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INDUSTRY PROFILE FOR THE SECONDARY LEAD SMELTERS NESHAP

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Industry Profile for the Secondary Lead Smelters NESHAP

Emissions Standards Division

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This report is issued by the Emission Standards Division of the Office of Air Quality Planning and Standards of the Environmental Protection Agency. It presents technical data cllected through December 1992 for the National Emission Standard for Hazardous Air Pollutants (NESHAP), which is of interest to a limited number of readers. It should be read in conjunction with the *Economic Impact Analysis for the Secondary Lead Smelters NESHAP* (June 1994). Both the *Industry Profile* and the *Economic Impact Analysis* are in the public docket for the NESHAP proposal. Copies of these reports and other material supporting the proposal are in Docket A-92-43 at EPA's Air and Radiation Docket and Information Center, Waterside Mall, Room M1500, Central Mall, 401 M. Street SW, Washington, D.C. 20460. The EPA may charge a reasonable fee for copying. Copies are also available through the National Technical Information Services, 5285 Port Royal Road, Springfield, Virginia 22161. Federal employees, current contractors and grantees, and non-profit organizations may obtain copies from the Library Services Office (MD-35), U.S. Environmental Protection Agency; Research Triangle Park, N.C. 27711; phone (919)541-2777.

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1.0 INTRODUCTION

Lead is a soft, heavy metal. Among nonferrous metals, it is surpassed in usage only by aluminum, copper, and zinc. Lead is highly malleable and ductile, a poor conductor of electricity, and the most impervious to radiation and corrosion-resistant of all common metals. While lead has many industrial uses, the majority is consumed in the manufacture of lead-acid storage batteries.

The United States is the world's largest producer and consumer of lead. About 70 percent of lead output in the U.S. is secondary (recycled) lead and about 30 percent is primary lead. Secondary lead is recovered from lead-bearing scrap. Most of this is old scrap, consisting of worn-out, damaged, or obsolete products and materials. The majority of old scrap for secondary lead production is in the form of spent automotive batteries. Other forms of old scrap include cable covering, pipe, sheet, type metal, and solder. Some secondary lead is also produced from new scrap, which consists of smelting and refining waste products such as drosses and furnace or flue residues.

The secondary lead production process involves collecting the scrap; separating the lead content of the scrap (e.g., breaking batteries); smelting the lead scrap in a blast, reverberatory, rotary, or electric furnace; and refining the molten lead obtained from the smelting furnace. Refined lead can be sold as pure lead (there are 20 commercial grades of pure refined lead — commonly referred to as "soft lead" — with a minimum lead purity of 99.85%) or can be alloyed with other metals to meet customer specifications.[1] The most common lead-base alloy is antimonial lead, containing up to six percent antimony. Other metals with which lead is frequently alloyed include calcium, aluminum, and tin. While the general properties of the 20 commercial grades of pure lead are similar, the mechanical, thermal, and electrical properties of alloys with less than 99 percent lead can vary considerably.[2]

Common cast forms for refined lead are pigs, bars, ingots, and blocks. In addition, lead is available in strip, rolls, sheet, foil, and many other forms. Lead is consumed not only as a metal — either pure or alloyed with other metals — but also as a chemical compound, primarily oxides. Pure lead is used to manufacture the oxides of lead. Litharge is the most common of these chemicals. Lead-acid batteries consume both lead metal and lead oxides.

Primary lead, in contrast, is derived from lead-containing ores, which are recovered from underground and open-pit mines. Primary lead is produced in the U.S. not only from ores mined primarily for their lead content, but also from ores in which lead and zinc are co-products, and as a by-product from ores mined chiefly for zinc, copper, gold, silver, or fluorine.[3] Missouri accounted for 79 percent of domestic lead mine production in 1990.[4] After recovery from the mine, the ores are crushed and milled into lead concentrate, which is then sent to a smelter. At the smelter, the concentrate is sintered and smelted in a blast furnace to produce impure lead bullion. Impurities are then reduced by drossing. From the smelter, the lead bullion is sent to a refinery where remaining impurities are removed.

As in the case of secondary lead, refined primary lead can be either sold as pure lead or alloyed with other metals. Pure refined primary lead is, on average, more pure than pure refined secondary lead. While primary lead smelting-refining typically achieves 99.99 percent lead purity, conventional secondary lead smelting-refining technology (i.e., excluding electrowinning and/or electrorefining) achieves, on average, only up to 99.985 percent lead purity.[5,6]

Nevertheless, "refined secondary lead may be substituted completely for primary lead in most applications."[7] Whether primary or secondary, pure refined lead is essentially a commodity. Likewise, the alloy products of secondary lead smelter-refineries are comparable to those of primary lead smelter-refineries. Therefore, primary and secondary lead producers tend to compete for the same markets. For example, the major market for both primary and secondary lead is automotive batteries. One major difference, though, is that antimonial lead is made almost exclusively by secondary producers.[8]

In this report, the U.S. secondary lead smelting industry is profiled. The purpose of the profile is to provide market information that might affect the nature and magnitude of the economic impacts of a NESHAP for secondary lead smelters. Since secondary lead and primary lead are substitutable and compete for the same markets, some information on the U.S. primary lead industry is also provided.

2.0 INDUSTRY STRUCTURE AND MARKET CHARACTERISTICS

2.1 SECONDARY LEAD

As of August 1992, 16 companies operated 23 secondary lead smelters with a minimum annual capacity of 6,000 metric tons in the U.S.[9] The companies and facilities, along with annual capacities, are listed in Table 1. Total industry capacity is 1,214.5 thousand metric tons per year. RSR Corporation of Dallas, Tx. is the biggest producer, with annual capacity of 261,000 metric tons, representing 21 percent of the industry total. RSR and the next three biggest producers — GNB Inc., Schuylkill Metals Corporation,

TABLE 1. SECONDARY LEAD SMELTERS IN
THE U.S., AUGUST 1992

Company	Facility	Capacity (10^3 Mg/yr)
Delatte Metals	Ponchatoula, LA	6.8
East Penn Manufacturing Co.	Lyon Station, PA	40.8
Exide Corp.	Muncie, IN	60.0
	Reading, PA	60.0
		120.0
General Smelting & Refining Co.	College Grove, TN	22.6
GNB Inc.	Columbus, GA	20.0
	Frisco, TX	40.0
	Vernon, CA	124.5
		184.5
Gopher Smelting & Refining, Inc.	Eagan, MN	90.7
Gulf Coast Recycling Inc.	Tampa, FL	29.0
Master Metals Inc.	Cleveland, OH	10.0
Metals Control of Oklahoma	Muskogee, OK	16.5
PBX Inc.	Norwalk, OH	28.2
Refined Metals Corp.	Beech Grove, IN	27.2
	Memphis, TN	27.2
		54.4
RSR Corp.	City of Industry, CA	87.0
	Indianapolis, IN	87.0
	Middletown, NY	87.0
		261.0
Sanders Lead Co.	Troy, AL	109.6
Schuylkill Metals Corp.	Baton Rouge, LA	99.8
	Forest City, MO	36.3
		136.1

