (once

¹⁰Levels were reduced from 1.7 g/gal in 1976 to 1.1 g/gal in 1982, to 0.5 g/gal in 1985, and finally to 0.1 g/gal in 1986.

the second largest use in the United States) virtually eliminated the domestic market for tetraethyl lead gasoline additives. The use of lead in ceramic glazes and enamel frits, in shot for hunting migratory waterfowl, in exterior house paints and other protective coatings, and some solders is declining because of the toxicity hazard. Consumption of lead in roofing, flashing, piping, and caulking also has declined. Legislation has significantly lowered the permissible lead content of any new pipe, solder, or flux used in public water systems. Thus, the manufacture of lead-acid batteries (for starting-lighting-ignition (SLI), industrial/traction, and consumer applications) has come to dominate the industry, representing about 80% of total lead demand. However, unit consumption of lead in the manufacture of automotive batteries is 3-4 lb lower than that of a decade ago, reflecting continuing technological advancements directed at reduced weight, extended life, and overall average vehicle size reduction.

Industry Structure (13, 86, 114-115)

Primary lead is mined as a coproduct of zinc or copper, and as a byproduct of zinc, fluorspar, and precious metals. A rationalization of primary capacity occurred during the 1970's because of a shift to predominantly Missouri concentrate sources, lower demand, increasing environmental costs, and falling prices. This resulted in substantially lower production of primary refined lead. Recent increases in mine production have been geared toward export markets.

Therefore, production of secondary lead has accounted for an increasingly greater share of domestic lead supply, rising from about half in 1980 to three-fourths of total production in 1992 (fig. 15). Refined lead production depends on secondary production to a greater extent than any of the other major metals.

The number of participants in all facets of the secondary lead industry—battery breakers, secondary lead smelters, refiners, and manufacturers of batteries, specialty alloys (solders), etc.—has dwindled. Yet, the dramatic

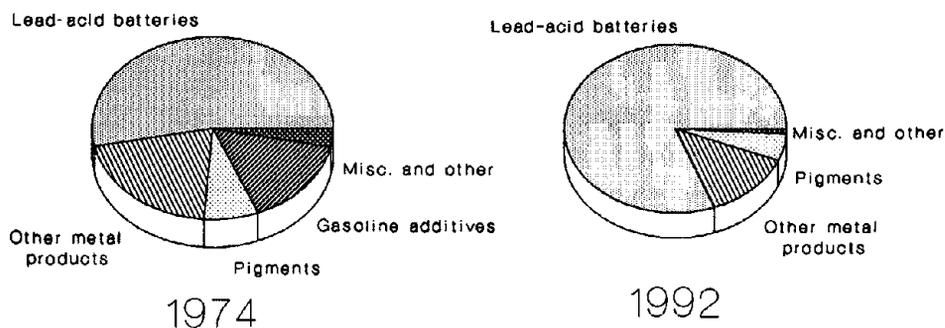


Figure 14.—Consumption of lead, by end use.

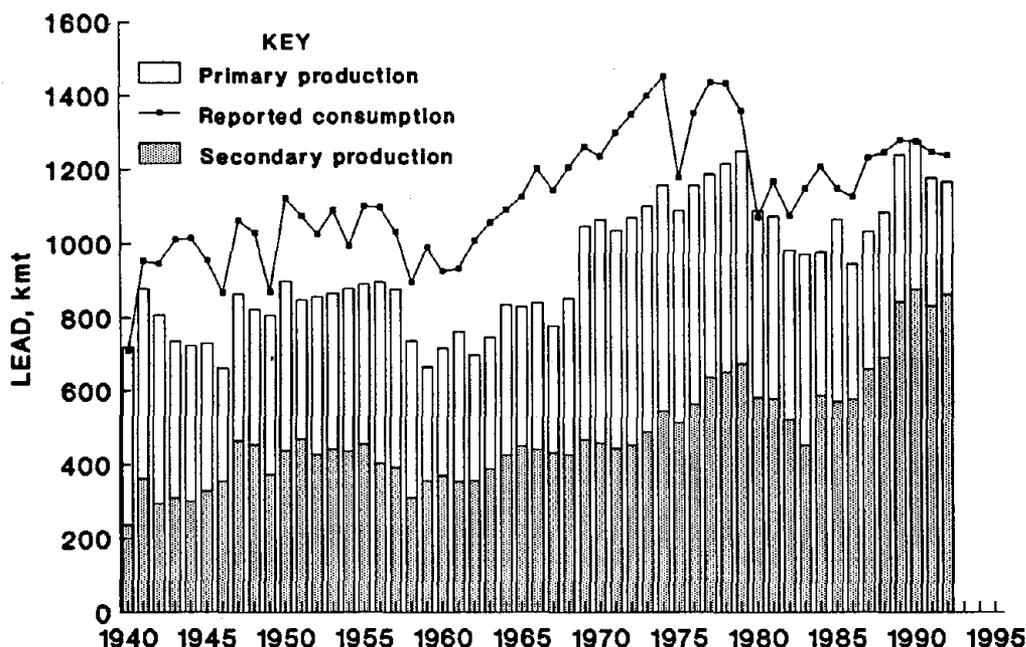


Figure 15.—Primary and secondary lead production as a share of reported consumption.

reduction in the number of facilities has resulted in only a small decrease in operating capacity, pointing up the inability of the smaller companies to cope with the rising costs associated with regulatory compliance. Meanwhile, the largest domestic secondary lead producer and the largest battery-metal integrated producer both announced plans in 1992 to build large smelter-refineries in the southeast, despite the increasing regulatory burden.

Recycling (13, 66, 86, 88, 114-118)

The lead industry has attained an enviable level of recycling, owing mostly to the fact that batteries have come to overshadow all other lead-containing products, and that an established and highly efficient network exists to recover them.

Nearly all secondary lead—about 95%—comes from old scrap, predominantly battery plates and oxides, but also products such as cable covering and solder (much of which are recovered at secondary copper smelters), pipe, sheet, and terne or bearing metals. The remainder is new scrap resulting from product manufacturing processes and from refined lead production (smelter and refinery drosses and residues, which includes flue dust, sludges, etc.) (fig. 16). Such material is smelted and refined at secondary plants to produce pure refined lead and various lead-base alloys. Most secondary lead materials are reused only after refining because of the need to meet exacting specifications.

Each year, about 80 million SLI batteries (i.e., from cars, trucks, buses, marine, golf carts, tractors, motorcycles, aircraft, etc.) plus additional motive power, stationary, and consumer batteries are available for recycling. The share of secondary lead feedstock provided by spent batteries has rapidly become larger and larger, rising from 71% of the secondary lead recovered in 1980, to 86% in 1992.

Battery recycling rates, which had slumped during the early 1980's because of shutdowns in regional capacity and low lead prices, have increased to about 97%-98% annually. Since 1985, spent battery generators and transporters, and intermediate battery storage facilities, have been exempt from the extensive array of regulations under Subtitle C, owing to recognition of the effective long-term performance of the established battery recycling system. However, the facilities engaged in reprocessing the batteries (i.e., breakers/secondary smelters) are still regulated. The long-standing battery collection and recycling system has been further enhanced by some recent developments including: mandatory scrap battery recycling and/or control laws, which have been enacted by nearly all of the States over the last several years; manufacturer-initiated scrapped battery buyback programs; and an increasing public awareness of the potential environmental impacts that could result from unrecycled batteries. Recycling of old batteries via buyback arrangements between distributors/retailers and battery manufacturers (who

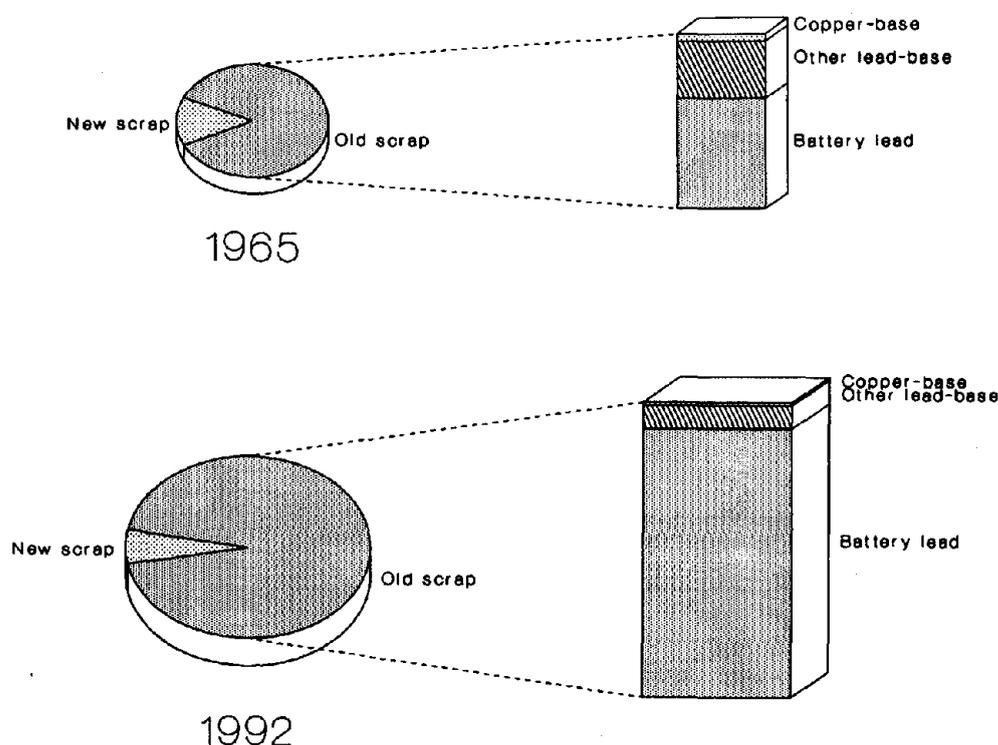


Figure 16.—Constituents of lead scrap, 1965 versus 1992.

either operate their own secondary smelters or rely on toll processing) serves to reduce the collection role of scrap dealers.

Improved battery recycling has been accompanied by the demise of leaded gasoline additives and paints, which accounted for much of the lead that was being dissipated. Thus, the overall recycling rate for lead has been enhanced substantially. Today, far less lead is being lost, and more is being recycled, compared with just a few years ago. It appears likely that there will be a further decline (both mandated and voluntary) in lead usage. If so, lead-acid batteries, and therefore secondary lead, would become even more prominent in the industry.

Regulations and Legislation

Background (119-122)

In the two decades since sulfur dioxide and lead particulate NAAQS were initially promulgated, the lead industry has been impacted by environmental and workplace regulations to a greater extent than any of the other major metals. USBM determined that the additional operating cost in 1987 for regulatory compliance in the secondary industry averaged 3.0 cents/lb refined lead. Even so, secondary lead smelters were not in full compliance with

existing regulations. That would have entailed a capital expenditure of about \$87 million, and increased operating cost by about 3.8 cents/lb.

The cost of complying with Government-imposed regulations continues to be the greatest problem confronting the domestic lead industry, as the future portends an even more stringent regulatory burden. Currently pending and proposed environmental legislation could require significant additional expenditures by the secondary lead industry with no assurance that standards will remain constant.

EPA Lead Strategy (123)

EPA has developed a strategy for lead with the goal of reducing lead exposures to the fullest extent practicable. One element is to strengthen regulations on the producing and consuming sectors of the industry that are "continuing" sources of lead. Another aspect is to develop abatement methods for "in-place" sources of lead exposure (especially paint and urban soil). Further, a long-range, multimedia pollution prevention program will identify and encourage cleaner technologies for lead production, and will employ regulatory mechanisms, such as the Toxic Substances Control Act (TSCA), and market-based incentives to reduce or eliminate lead use in current and future products. The strategy also endeavors to "...encourage the availability of

environmentally sound recycling..." but EPA acknowledges that "...activities recently completed or under consideration...may have significant impact on recycling capacity... [which] highlights the inherent conflicts [that] are possible as individual offices strive to minimize lead emissions to their particular media..."