TABLE 1 (CONTINUED)

Company	Facility	Capacity (10^3 Mg/yr)
Tejas Resources, Inc.	Terrell, TX	22.7
The Doe Run Company	Boss, MO	81.6
TOTAL		1,214.5

Source: "Secondary Lead Model Plants for New Facilities (Draft)". Memorandum from Rich Pelt, Radian Corporation to George Streit, U.S. EPA, July 9, 1992.

and Exide Corporation — account for 58 percent of industry capacity.

The U.S. secondary lead industry has been marked in recent years by numerous facility closings and openings. Compared to the 23 smelters in August 1992, there were 43 in 1984.[10] Within that period, 25 facilities closed and 5 opened. A major trend has been for small facilities to close. In 1984, there were 11 smelters with annual capacity less than 9,100 metric tons. All of these facilities have shut down. One facility with an annual capacity of 6,800 metric tons (Delatte Metals, Ponchatoula, La.) has opened since 1984.

The net change in annual industry capacity from 1984 to 1992 was -98,400 metric tons. This resulted from a loss of 501,200 metric tons from the 25 closings, a gain of 155,900 metric tons from the 5 openings, and a gain of 246,900 metric tons from plant expansions. The net decrease in industry capacity over the past eight years has been primarily attributable to stagnant demand, overcapacity, and the costs of complying with environmental regulations.

There have been a number of recent facility openings and closings. In 1989, Exide opened its facility in Muncie, In. This was the first start-up of a large secondary lead smelter since 1981.[11] In 1991, The Doe Run Company opened a facility in Boss, Mo. and Tejas Resources, Inc., a unit of Powerlab Inc., opened a facility in Terrell, Tx. Doe Run is one of only two primary lead producers in the U.S. With the start-up, Doe Run became the first primary lead producer to enter the secondary lead market (though Doe Run had previously been purchasing scrap batteries and tolling them elsewhere). The new facility is converted from a primary lead facility that Doe Run formerly operated in Boss, Mo. PBX Inc. opened its facility in Norwalk, Oh. in March 1992.

In 1990, Exide closed its Dixie Metals Company plant in Dallas, Tx. and Alco Pacific Inc. closed its plant in Carson, Ca. "Environmental reasons" were cited for these closures.[12] After filing a Chapter 11 petition for reorganization in July 1991, Interstate Lead Company shut down its Leeds, Al. facility in March 1992. The company cited "heavy financial costs for environmental rules."[13] Also in early 1992, four facilities — Schuylkill Metals, Baton Rouge; Refined Metals, Memphis; Gopher Smelting & Refining, Eagan, Mn.; and Sanders Lead, Troy, Al. — temporarily shut down a furnace. Temporary shutdowns due to unfavorable market conditions are common in the secondary lead industry. In this case, the shutdowns were prompted by a squeeze on profits, resulting from a combination of low lead prices and high scrap prices. The low lead prices were caused by weak demand and overcapacity, while the high scrap prices were caused by tight supplies of spent batteries. Along with the closure of the Interstate Lead facility, the furnace shutdowns caused annual industry capacity to (temporarily) decline by 150,000 metric tons.

Later, in July 1992, Ross Metals Inc. shut down its secondary lead smelting facility in Rossville, Tn. Thirty of the plant's 36 employees were laid off. The facility had an annual capacity of 13,200 metric tons. Reopening was said to be "uncertain."[14] The company continued to operate a secondary lead smelter in Reynosa, Mexico, across the border from McAllen, Tx.

In addition to the facilities listed in Table 1, the U.S. Bureau of Mines defines the U.S. secondary lead industry to have included, at the end of 1990, "21 small companies with 22 plants of less than 1,000 tons per year of capacity ... producing mainly specialty alloys."[15] These small facilities account for only about 1 percent of secondary lead production.[16] In addition to these small facilities, the Bureau of Mines identified, at the end of 1990, 15 companies operating 22 battery breaker-smelters with capacities from 6,000 to 110,000 metric tons per year, and 6 smaller operations that do not process batteries with capacities from 6,000 to 10,000 metric tons per year.

Only two secondary lead producers are publicly owned.[17] They are GNB, which is a subsidiary of Pacific Dunlop Limited, an Australian company, and Doe Run, which is a subsidiary of Fluor Corporation. In 1990, Schuylkill Metals was acquired by a Citicorp investor group, permitting the recapitalization of its two plants.[18] Powerlab Inc., the parent of Tejas Resources, has been operating under Chapter 11 protection from its creditors.

The facility locations in Table 1 indicate that the U.S. secondary lead industry is geographically dispersed. However, all but two smelters are located east of the Rocky Mountains. Because spent batteries are heavy and therefore expensive to ship, smelters are located to serve regional markets, usually near large population centers.[19] Such factors as scrap availability and labor costs can vary considerably from region to region. Secondary lead producers are said to vary considerably not only with respect to regional market conditions, but also with respect to finished products, size (e.g., production capacity), and degree of vertical integration.[20]

Estimated sales of the four largest secondary lead producers in 1991 ranged from $45 million for Schuylkill Metals to $750 million for Exide.[21] Estimated employment was 330 at Schuylkill Metals and 5,000 at Exide. These figures reflect company-wide operations, not just secondary lead production, however. Exide, for example, is a major battery producer. A significant portion of its sales and employment are attributable to battery production. The other secondary lead producers that manufacture batteries are East Penn

Manufacturing and GNB. Total employment at U.S. secondary lead smelters and refineries in 1991 was estimated to be 1,700.[22]

Vertical integration in the U.S. secondary lead industry is not limited to cases in which batteries are produced downstream. For example, Powerlab produces lead oxide downstream from its new Tejas Resources secondary smelter. And, as mentioned, the majority of secondary lead smelters also have battery breaking operations. This represents backward integration with processing of the scrap fed to the smelting operations.