Toxic Substances Control Act (124-125)

TSCA grants EPA the authority "...to regulate chemical substances and mixtures" should EPA find that there is "...a reasonable basis to conclude that [their] manufacture, processing, distribution in commerce, use, or disposal, or any combination of such activities, presents or will present an unreasonable risk of injury to health or the environment." EPA's approach to lead within the framework of TSCA is to prevent new uses of lead, and limit or ban current uses of lead, if they present unreasonable risks. Numerous pieces of legislation, exemplified by the Lead Exposure Reduction Act, a bill to amend TSCA, have been proposed for the purpose of minimizing society's interaction with lead by setting maximum lead-content levels for a wide variety of consumer and industrial products. Restrictions on some of these lead-containing items, such as plumbing fittings and fixtures,¹¹ could actually hinder recycling of, and the manufacturing of products from, certain nonferrous metal alloys. Other legislative and regulatory debate concerning lead has included labeling of all lead products; premanufacture notification and approval for any new lead products; comprehensive inventorying of lead products; and tightening of standards regarding paint, pesticides, packaging, cosmetics, and toys.

Lead Production Tax (126)

EPA and the Congress have been considering imposing a tax on primary lead in order to reduce consumption, generate revenues for abatement programs, and encourage recycling. A bill introduced in the 102d Congress, the Lead-Based Paint Hazard Abatement Act, proposed such a tax. An impact analysis of this policy, conducted by the Bureau, found that no significant increase in recycling would occur in the United States, and that the competitiveness of the domestic battery manufacturing industry would be weakened. A new version of this legislation, The Lead-Based Paint Hazard Abatement Trust Fund Act of 1993, was introduced in the 103d Congress, proposing a tax on all (primary and secondary) lead production.

33/50 Program (127)

U.S. lead producers, including battery manufacturers, have agreed to participate in EPA's 33/50 Program, a

voluntary effort whose goals are to reduce aggregate releases and off-site shipments of 17 high-priority toxic pollutants (including lead and its compounds) one-third by the end of 1992, and at least one-half by the end of 1995, relative to a 1988 baseline.

Lead-Acid Battery Recycling (128-129)

Spent lead-acid batteries are a characteristic hazardous waste because of their toxicity and corrosivity. Yet the regulation of lead-acid batteries is unique in comparison with other RCRA Subtitle C hazardous wastes, so as not to hinder the effectiveness of the long-established battery recycling system. In its 1985 definition of solid waste, EPA ruled that "persons who generate, transport, or collect spent batteries, or who store spent batteries but do not reclaim them [e.g., retailers, wholesalers, local service stations] are not subject to regulation..." However, "owners or operators of facilities that store spent batteries before reclaiming them [i.e., battery breakers and secondary lead smelters] are subject to [certain] requirements."

Land Disposal Restrictions (43, 45)

The secondary smelters and battery breaking operations are regulated under Subtitle C, because storage of hazardous waste in "waste piles," the standard industry practice for holding spent lead-acid batteries prior to reprocessing, is defined as "land disposal" under HSWA. Storage of old batteries in piles must be accomplished in a structure (e.g., a "containment building") having rigorous environmental safeguards (as of May 8, 1994).

"Third Third" Rule (130)

Promulgated in June 1990, the "third third" rule specifies the best demonstrated available technology (BDAT) for treating characteristic lead wastes destined for land disposal. The rule mandates that BDAT for spent lead-acid batteries is recovery of the lead in secondary smelters. This effectively renders moot the existing regulatory requirements governing battery disposal. The rule also impacts secondary lead producers with regard to the disposal of hazardous furnace slag. A smelter must be in compliance with Subtitle C if the slag is deposited in an on-site landfill, or else the slag must be transported to an approved disposal facility. The industry did gain a 2-year reprieve in the form of a less strict interim standard.

Mandated Lead-Acid Battery Recycling by the States (56)

Currently nearly all of the States have legislation in place or pending to promote lead-acid battery recycling.

¹¹See also the Copper section of this report.

Provisions include prohibiting disposal in MSW; requiring retailers to accept used batteries when new ones are purchased; requiring retailers to post notices informing consumers of State requirements; compelling battery manufacturers to accept used batteries from retailers when new ones are purchased; requiring a deposit if a spent battery is not returned when a new one is purchased; accepting used batteries even if no battery is purchased; and time limits on used battery storage.

Historically, high lead prices also stimulate the longstanding voluntary battery collection mechanism. However, the implementation of these State laws, in concert with RCRA provisions, should ensure continued high recycling rates even when lead prices slump (fig. 17).

Regulatory Negotiation (56, 131)

An advisory committee established by EPA to write a lead-acid battery recycling rule under TSCA was terminated in September 1991, after a 9-month regulatory negotiation. EPA determined that a further increase in the lead-acid battery recycling rate would not have a significant effect on lowering lead emissions and reducing the risk of lead exposure.

Air Quality (32, 56, 114)

In spring 1990, EPA estimated that the cost of bringing the 23 secondary smelters into compliance with the current

NAAQS would total \$191 million for capital costs and \$33.7 million for operating costs. Also, it was estimated that only 12 of the 23 secondary smelters would be able to comply if the NAAQS were tightened to half of the current level of emissions. EPA has undertaken comprehensive reviews of both the NAAQS, and the NSPS for secondary lead plants, which indicates that stricter standards may be forthcoming. The technology-based, industry-specific NESHAP are scheduled to be promulgated for secondary lead smelting in May 1995, and for lead-acid battery manufacturing in November 2000.

Water Quality (132-135)

Final effluent limitations under CWA, that included standards for lead and battery manufacturing plants, became effective in 1984. EPA itself estimated that these regulations could cost the secondary lead-refining and battery-manufacturing industries an additional \$28 million over 10 years in capital costs plus \$7 million annually in operating costs.

Amendments to SDWA that went into effect in 1986 limited pipes and fittings in public water systems to a lead content of 8%; strict standards for lead in solders and fluxes were established as well.

Final national primary drinking water regulations for lead were promulgated under SDWA during 1991, and became effective in 1992. The rule establishes an "action level" of 0.015 milligram/liter at the tap, which triggers

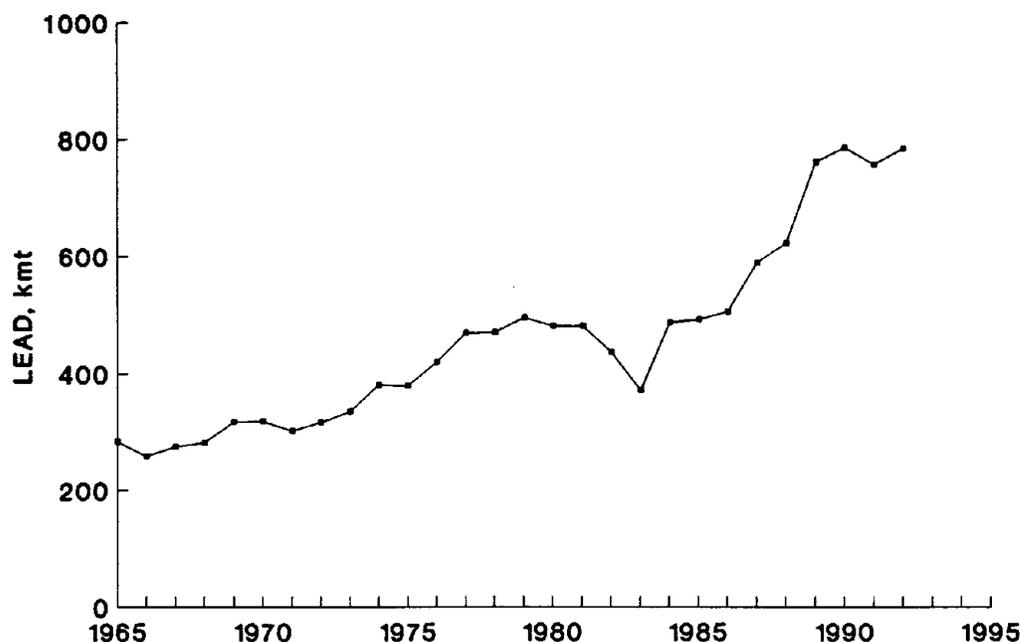


Figure 17.—Lead recycled from old battery-lead scrap.

various corrosion control, source water monitoring and treatment, service line replacement, and public education options for the water supply system. The previous "maximum contaminant level" standard was 0.050 milligram/liter in water delivered to the user.

Workplace (105-106)

OSHA established final standards in 1979 setting a permissible exposure limit (PEL) for in-plant airborne lead, and a blood-lead level that requires temporary removal of a worker pursuant to a medical removal protection (MRP) program. Final compliance, phased in over several years, was based on a combination of engineering, work practice, and other administrative controls. OSHA had originally mandated that full compliance would be accomplished solely by engineering controls, but subsequently found that approach to have been economically and/or technologically infeasible. In addition to lead production and lead-acid battery manufacture, other sectors such as secondary copper smelting, brass and bronze ingot manufacture, and nonferrous foundries were required to implement lead-reduction methods in the workplace.¹²

ZINC

Demand (136-137)

The quantity of zinc consumed in the United States is nearly the same as lead. Zinc is used as a protective coating on steel (galvanizing), in diecastings (zinc-base alloys in which aluminum and copper are the principal alloying elements), as an alloying metal with copper to make brass, and in chemical compounds for rubber and paints. Construction and transportation have long been the predominant zinc-consuming industrial sectors.

The weight of zinc die-cast components used in domestically produced automobiles is down from about 45 lb

¹²See footnote 11.

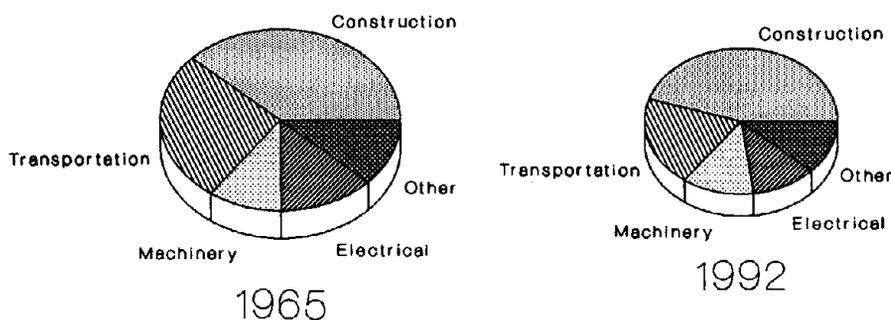


Figure 18.—Consumption of slab zinc, by end use.

per vehicle in 1976 to less than one-half that amount at present because of downsizing and weight reduction, the elimination of parts, and the development of thin-wall die-casting technology. High imports of finished goods and the restructuring of the steel industry also have had a great effect on domestic zinc consumption. As a result, despite increased use of zinc-based corrosion protection for auto-body parts, consumption of zinc has declined from the levels seen from the mid-1960's through the mid-1970's (fig. 18).

Industry Structure (14, 86, 136-137)

Primary zinc is mined as a principal product (from zinc ore), as a coproduct (with lead and/or copper), and as a byproduct (of copper or fluorspar). During the period 1968-1985, declining demand, foreign competition, plant obsolescence, environmental regulations, and low prices resulted in a dramatic retrenchment for the industry, as primary smelter capacity declined by 73%. However, unlike the structural change experienced by the lead industry, imports of refined zinc, rather than secondary production, increased to fill the void.