With the start-up of its Boss, Mo. secondary smelter, Doe Run became the first U.S. company to be horizontally integrated as a producer of both primary and secondary lead. This type of integration is more common overseas.[23]

Even though the top four secondary lead producers account for 58 percent of domestic capacity, the industry is highly competitive. This was evidenced by the "bidding war" waged by secondary lead producers for tight scrap battery supplies in early 1992, despite depressed lead prices.[24] U.S. secondary lead producers compete not only among each other, but also with domestic primary lead producers and overseas producers.

2.2 PRIMARY LEAD

Like the U.S. secondary lead industry, the U.S. primary lead industry underwent retrenchment in the 1980s. Refined primary lead capacity was 715,000 metric tons per year in 1981. Since then, however, Bunker Hill shut down a smelter-refinery in Kellogg, Id. (in 1981); Asarco shut down a smelter in El Paso, Tx.; Doe Run closed a smelter-refinery in Boss, Mo., replacing it with a secondary lead facility (in 1991); and Doe Run cut annual capacity at its Herculaneum, Mo. smelter-refinery by 54,000 metric tons (in April 1991). As the industry is presently structured, Doe

Run operates the Herculaneum smelter-refinery and Asarco operates a smelter-refinery in Glover, Mo.; a custom smelter in East Helena, Mt.; and a refinery in Omaha, Ne. The Omaha refinery receives bullion from the East Helena smelter. Herculaneum's annual refined lead capacity is estimated to be 159,000 metric tons and Asarco's combined annual refined lead capacity is estimated to be 181,000 metric tons.[25] Total industry capacity is therefore 340,000 metric tons per year, down 52 percent from 1981. The retrenchment in the past decade has been mainly due to stagnant lead consumption, worldwide overcapacity, low lead prices, and the costs of environmental regulations.

Before the capacity cutbacks in 1991, the U.S. had 525,000 metric tons of annual primary lead smelting capacity and 605,000 metric tons of annual primary lead refining capacity.[26] Worldwide, smelting capacity was 4,490,000 metric tons and refining capacity was 4,560,000 metric tons at the end of 1990. Therefore, the U.S. accounted at the end of 1990 for 12 percent of world smelting capacity and 13 percent of world refining capacity.

Doe Run and Asarco are integrated producers of primary lead, as they produce lead ores and concentrates for their smelting and refining operations. Of the top nine lead-producing mines in the U.S. in 1990, five were operated by Doe Run and two by Asarco.[27] The other two were operated by Cominco Ltd., a Canadian company (one of these was co-owned by Dresser Industries Inc.) While Doe Run's mines and mills supply all of Herculaneum's needs for lead ores and concentrates, about one-half of Asarco's lead metal production in 1990 was from its own mines (the other half was either custom-produced or tolled). However, "at year end it was estimated that the company had an approximately 85 percent captive domestic capability if its own mine production were fully optimized."[28]

The two U.S. primary lead producers are more integrated, on average, than their overseas competitors.[29] This is because unlike the U.S., many mine-producing areas are not a major market for consumption. Mine output in many areas therefore tends to be exported. For example, in Europe, where refined lead production exceeds lead mine output, many lead producers have contracts with overseas mines and smelters.

In 1983, there were 39 lead-producing mines in 11 states in the U.S.[30] In 1990, the top 15 mines accounted for over 99 percent of lead output.[31] Included in these top 15 were 8 mines in Missouri, 2 in Alaska, 2 in Idaho, 2 in Colorado, and 1 in Montana. Annual U.S. lead mine production capacity at the end of 1990 was 759,000 metric tons.[32] This was an increase of 79,000 metric tons from the year before. The increase is primarily attributable to the opening in February 1990 of Cominco's Red Dog mine in Alaska, which is projected to have a contained-lead (it also produces zinc and silver) capacity of 70,000 metric tons per year.[33] Total world lead mine production capacity at the end of 1990 was 4,185,000 metric tons. The U.S. therefore accounted for 18 percent of worldwide capacity.

The reserve base (includes reserves that are currently economic, marginally economic, and subeconomic) of lead in ores in the U.S. is estimated to be 22 million metric tons.[34] The worldwide reserve base is estimated to be 120 million metric tons. Australia leads with 26 million metric tons. Other countries with significant reserve bases include Canada with 13 million metric tons, the former republics of the Soviet Union with 12 million metric tons, and China with 9 million metric tons.

The Doe Run Company is a subsidiary of the highly diversified Fluor Corporation. Previously, Doe Run was jointly owned by Fluor and Homestake Mining Company.

However, in 1990, Fluor purchased Homestake's 42.5 percent share in Doe Run for $125 million. Asarco is a diversified, multinational mining and minerals company. Both Fluor and Asarco are publicly owned.

Total employment in 1991 at U.S. primary lead smelters and refineries was estimated to be 700.[35] Peak lead mine and mill employment was estimated to be 2,300.

3.0 PRODUCTION AND SUPPLY DETERMINANTS

Secondary lead is classified in SIC 33413, Lead Smelting and Refining, Secondary. SIC 33413 is a subset of SIC 3341, Secondary Smelting and Refining of Nonferrous Metals. Total shipments in 1987 of all products classified in SIC 33413 were $519.2 million.[36]

Lead production in the U.S. from 1980 to 1991 is shown in Table 2. After falling from higher levels in the early 1980s, recoverable lead mine output has increased since 1987. The increase of 63,077 metric tons from 1989 to 1990 is attributable to the start-up in 1990 of Cominco's Red Dog mine in Alaska, at which 61,700 metric tons of lead were produced in 1990. Output at Red Dog was expected to be 90,000 metric tons in 1991, but total recoverable lead mine output in the U.S. was down slightly in 1991 from 1990, in large part due to the closure by Doe Run of two mines in Missouri.[37]

Missouri produced 372,383 metric tons of recoverable lead from mines in 1990.[38] This represented 79 percent of the nationwide total of 473,992 metric tons. Alaska, Colorado, Idaho, and Montana accounted for another 18 percent. Over 99 percent of recoverable lead mine output came from the top 15 mines, and 90 percent came from the top three producers — Doe Run, Asarco, and Cominco.