Secondary zinc smelters are the principal consumers of zinc scrap in the form of die-cast zinc (mostly from automobile and construction applications), and as residual materials from galvanizing operations, to produce slab zinc, zinc dust, and/or zinc oxide. Remelters and alloyers use zinc scrap and other metals for various alloy products; typically brass scrap is remelted and recast as brass ingot. Chemical plants rely on scrap as the source material for about one-half of the zinc oxide production, and most of the domestic output of zinc dust and chemicals such as zinc chloride and zinc sulfate which are produced by leaching skims, drosses, and residues with acids.

Recycling (14, 86, 88, 136-139)

New scrap is the traditional source of most secondary zinc. In 1992, it accounted for about two-thirds of the zinc recovered from scrap (fig. 19).

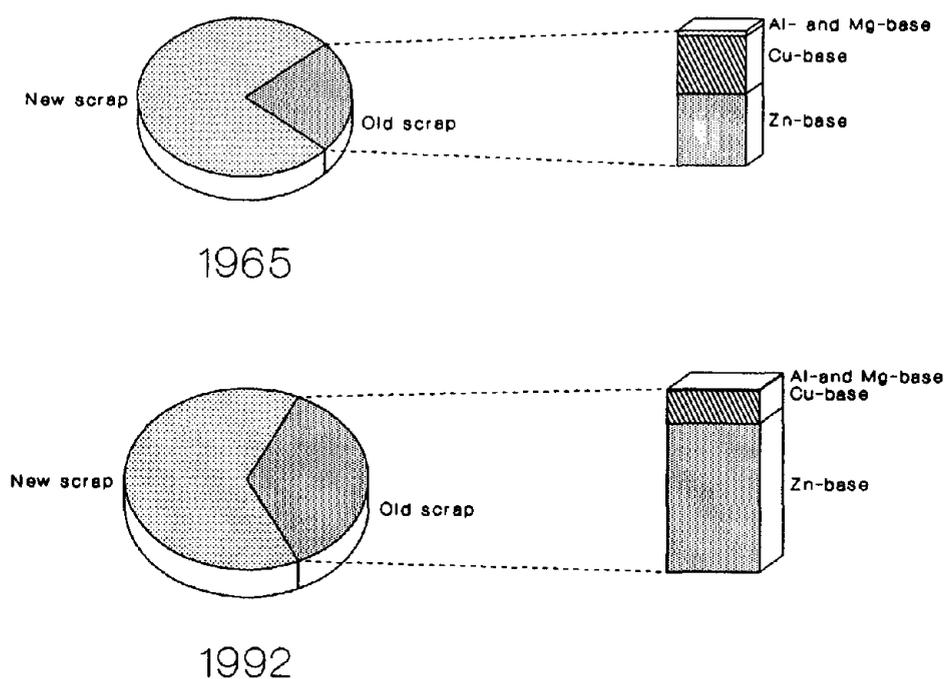


Figure 19.—Constituents of zinc scrap, 1965 versus 1992.

New scrap is comprised of the trimmings resulting from the fabrication of galvanized steel sheet and strip, rolled zinc, and brass sheet; and drosses, skims, furnace dusts, and other residual materials from galvanizing and diecasting operations, brass mills, and chemical plants. The quantity of zinc recovered from new scrap has stayed fairly constant, because less diecasting and more efficient manufacturing processes have been offset by increased production of galvanized steel (mainly for the auto industry).

Previously, old scrap was essentially limited to diecastings, rolled zinc items, and brass products. The substantial use of zinc in galvanizing, paints, and rubber had precluded further recovery of zinc from old scrap. However, during the last several years, increasing quantities of zinc have been recovered indirectly from old galvanized steel scrap (automobiles and large appliances) via the processing of EAF-steelmaking dust, and from discarded tires by treating the resultant fly ash from energy-generating tire-burning plants.

Zinc recovery resulting from the recycling of galvanized products has risen so dramatically, that it now ranks third, behind brass scrap and dross, as a source of secondary zinc. The zinc recovered from domestically generated EAF dust has gone from practically nothing in the early 1980's to approximately 75,000 mt in 1992; in the near future EAF dust is expected to yield more than 100,000 mt/yr of zinc. U.S. capacity currently stands at 94,000 mt/yr. Some EAF dust is exported to Mexico for treatment, but most of it is treated domestically, usually

offsite. Secondary zinc output from EAF dust could rise even more, if processing low-zinc-content EAF dust becomes routine practice, and/or if EAF steelmakers begin utilizing spent alkaline household batteries as scrap feedstock.

Tire rubber formulations contain small quantities of zinc compounds, usually zinc oxide, that serve as activators and accelerators. Currently there are several kinds of facilities in the United States that generate energy by burning tires. The combustion of "tire derived fuel" (TDF) leaves a fly ash that is rich in zinc. Currently, domestic secondary zinc producers are treating calcined fly ash from two TDF electric powerplants to recover the contained zinc. Recovery of zinc from old tires thus far is small—probably about 500 mt of zinc annually. However, additional TDF plants are planned. Further, proposed amendments to previous RCRA reauthorization bills endeavored to prohibit the disposal of used tires in landfills and tire monofills without some form of treatment, and also sought to eliminate existing used tire piles, estimated to contain 3 billion tires, by the year 2005. If this is reintroduced as part of the next RCRA reauthorization agenda, old tires could become a more significant source of secondary zinc.

The share of total slab zinc output provided by secondary slab zinc has increased in the last few decades, albeit mainly due to decreased metal production of primary origin. In 1992, secondary slab zinc accounted for one-third of U.S. slab zinc production. Although there have been

gains in metal production as a result of increased processing of EAF dusts, zinc is still recycled at a relatively low rate in comparison with the other major metals. Old scrap now constitutes about 10% of the total U.S. zinc demand (fig. 20).