After increasing gradually since 1986, primary lead production dipped in 1991. The decline can be traced to a

TABLE 2. U.S. LEAD PRODUCTION, 1980-1991 (Mg)

	Recoverable lead content in ores (from mines)	Refined lead		
		Primary	Secondary	% Secondary
1991 (preliminary)	465,931	345,714	883,700	71.9%
1990	473,992	403,657	922,911	69.6%
1989	410,915	396,455	891,341	69.2%
1988	384,983	392,087	736,401	65.3%
1987	311,381	373,610	710,067	65.5%
1986	339,793	370,288	624,769	62.8%
1985	413,955	494,003	615,695	55.5%
1984	322,677	389,398	633,374	61.9%
1983	449,295	519,167	503,501	49.2%
1982	512,516	512,160	571,276	52.7%
1981	445,535	495,323	641,105	56.4%
1980	550,366	547,590	675,578	55.2%

Sources: U.S. Bureau of Mines, "Mineral Industry Surveys: Lead Industry in April and May 1992" and "Annual Report 1990: Lead;" and American Metal Market, "Metal Statistics 1990-91."

decrease in output at Doe Run's Herculaneum, Mo. facility from about 218,000 metric tons in 1990 to about 145,000 metric tons in 1991.[39] This was the result of a permanent capacity reduction. Primary lead production has dropped from levels of the 1970s and early 1980s. The high year was 1972, in which 617,248 metric tons of primary lead were produced.

Secondary lead production reached all-time highs in 1989 and 1990 (the previous record-high was 801,368 metric tons in 1979) before slipping to 883,700 metric tons in 1991. The increase in secondary lead output throughout much of the 1980s is in part due to the decreasing importance of dissipative uses such as tetraethyl lead (previously a gasoline antiknock additive, before its use was phased out). A greater percentage of lead is now consumed in products that are recyclable. Additional impetus was provided in the late 1980s by stricter battery disposal and recycling laws, which make more lead scrap available for secondary production. At year-end 1991, 37 states had strict battery disposal and/or mandatory recycling laws, and 6 states had legislation pending.[40] Along with the increase in secondary lead production in the 1980s, note in Table 2 that secondary lead production as a percent of total refined lead output — both secondary and primary — also increased. Secondary lead now accounts for over 70 percent of total refined lead production in the U.S.

As a result of the production drop in 1991 and the facility start-ups in 1991 by Doe Run and Tejas Resources, average secondary lead capacity utilization declined from 90 percent in 1990 to 82 percent in 1991.[41,42]

Table 3 captures some trends in worldwide lead production from 1985 to 1990. While lead mine and primary lead output declined slightly from 1985 to 1990, secondary lead output increased by 19 percent. The contribution of

TABLE 3. WORLD LEAD PRODUCTION, 1985-1990 (10^3 Mg)

	Lead content in concentrates (from mines)	Refined lead		
		Primary[a]	Secondary	% Secondary
1990 (estimate)	3,367[b]	3,214[c]	2,728[d]	45.9%
1989 (preliminary)	3,368	3,285	2,702	45.1%
1988	3,430	3,246	2,604	44.5%
1987	3,425	3,194	2,524	44.1%
1986	3,345	3,191	2,361	42.5%
1985	3,431	3,357	2,284	40.5%

[a]Includes secondary lead if inseparably included in country total.

[b]Leading producer nations include, in 10^3 Mg: Australia, 563; United States, 495; U.S.S.R., 450; China, 315; Canada, 236.

[c]Leading producer nations include, in 10^3 Mg: U.S.S.R., 420; United States, 404; China, 235; Australia, 212; Japan, 205; Germany, 199.

[d]Leading producer nations include, in 10^3 Mg: United States, 923; U.S.S.R., 280; United Kingdom, 200; Germany, 198; Japan, 124; France, 110; Italy, 100.

Sources: U.S. Bureau of Mines, "Annual Report 1990: Lead" and "Minerals Yearbook 1989: Lead."

secondary lead to overall refined lead output increased from 40.5 percent to 45.9 percent. This is a lower contribution than in the U.S. There are two major reasons for this.[43] First, the U.S. is relatively dependent on the automobile, the batteries for which are the most important source of scrap to the secondary lead industry. Secondly, the rest of the world consumes more lead in chemicals, a dissipative use that cannot be recycled.

The leading lead producer nations are listed in the footnotes to Table 3. The U.S. is by far the top secondary lead producing nation, accounting for 34 percent of world output in 1990. In comparison, the U.S. accounted for 15 percent of world lead mine output and 13 percent of world primary lead output. Note that U.S. output of lead content in concentrates was 495,000 metric tons in 1990, while the recoverable lead content in ores in 1990 was stated in Table 2 to be 473,992 metric tons. The difference follows from the fact that not all lead in concentrate is recoverable (on average, about 95% is recoverable).

The major determinant of the supply of secondary lead is the availability of scrap. The majority of lead scrap derives from lead-acid storage batteries. This is demonstrated in Table 4. Of total secondary lead output of 922,911 metric tons in 1990, 783,860 metric tons, or 85 percent, were recovered from spent batteries. Table 4 also shows that soft lead accounted for 50 percent, and antimonial lead for 46 percent, of all lead recovered (i.e., of all secondary lead produced).

The availability of scrap for secondary lead production is contingent on such factors as the amount of prior consumption of lead-bearing goods, the durability of lead-bearing goods, the weather, the incentive to recycle, environmental risks, and competition from foreign markets.

TABLE 4. U.S. SECONDARY LEAD PRODUCTION IN 1990, BY SOURCE OF SCRAP AND TYPE OF LEAD RECOVERED (Mg)

Source of Scrap:		
New scrap		
Lead-base	43,608	
Copper-base	5,000	(estimate)
Tin-base	4	
Old scrap		
Battery lead	783,860	
Other lead-base	79,439	
Copper-base	11,000	(estimate)
Total	922,911	
Type of lead recovered:		
Soft lead[a]	461,868	
Antimonial lead	425,979	
Other lead-base alloys[b]	19,060	
Copper-base alloys	16,000	(estimate)
Tin-base alloys	4	
Total	922,911	

[a]Includes a small amount of remelt lead.

[b]Mostly solder, but also lead-base babbit (530 Mg), type metal (868 Mg), cable lead (amount unknown), and other alloys.

Source: U.S. Bureau of Mines, "Annual Report 1990: Lead."

Consumption of lead-bearing goods affects the supply of lead scrap with a lag. For example, low consumption in 1991 has been blamed for tight scrap supplies in 1992.[44] The weather has a major effect on the rate of automotive battery replacement. Extreme temperature fluctuations — cold winters and hot summers — increase the replacement rate. In June and July of 1992, for example, scrap tightness began to alleviate as warm temperatures increased scrap battery supplies.[45]

The incentive to recycle has increased significantly in the past several years as many states have instituted strict battery disposal and recycling laws, including, for example, mandatory point-of-sale battery exchanges. As a result, 97.8 percent of all spent lead-acid storage batteries were recycled in 1990, up from 88.6 percent in 1987 and 95.3 percent in 1989.[46,47] While only 77.7 million batteries were available for recycling in 1987, 85.6 million were available in 1989.[48] Batteries are recycled in the U.S. at a higher rate than any other material, including plastic, paper, glass, and aluminum.[49]

Environmental risk has recently emerged as a factor in the availability of lead scrap. Specifically, under CERCLA, scrap dealers and processors (who are middlemen in the supply of scrap to secondary lead producers) can be named by EPA as "potentially responsible parties" (PRPs) for clean-up costs at Superfund battery-breaking sites to which they have shipped lead-acid batteries. The Institute of Scrap Recycling Industries estimates that more than half of its 1,800 members have been named as PRPs at one or more of about 20 Superfund sites contaminated by lead-acid batteries.[50] This has resulted in a growing reluctance by scrap dealers and processors to handle lead-acid batteries. More batteries are also being exported to countries such as Canada and the Philippines, where hazardous waste clean-up liability is not as broadly defined as in the U.S. In response to this growing problem, RSR Corporation announced in February 1992 that it is willing to indemnify battery suppliers against potential Superfund liabilities arising at any of its three secondary lead plants.[51] The value of this assurance is uncertain, however.

Finally, domestic secondary lead smelters must compete for lead scrap with foreign secondary smelters. Such competition can create regional differences in scrap availability. For example, the Northeast faces competition from Canada and the West faces competition from the Far East and Mexico.[52] In August 1992, RSR was only able to operate its smelter in City of Industry, Ca. at 70 percent of capacity because of a shortage of spent batteries on the West Coast.[53] RSR's two other smelters in Indianapolis and Middletown, N.Y., in contrast, were operating at 100 percent of capacity.

4.0 CONSUMPTION AND DEMAND-SIDE FACTORS

4.1 END USES

Lead is consumed in a number of industries, including building construction, ammunition, electronic and electrical equipment, power and communications equipment, packaging, chemicals, and paints. However, by far the biggest end-use industry is transportation, which comprises about three-quarters of lead demand. In turn, storage batteries account for the great majority of the demand for lead in the transportation sector. Overall, storage batteries (for which some applications are not in transportation) accounted for 80 percent of U.S. lead consumption in 1990, up from 43 percent in 1970 and 60 percent in 1980.[54]

Secondary lead has a symbiotic relationship with storage batteries that is unique to recycled products. Not only are spent batteries the main source of feed for secondary lead smelting, but batteries are also the major marketing outlet for secondary lead. While storage batteries are the leading end use of both secondary and primary lead, a greater percentage of secondary output goes to storage batteries than primary output (i.e., secondary lead is more reliant on storage batteries).[55]

A distribution of the end uses of lead in 1990 is presented in Table 5. The 80-percent contribution of storage batteries to overall lead consumption is seen (1,019,637 out of 1,275,233 metric tons). In 1990, storage batteries consumed 80 percent of all soft lead, 81 percent of all lead in antimonial lead, 83 percent of all lead in other alloys, and no lead in copper-base scrap. The second biggest end use in 1990 was shot and bullets (58,210 metric tons, or 4.6% of total demand). Transportation applications other than storage batteries include bearing metals (e.g., to balance motor vehicle wheels), terne metal for fuel tanks, solder and filler, and gasoline antiknock additives (though this use is being phased out).

There are numerous uses in construction. For example, sheet lead is used as a sound dampener and, because lead is the most impervious to radiation of all common metals, as protection from x-rays and nuclear radiation. This includes applications in hospital x-ray rooms and in both permanent and portable structures containing nuclear materials (e.g., nuclear reactors). Other construction applications include solder, glass windows, and bearing pads in the foundations of large structures for vibration dampening. Lead is also used in roofing, flashing, piping, and calking, though these uses have diminished in recent years.

A major application in the power and communications equipment industry is cable sheathing. Lead protects underground and underwater cables from corrosion and damage from moisture. Packaging applications include foil and

TABLE 5. U.S. REPORTED CONSUMPTION OF REFINED LEAD, BY END USE, 1990 (Mg)

	Soft lead	Lead in antimonial lead	Lead in other alloys	Lead in copper-base scrap	Total
Metal Products					
Shot and bullets (ammunition)					58,210
Bearing metals[a]					2,878
Brass and bronze					9,943
Cable covering[b]					18,253
Calking lead[c]					1,688
Casting metals[d]					14,843
Pipes, traps, other extruded products[e]					9,281
Sheet lead[f]					21,013
Solder[g]					16,490
Terne metal[h]					2,341
Other[i]					3,812
Total	66,523	64,617	20,395	7,216	158,751
Storage batteries					
Grids, post, etc.					571,187
Oxides					448,450
Total	624,241	279,571	115,825	-	1,019,637

TABLE 5. (CONTINUED)

	Soft lead	Lead in antimonial lead	Lead in other alloys	Lead in copper-base scrap	Total
Other oxides[j]	56,484	-	-	-	56,484
Misc.[k]	35,899	1,109	3,353	-	40,361
Grand Total	783,147	345,297	139,573	7,216	1,275,233

[a]Mostly for motor vehicles and motor vehicle equipment.

[b]For power and communications equipment.

[c]For the building construction industry.

[d]Includes nuclear radiation shielding.

[e]Mostly for the building construction industry.

[f]Mostly for the building construction industry. Includes medical radiation shielding.

[g]Major end-use industries include building construction, electronic components and accessories, and motor vehicles and motor vehicle equipment.

[h]For motor vehicles and motor vehicle equipment.

[i]Includes type metal and lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, and fishing weights.

[j]Used in paints, glass and ceramics products, and other pigments and chemicals.

[k]Includes gasoline additives.

Source: U.S. Bureau of Mines, "Annual Report 1990: Lead."

sheet to protect X-ray film and certain radioactive materials, and collapsible tubes for pastes and artists' colors. Lead is used to make type metal for printing. Lead oxides, in addition to their major use in storage batteries, are used to protect process vessels and other storage containers against corrosive chemicals such as sulfuric acid; in protective coatings to make steel structures corrosion-resistant; and to impart brilliance, clarity, and other properties to glass, porcelain enamel, ceramics, and crystal. Color TV tubes account for the majority of lead consumption in glass and ceramics.

There are four main kinds of storage batteries that consume lead:

1. Starting-lighting-ignition (SLI) batteries for motor vehicles (mainly automobiles) and other vehicles such as ships and aircraft.
2. Motive power, or traction, batteries for industrial electric vehicles such as forklifts, airport tugs, and mining equipment.
3. Uninterruptible-power-supply (UPS) batteries designed to ensure constant voltage for, for example, hospitals, computer networks, and telecommunications systems.
4. Standby-power-supply (SBS) batteries for emergency lighting and some telephone systems.