Regulations and Legislation

EAF Dust (75-77, 138-142)¹²

Secondary recovery of zinc has been stimulated by EPA's listing of EAF dust as a hazardous waste (K061) under RCRA, and the subsequent requirement by HSWA that HTMR be used to treat dust containing 15% or more zinc. However, other provisions of RCRA, most notably the "derived from" rule, have impacted the costs associated with aspects of the HTMR process.

HTMR technology ultimately yields zinc, recoverable quantities of lead and cadmium, and a slag that has commercial applications as cement aggregate and in other construction materials. However, because the slag is derived from a hazardous waste, it too can be considered a hazardous waste depending on the way it is used or disposed. EPA exempts certain uses of "derived from" hazardous wastes from regulation under the stipulation that the material meet stringent, health-based leachate standards (referred to as "generic exclusion" levels) that would enable it to be disposed of in a nonhazardous solid waste landfill or a pile. While this provision theoretically enables

HTMR slag to be used in specific instances, the slag retains its designation as a hazardous waste, thus rendering it unattractive to prospective consuming industries. Without this label, HTMR slag would be more marketable, and the economics of the process would improve.

Analogous to the circumstances encountered with lead acid batteries, an onsite facility in which the EAF dust is held before it undergoes treatment can be regulated if it is considered to be a storage unit. Individual States differ over whether a permit must be obtained for such a structure.

Lead in Zinc-Rich Paints (143)

Zinc dust is used in the manufacture of zinc-rich paints, which are applied to structures such as bridges, water tanks, etc., for corrosion protection. Zinc dust typically contains a small amount of lead that originates from the scrap used in its production.

Proposed legislation intending to alleviate concerns regarding "lead-based paints" continues to be debated, often without sufficient recognition that a zinc-rich paint is not a lead-based paint (to which lead has been intentionally added). Producers and consumers of zinc-rich industrial paints point to the fact that there have been no cases of lead poisoning associated with these products. In addition, the Consumer Product Safety Commission has exempted zinc-rich paints from the ban on paint containing more than 0.06% lead.

¹²See also the Iron and Steel section of this report.

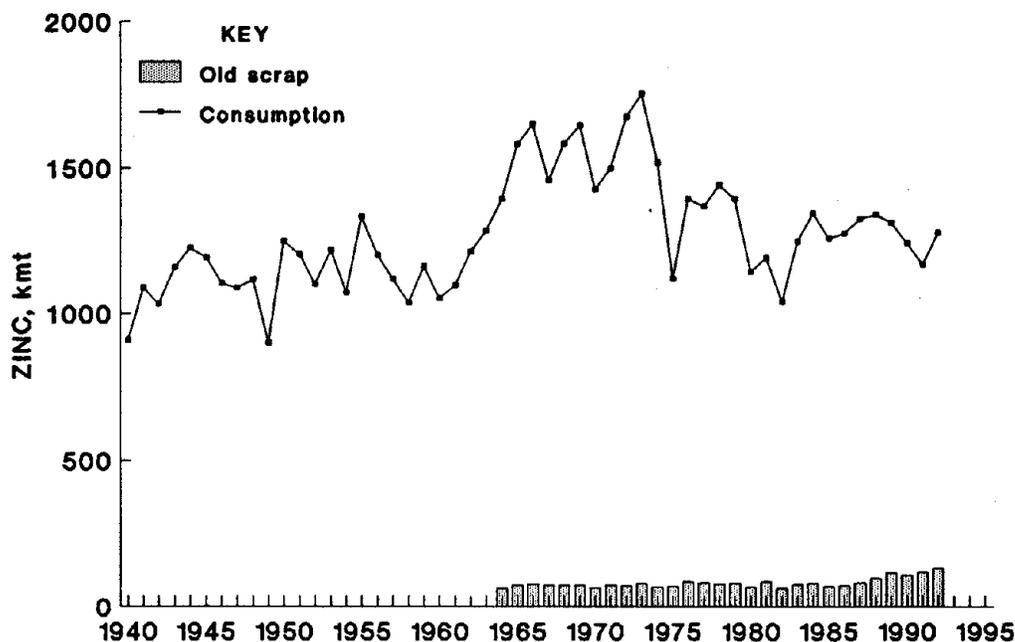


Figure 20.—Secondary zinc production as a share of apparent consumption.

If zinc-rich paints were to become included under rules intended for lead-based paints, certain lead-containing scrap would no longer be recycled for zinc dust production.

Workplace Exposure to Cadmium (144-145)

In February 1990, OSHA proposed to substantially reduce the existing limit for occupational exposure to cadmium dust and fume. These new PEL standards for cadmium threatened the viability of zinc production. From the

standpoint of the secondary zinc industry, the most prominent occurrence of cadmium is in concert with EAF dust processing. The Bureau, other Federal agencies, and cadmium producers and consumers demonstrated the adverse economic impacts and technical infeasibility of the proposed standard, and subsequently the final rule established separate engineering control air limits (SECAL), which allow somewhat higher cadmium levels for particular processes in selected industries, including zinc/cadmium refining.

SUMMARY AND CONCLUSIONS

ROLE AND BENEFITS OF RECYCLING

The preferred approach for achieving environmental protection is source reduction. However, recycling is considered to be the next best means of protecting the environment. Recyclable materials initially may be incorporated in a particular waste stream, but they should not be considered as waste or trash themselves.

The benefits derived from recycling are considerable. Recycling provides significant energy savings, an alternative source of raw materials, reductions in pollution and waste, additional landfill space, jobs and tax revenues, and foreign trade.

MAJOR METAL RECYCLING TRENDS AND DEVELOPMENTS

Steel, aluminum, copper, lead, and zinc are the most extensively used and the most extensively recycled metals. Ferrous and nonferrous scrap is generated at all stages of the material life cycle—during the initial production of the metal, the fabrication of intermediate forms, the manufacture of industrial and consumer end products, and, ultimately, at the end of a product's useful life. Efficient scrap recycling systems have long been an integral part of these major metal industries.

Steel is the Nation's most recycled material. Increased reliance on EAF's and expanded utilization of continuous casting have necessitated a greater dependence on old scrap. Traditional sources are now being supplemented by steel cans, used oil filters, and steel belts from discarded tires.