SLI batteries are the biggest lead consumer. Of the 1,019,637 metric tons of lead consumed by storage batteries in 1990 (see Table 5), about 808,000 metric tons went to SLI batteries; 172,000 metric tons to traction, UPS, and SBS batteries; and 40,000 metric tons to miscellaneous specialty batteries (including some consumer batteries).[56] Together, UPS and SBS batteries accounted for about twice as much lead consumption as traction batteries.

Shipments in 1987 of products classified in SIC 3691, Storage Batteries, are shown in Table 6 (1987 is the last year for which value of shipments is available). Shipments of lead-acid batteries totalled $2,677.9 million, compared to $340.5 million for batteries that are not lead-acid (this excludes "storage batteries not specified by kind"). SLI batteries accounted for 85 percent of total shipments of lead-acid storage batteries, excluding those that are not specified by kind. Also notable is that 77 percent of SLI shipments were replacement batteries and 23 percent were original-equipment (OEM) batteries. While SLI batteries are all 1.5 cubic feet and smaller, traction batteries and SBS batteries (and presumably UPS batteries) are all larger than 1.5 cubic feet.

4.2 DEMAND DETERMINANTS

Automobiles are generally used under all economic conditions. Therefore, the demand for lead from automotive replacement batteries, which account for over half of lead consumption, is shielded from fluctuations in the business cycle. Other components of lead demand — OEM batteries, industrial (traction, UPS, SBS) batteries, and non-battery uses — are cyclical, however. The demand for industrial batteries, for example, depends on capital spending, which is linked to the business cycle. The recession in 1991 is said to have affected all lead end-use markets apart from automotive replacement batteries.[57]

The demand for lead from automotive batteries depends greatly on the replacement rate, which increases with extreme temperatures in the summer and winter. Replacement battery demand is seasonal, as battery producers gear up in the fall for winter demand. In addition, retailers and

TABLE 6. U.S. SHIPMENTS OF PRODUCTS CLASSIFIED IN SIC 3691, STORAGE BATTERIES, 1987

Product	Shipments ($ million)	Percent of total shipments
Lead-acid storage batteries		
1.5 ft.[3] and smaller		
Starting, lighting, and ignition (SLI)		
Original equipment	508.6	15.9%
Replacement	1,722.1	53.9%
Not specified by kind	28.8	0.9%
Greater than 1.5 ft[3]		
Starting, lighting, and ignition (SLI)	-	-
Other than SLI		
Motive power		
Industrial truck	91.8	2.9%
Other[a]	15.5	0.5%
Standby emergency power/other[b]	294.4	9.2%
Not specified by kind	16.7	0.5%
Other than lead-acid storage batteries		
Nickel-cadmium	254.7	8.0%
Other than nickel-cadmium/parts for all storage batteries	81.3	2.5%
Not specified by kind	4.5	0.1%
Storage batteries not specified by kind	176.3	5.5%
TOTAL[c]	3,194.7	

[a]Includes mining and industrial locomotion.
[b]Includes railway diesel starting batteries.
[c]Percentages do not add to 100% due to rounding.

Source: U.S. Bureau of the Census, "1987 Census of Manufactures: Industry Series."

vehicle fleet operators stock up on batteries in the fall in anticipation of winter demand. Exide, for example, sells two-thirds of its batteries from August to December.[58] The demand for lead from automotive batteries — both replacement and OEM — also depends on the lead content of batteries. The use of high-performance batteries, which contain more lead, has been increasing. The typical automotive battery contained about 22 pounds of lead in 1990, compared to about 19 pounds in 1986.[59] Finally, automotive-battery lead demand depends on the motor vehicle population, which has been growing in the U.S. by about 1-2 percent per year.[60]

4.3 CONSUMPTION

U.S. and world consumption of refined lead from 1985 to 1991 are shown in Table 7. Both U.S. and world consumption increased from 1985 to 1989 before decreasing in 1990 and 1991. Although U.S. lead consumption gradually increased in the 1980s to the peak of 1,277,604 metric tons in 1989, some years in the 1970s recorded higher levels. The gradual increase in consumption in the 1980s was achieved despite phase-downs in the use of lead solder, lead-base paints (already eliminated in interior house paints), and lead-base gasoline antiknock additives.

World consumption, on the other hand, recorded an all-time high of almost 6.1 million metric tons in 1989 after increasing for seven consecutive years at an average annual rate of 2.3 percent.[61] Lead demand in the rest of the world is less dependent on storage batteries than in the U.S. While, as discussed, storage batteries consume 80 percent of all lead in the U.S., they consume 62-63 percent of all lead in the entire Western World.[62]

A considerable part of the decline in world lead demand in 1990 was attributable to lower consumption in the former U.S.S.R. and Eastern Europe, which underwent political and

TABLE 7. U.S. AND WORLD CONSUMPTION OF REFINED LEAD, 1985-1991 (Mg)

	U.S.[a]	World[b]	U.S. share of world consumption
1991	1,246,300 (preliminary)	5,800,000 (approximation)	21.5%
1990	1,275,233	5,896,000 (estimate)	21.6%
1989	1,277,604	6,062,000 (preliminary)	21.1%
1988	1,245,170	5,856,000	21.3%
1987	1,230,373	5,681,000	21.7%
1986	1,125,521	5,603,000	20.1%
1985	1,148,298	5,587,000	20.6%

[a]Reported consumption.

[b]Apparent consumption (refinery production minus change in stocks).

Sources: U.S. Bureau of Mines, "Mineral Commodity Summaries 1992," "Mineral Industry Surveys: Lead Industry in April and May 1992," "Annual Report 1990: Lead," and "Minerals Yearbook 1989: Lead."

economic reorganization.[63] The declines in both U.S. and world lead consumption in 1991, on the other hand, resulted from the general recession. In the U.S., the recession particularly affected the automotive and construction industries. According to Battery Council International, SLI OEM battery shipments declined from 12.1 million units in 1990 to 10.7 in 1991.[64] However, total SLI battery consumption was unchanged at 77.3 million units, as replacement battery shipments increased from 65.2 to 66.6 million units due to a very hot summer in 1991.

Table 8 shows how the distribution of lead consumption by end-use industry has changed over the past two decades. The biggest change has been the decline, due to a mandatory phase-out, of the use of lead in gasoline antiknock additives. In 1970, gasoline additives, primarily tetraethyl lead, accounted for over 20 percent of total lead consumption in the U.S. This use has been virtually eliminated. Also notable are the declining share of construction applications (uses in roofing, flashing, piping, and calking have been diminished) and the increasing share of transportation applications (mainly batteries).

4.4 SUBSTITUTES AND DEMAND ELASTICITY

Lead faces competition from alternative materials — namely other metals and plastics — in a number of applications. Lead is no longer used in interior house paints and has been essentially replaced in exterior house paints by titanium and zinc pigments.[65] Substitution of plastics has reduced the use of lead in building construction, cable covering, and cans and containers.[66] Lead also competes in construction with other metals such as galvanized steel, copper, and aluminum. Tin has almost completely replaced lead in solder for new and replacement drinking water systems. Metal-based alternatives to lead-

TABLE 8. U.S. LEAD CONSUMPTION BY END-USE INDUSTRY, 1970, 1980, 1990

	Apparent consumption of refined lead (10^3 Mg)			Percent of total consumption		
End-use industry	1990 (est.)	1980	1970	1990 (est.)	1980	1970
Ammunition	58	49	66	4.5%	4.6%	5.4%
Construction	34	37	90	2.6%	3.5%	7.3%
Electrical	143	70	80	11.0%	6.6%	6.5%
Gasoline additives	W/H	128	253[a]	W/H	12.0%	20.6%
Oxides and chemicals	57	78	90	4.4%	7.3%	7.3%
Transportation	950	640	560	73.2%	60.1%	45.6%
Other	55	63	89	4.2%	5.9%	7.2%
Total[b]	1,297	1,065	1,228			

W/H Withheld to avoid disclosing proprietary company information, but included in "other."

[a]Record high.

[b]Percentages may not sum to 100% due to rounding.

Source: U.S. Bureau of Mines, "Annual Report 1990: Lead."

acid batteries have been studied. While they can supply the same power, they tend to be more costly and have less-favorable recycling economics.[67]

As a result of strict environmental and health regulations, many nonessential uses of lead have been weeded out in the past couple decades. Additional substitution of alternative materials is likely to be limited unless there is significant economic incentive (e.g., even stricter regulations, or much higher lead prices) to do so. This suggests that the demand for lead is relatively price-inelastic.

This does not necessarily mean that domestic producers can increase lead prices with impunity (i.e., without a significant attendant drop in output), however. Lead is an internationally traded commodity whose price is determined by global market factors. In a global context, the lead market is competitive. Domestic producers act as price takers, constrained to set prices that are in line with the international exchange (London Metal Exchange, or LME) price, tariffs, and shipping cost differentials. If prices were increased so that they were out of line, market share could be lost to foreign suppliers (i.e., there is a high import elasticity of supply). The ability of domestic secondary lead smelters to increase prices without losing market share would ultimately depend, however, on the terms of the long-term contracts that they — especially the large-capacity plants — tend to have with battery producers.[68]

5.0 FOREIGN TRADE

U.S. imports of lead from 1985 to 1991 are shown in Table 9. While there are no noticeable trends in imports of lead in ores and concentrates and imports of lead in bullion, imports of unwrought lead from 1989 to 1991 were lower than in any of the prior four years, imports of wrought lead have been increasing, and imports of lead scrap

TABLE 9. U.S. IMPORTS (FOR CONSUMPTION) OF LEAD, 1985-1991 (Mg)

	Lead in ores and concentrates	Lead in base bullion	Unwrought lead and lead alloys[a]	Lead scrap[b]	Wrought lead and lead alloys[c]	Misc. products containing lead[d]
1991* (preliminary)	12,437	419	116,473	117	N.A.	N.A.
1990*	7,790[e]	2,713	90,638[f]	281	6,723[g]	515
1989*	2,939	5,782	115,681	677	6,068	852
1988	20,606	4,046	148,604	7,289	3,445	992
1987	873	10,827	185,673	6,587	2,793	515
1986	4,604	142	143,511		N.A.	517
1985	2,649	760	134,521		N.A.	N.A.

N.A. Not available.

*Not necessarily comparable to 1988 and before due to the implementation of the Harmonized Tariff System in January 1989.

[a]Lead content of blocks, pigs, anodes, etc.

[b]Includes the lead content of ash and residues (e.g., drosses).

[c]Lead content of sheets, foil, wire, powder, flakes, etc.

[d]Includes the lead content of babbit metal, solder, white metal, and other lead-containing combinations.

[e]Leading foreign source is Peru (3,875 Mg).

[f]Leading foreign sources are Canada, 70,662 Mg and Mexico, 18,055 Mg.

[g]Leading foreign sources are Mexico, 2,769 Mg and Canada 1,152 Mg.

Sources: U.S. Bureau of Mines, "Mineral Industry Surveys: Lead Industry in April and May 1992," "Annual Report 1990: Lead," and "Minerals Yearbook 1989: Lead."

have been diminishing. Footnote "f" indicates that Canada supplies the bulk of U.S. imports of unwrought lead. Imports of lead in ores and concentrates, lead in bullion, unwrought lead, and lead scrap in 1991 (129,446 metric tons) accounted for 10 percent of U.S. consumption that year (1,246,300 metric tons). As of January 1, 1992, the U.S. ad valorem import tariff was 3 percent (but not to be less than 2.3424 ¢/kg) for unwrought lead from countries with Most-Favored-Nation status and 10 percent for unwrought lead from other countries.[69]

U.S. exports of lead from 1985 to 1991 are shown in Table 10. Exports of lead in ores and concentrates have shot up since 1987. A big boost was given by the start-up in 1990 of Cominco's Red Dog mine in Alaska. All of Red Dog's output — which is projected to reach 70,000 metric tons of contained lead annually — is exported to Canada and the Far East.[70] Exports of lead materials (i.e., unwrought lead, wrought lead, ash and residues) have also grown tremendously since 1987. In 1991, exports of lead in ores and concentrates accounted for 19 percent of domestic recoverable lead mine output (465,931 metric tons), compared to only 3 percent in 1987. Exports of lead materials accounted for 9 percent of total lead refinery (primary and secondary) output in 1991 (1,229,414 metric tons), compared to only a little over 1 percent in 1987.

Exports of lead scrap have also increased as of late, reaching an all-time high of 93,262 metric tons in 1991. Exports compete with domestic secondary lead production for scrap supplies. The allocation of lead scrap to the export and domestic markets depends in part on comparative prices. The recent surge in lead scrap exports is largely due to the growing reluctance of domestic scrap dealers and processors to ship lead scrap in the U.S. because of potential

TABLE 10. U.S. EXPORTS OF LEAD, 1985-1991 (Mg)

	Lead in ores and concentrates	Lead materials, excluding scrap[a]	Lead scrap
1991* (preliminary)	87,953	113,872	93,262
1990*	56,600[b]	76,749[c]	75,507[d]
1989*	57,038	43,837	59,909
1988	20,902	29,077	81,910
1987	8,764	13,586	52,823
1986	4,380	19,778	N.A.
1985	9,987	37,322	N.A.