Aluminum recovered from scrap has increased by an order of magnitude since 1950. Recovery from old scrap has been especially remarkable, growing by a factor of 23. The phenomenal success of aluminum in the beverage can market led to the development of an extensive buyback recycling network, which has resulted in UBC's becoming

the largest single source of old aluminum scrap. For 4 consecutive years (1989-92) the recycling rate for aluminum beverage cans in the United States has exceeded 60%. Recently, the industry began actively promoting increased recycling of formed aluminum containers and household foil.

Copper recovery from old scrap has accounted for 19%-33% of annual consumption over the past 50 years. The increasing dominance of electrical applications has led the copper industry to become more reliant on refined scrap.

Lead production from secondary sources, mainly spent batteries, has accounted for an increasingly greater share of domestic lead supply. The recycling rate for batteries has risen significantly since the mid-1980's because of mandatory recycling and/or control laws; a well-developed recycling system; manufacturer-initiated buyback programs; and increasing public awareness. Improved battery recycling, in combination with the demise of the major dissipative uses (leaded gasoline additives and paints), has enhanced the overall recycling rate as well. There has been a reduction in the number of secondary lead facilities, but the net result has been only a small decrease in operating capacity, pointing up the inability of the smaller companies to cope with the rising costs associated with regulatory compliance.

Zinc consumption has declined from the levels seen 20-30 years ago, but there has been greater use of zinc-based corrosion protection for autobody parts. Thus, increasing quantities of zinc have been recovered from galvanized steel scrap (old and new) via the processing of EAF-steelmaking dust, to the extent that galvanized products now rank third as a source of secondary zinc. Another recent development is the recovery of zinc from discarded tires by treating the resultant fly ash from energy-generating tire-burning plants. Restrictions on tire disposal could result in old tires becoming a more significant source of secondary zinc.

SCRAP INFRASTRUCTURE

Scrap suppliers consist of collectors and small dealers, large dealer/processors, and brokers. But the most important stage of the recycling loop is the industry that consumes the recyclable material as input into its manufacturing process for its product. Without this demand, the collection and processing steps are irrelevant.

NEW PERSPECTIVES

Conventional recycling is grounded in the fundamentals of economic and technical feasibility. More and more, however, the pragmatic aspects of recycling have been yielding to other considerations. Thus, recycling of materials occurs even when the recoverable value is less than the treatment cost, if it results in avoidance of future environmental problems, or if it saves landfill space, as is the case with MSW. On the other hand, recyclable materials with a "hazardous" stigma may be avoided by recyclers. Fledgling MSW programs have been able to tap into the aluminum and steel scrap markets for the bulk of their revenues, but insufficient market demand for other MSW recyclables (paper, glass, plastics) has made the overall economics of these programs unfavorable, necessitating subsidization.

REGULATORY FRAMEWORK

Major Regimes

The entire recycling system operates within the framework of numerous (and often complex and controversial) regulations affecting the environment and the workplace. The two major regulatory regimes that are having the greatest impact on recycling are the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its amendments (SARA). RCRA was designed to minimize generation and land disposal of solid waste and also to regulate waste treatment and disposal from cradle to grave; CERCLA was developed to provide a mechanism for the cleanup of hazardous waste sites. Each presents a number of obstacles to recycling. In addition, the Basel Convention, an international agreement dealing with the export and import of hazardous wastes, may impose further constraints.

Specific Impacts on the Major Metal Industries

The principal regulatory issues concerning secondary steel are the treatment and export of EAF dust.

Designating EAF dust as a hazardous waste has increased steel production costs. Export of EAF dust to Mexico for treatment is threatened by proposed requirements that foreign facilities meet all of the requirements of RCRA, regardless of total compliance with their own Government regulations. There are also concerns about the need to regulate the disposal of shredder residue ("fluff") produced at metal salvage and recycling facilities because of the presence of PCB's, lead, and cadmium, and about setting recycling rates for steel in MSW.

A major focus of regulatory policymakers with regard to aluminum is packaging, especially in the areas of eliminating the use of heavy metals and lessening the contribution to MSW. One of the industry's concerns is that governments should not limit the options on who can collect, receive, and/or dispose of solid waste, because such "flow control" could jeopardize the established recycling infrastructure and affect the economics and competitiveness of the marketplace. "Rates and dates" legislation also is viewed with caution by the industry, holding that the present recycling rate for aluminum, relative to that for other forms of packaging, warrants consideration before an even higher level is arbitrarily mandated.

EPA's lead exposure reduction strategy, plus various legislation directed at discouraging lead use, impacts the manufacture of many copper products that contain lead (plumbing fittings, fixtures, and related solders, cable sheathing, etc.), and thus the recycling of the lead-containing copper scrap used as feedstock. These materials are also a problem for the workplace, in terms of complying with OSHA permissible exposure limits.

The lead industry has been impacted by environmental and workplace regulations to a greater extent than any of the other major metals. The present and future cost of compliance with Government-imposed regulations continues to be the industry's greatest problem. EPA has developed a strategy for lead designed to reduce lead exposures to the fullest extent practicable. The policy is to strengthen regulations on the producing and consuming sectors of the industry; to develop abatement methods for in-place sources of exposure; to establish a pollution prevention program that will promote cleaner production technologies, and will employ regulatory mechanisms and market-based incentives to reduce or eliminate lead use; and to encourage environmentally sound recycling. TSCA is the chief regulatory framework being used to prevent new uses of lead, and to limit or ban current uses. Much legislation has been introduced in an attempt to set lead-content levels for consumer and industrial products, but restrictions on some of these items (e.g., plumbing fittings and fixtures) could hamper both recycling and manufacturing. Other recent legislative and regulatory proposals have dealt with product labeling, premanufacture notification

and approval, and inventorying; paint and packaging standards; and imposing excise taxes on lead production. The regulation of lead-acid batteries as hazardous waste under RCRA is unique in that generators, transporters, and intermediate storage facilities are exempt from Subtitle C requirements. However, battery processing facilities are regulated because HSWA land disposal restrictions encompass on-site battery storage. The "third third" rule specifies that recovery of lead in secondary smelters is BDAT for lead-acid batteries, and regulates the disposal of hazardous secondary furnace slag according to Subtitle C. EPA has estimated that the cost of bringing the secondary lead smelters into compliance with the current NAAQS will total \$191 million for capital costs and \$33.7 million for operating costs. Also, it is estimated that only 12 of the 23 secondary smelters would be able to comply if the NAAQS were tightened to half of the current level of emissions. The NAAQS, and the NSPS for secondary lead plants, have been under review; and NESHAP are scheduled for secondary lead smelting and lead-acid battery manufacturing. Water quality regulations include plant effluent limitations under CWA, and limits on the lead content for materials used in water systems and a new NPDWR under SDWA. OSHA has placed strict limits on airborne lead exposure and blood-lead levels in the workplace, which apply not only to lead and lead-acid battery production, but also to other nonferrous metal operations.

Listing EAF dust as a RCRA hazardous waste, and requiring HTMR treatment, have resulted in greater recycling of zinc. However, certain provisions of the "derived from" rule hinder the utility and marketability of HTMR slag, and some States have elected to require a permit for EAF dust storage—factors that impact the economics of the process. Proposed legislation intending to alleviate concerns regarding "lead-based paints" continues to be debated, often without sufficient recognition that a zinc-rich paint is not a lead-based paint. Regulating zinc-rich paints as lead-based paints could discourage recycling, because certain lead-containing scrap would no longer be recycled for zinc dust production.

POLICY ASPECTS

One option for Government to promote recycling is to proactively expand markets for recycled products, such as by legislating that certain items have a specified recycled content, and by modifying its own procurement practices to accommodate such products. This could provide an impetus for greater recycling of some MSW materials whose supply far exceeds demand (particularly newspaper, cardboard, and plastics), but the recycling "infrastructure" of the major metal industries is well established. From

their perspective, the more preferable Government stimulus for recycling would be one that endeavored to remove regulatory impediments.

Certainly it is not feasible for recycling activities to proceed entirely free from regulatory control, but regulations directed at recycling ought to be commensurate with the risk presented. It falls upon Government to establish a regulatory framework with which to ensure the public health, safeguard the workforce, and protect the environment. At the same time, Government attempts to balance these responsibilities with concerns about the impacts on the industries it regulates. When aspects of a specific regulation or overall regulatory scheme serve to hinder, or to create disincentives for, a beneficial activity, or are in effect contrary to the intent of other legislation, it is apparent that the regulatory policy that is in place needs to be reexamined.

Recognizing as it does that recycling is a vital element of environmental protection strategy, Government policy should be one of advocating valid recycling practices and encouraging the pursuit of new recycling technologies. In order to accomplish this, some fundamental issues need to be resolved. Basically, recyclables have to be viewed from the proper perspective—not as waste materials destined for treatment or disposal, but as recoverable resources that are starting materials for industrial production processes. This concept then should become the foundation for the development of regulatory policy. A workable definition of the term "solid waste," and clear guidelines that differentiate between "recycling" and "treatment/disposal" are essential.

Blurring these distinctions can lead to misinterpretation of legislative intent during the regulatory process, which can have ominous consequences for recyclers, particularly when dealing with hazardous waste regulations. If the recycling activities performed by scrap dealers are viewed as arranging for the treatment or disposal of a hazardous waste, they would fall under the potentially responsible party liability provisions of CERCLA, meaning that, should the facility that consumed the recyclable materials eventually become a Superfund site, the scrap dealer could be held responsible, regardless of the lack of direct involvement. The inclusion under the liability umbrella of dealers who provide materials to recycling processes threatens the continuity of the recycling loop. A policy that holds this expansive view of responsibility appears likely to have counterproductive consequences by discouraging the handling of many otherwise recyclable materials. Moreover, it effectively places CERCLA in conflict with the aims of RCRA.

Not only is it important to establish a clear and coordinated domestic regulatory policy that supports sound recycling activities, but legislators and policymakers should

also be mindful to ensure that international agreements are drafted along the same lines. Obviously there can be no objection to restricting the export of wastes when it is clear that such trade is taking place merely to facilitate disposal without sufficient regard for the environmental consequences. Nevertheless, in the course of reaching international accord on this issue, it is essential that exports of materials destined for legitimate recycling not be hindered. Such action would shrink the market for recyclables, affect the balance of trade, and cause recyclable materials to accumulate and perhaps ultimately be disposed of as if they were waste.

For the most part, industry has come to accept the fact that it is going to be regulated by Government. But lawmakers, regulators, and the environmental community should recognize that every regulation has unique economic consequences. In addition, those involved in the regulatory process should also take into account the fact that standards targeting a specific material can produce a ripple effect, extending the impact of the regulation to other industries beyond the material of immediate concern. Regulatory compliance already has added significantly to the capital and operating costs associated with

recycling, while pending and proposed regulatory actions are expected to increase costs further. MSW recycling programs can be sustained by offsetting unfavorable economics with higher taxes or fees, but the continued viability of conventional recycling in the major metal industries is assured only if total costs, including those perceived for liability, remain reasonable. An intimidating regulatory climate could translate into less recycling capacity, and, should reduced scrap recycling ensue, the problems associated with solid waste disposal would intensify. Thus, well-meaning but over-zealous regulation of recycling activities may remedy some specific problems, but at the same time have far-reaching, adversarial ramifications for the system as a whole.

In sum, any legislation, regulations, and international agreements that seek to place controls on solid waste should not inadvertently deter legitimate recycling practices. Instead, Government should endeavor to facilitate greater recovery and utilization of recyclable materials. The fundamental guidelines should clearly differentiate between recyclables and solid waste, and between recycling and treatment/disposal, while establishing common-sense liability provisions.

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