N.A. Not available.

*Not necessarily comparable to 1988 and before due to the implementation of the Harmonized Tariff System in January 1989.

[a]Comprises the lead content of both wrought (blocks, pigs, anodes, etc., including bullion) and unwrought (sheets, foil, wire, powder, flakes, etc.) lead and lead alloys, and the lead content of ash and residues (e.g., drosses).

[b]Leading foreign destinations are Canada, 19,484 Mg and Belgium, 17,346 Mg.

[c]57,226 Mg unwrought lead, 6,759 Mg wrought lead, and 12,765 Mg ash and residues. Leading foreign destinations are South Korea, 14,488 Mg; Belgium, 11,684 Mg; and Taiwan, 11,553 Mg.

[d]Leading foreign destinations are Canada, 34,497 Mg and Mexico, 9,361 Mg.

Sources: U.S. Bureau of Mines, "Mineral Industry Surveys: Lead Industry in April and May 1992," "Annual Report 1990: Lead," and "Minerals Yearbook 1989: Lead."

Superfund liability exposure, and the Free Trade Agreement with Canada, the largest export market.[71]

In 1991, the U.S. imported 12.8 million lead-acid batteries, down from 14.1 million in 1990 (though only 4.6 million units were imported in 1983).[72] Japan, Taiwan, Mexico, and South Korea accounted for 92 percent of the total. Lead-acid battery exports increased from about 4.1 million units in 1990 to 5.3 million units in 1991.

6.0 PRICES AND PROFITABILITY

Commodity prices are notoriously volatile. Lead is no exception. The wide variation in the price of lead over the past twelve years is demonstrated in Table 11. After bottoming out in 1985, lead prices began an ascent that climaxed in 1990 with an average North American producer price of 46.0 ¢/lb and an average LME price of 37.1 ¢/lb. The ascent was due primarily to increasing demand (evidenced in Table 7) and capacity rationalizations in prior years. In March 1990, production problems at a primary smelter in Italy precipitated an all-time high of 59.8 ¢/lb for the LME lead price (the North American producer price reached 65 ¢/lb in March 1990, 2 ¢/lb below the record high in December 1979). In April 1990, supply concerns abated and the LME price fell to around 45 ¢/lb.[73] Lead prices were significantly lower in 1991 than in 1990 owing to weak demand, fewer production disruptions, and increased production capacity resulting from facility openings.

Lead prices remained depressed in the first few months of 1992 before starting to pick up in late May. On May 28, 1992, the LME lead price was 23.26 ¢/lb. By August 13, it had increased 28 percent to 29.70 ¢/lb.[74] Meanwhile, the North American producer price increased from 33 ¢/lb in February and March to 40 ¢/lb in August.[75] Prices were low in the early part of the year due to excess supply, resulting mainly from depressed demand and heavy exports

TABLE 11. AVERAGE LEAD PRICES, 1980-1991 (¢/lb)

	Metals Week North American producer list price, delivered basis	LME pure lead cash price	Difference
1991	33.5	25.3	8.2
1990	46.0	37.1	8.9
1989	39.4	30.6	8.8
1988	37.1	29.7	7.4
1987	35.9	27.0	8.9
1986	22.0	18.4	3.6
1985	19.1	17.8	1.3
1984	25.6	N.A.	N.A.
1983	21.7	N.A.	N.A.
1982	25.5	N.A.	N.A.
1981	36.5	N.A.	N.A.
1980	42.4	N.A.	N.A.

N.A. Not available.

Sources: U.S. Bureau of Mines, "Mineral Industry Surveys: Lead Industry in April and May 1992," "Annual Report 1990: Lead," and "Minerals Yearbook 1989: Lead."

from the former U.S.S.R. Capacity rationalizations contributed to the price run-up in June and July. Additional impetus to rising prices was provided in August by a strike at Doe Run's primary lead smelter in Herculaneum, Mo., which threatened to restrict supplies. The beginning of the seasonal demand for batteries also helped to lift prices.

Note in Table 11 that the spread between the North American producer price of lead and the LME lead price averaged between 8 and 9 ¢/lb from 1989 to 1991. By August 13, 1992, the spread had increased to 10.3 ¢/lb (40 ¢/lb versus 29.7 ¢/lb). This does not necessarily mean that lead prices in North America outpaced the LME lead price, however, as the North American producer price is a list price, and discounting is the norm. In fact, two U.S. lead producers — one primary and one secondary — are known to link their prices to the LME price. Effective August 1, 1992, Asarco was charging a premium of 5 ¢/lb over the LME cash settlement price.[76] Prior to August 1, the premium was 4.75 ¢/lb. Early in the year, the premium was 4.5 ¢/lb. RSR Corporation charges what it calls a "four-corners premium," based on the LME spot bid price, spot ask price, three-month forward bid price, and three-month forward ask price.[77] In July 1992, RSR's premium over the LME cash price was 5.5 ¢/lb. The premiums that Asarco and RSR charge over the LME lead price reflect shipping costs (including ocean freight, delivery, and insurance) and tariffs.

Although the North American producer price is not a net price, the high spread in March 1992 between it and the LME cash price (10.7 ¢/lb) was said to be "attractive for importation."[78] The spread of only 6 ¢/lb one year earlier (March 1991), on the other hand, was said to be "favorable for exportation of delivered U.S. premium metal."

Profitability varies among secondary lead smelters according to a number of factors. For example, large smelters can have economies of scale. Also, secondary smelters vary in the degree to which they are integrated downstream into further refinement, alloying, casting, etc. of soft lead. Such additional value added can set a smelter apart from its competitors, enabling it to enhance profitability by charging a premium price.[79] Small smelters, in particular, produce to customer order.[80]

Smelter location can affect the costs of such important inputs as electricity, natural gas, coke, and labor, as well as the cost of lead scrap. Demand conditions for spent batteries vary from region to region. For example, the Northeast faces competition for spent batteries from Canada, while the West faces competition from the Far East and Mexico. In 1987, the South had the least competition and consequently the lowest prices for scrap.[81] In February 1992, the highest prices for spent batteries were in the Midwest, where they were as high as 7.5 ¢/lb.[82] In addition to regional location, proximity to suppliers and customers can affect profitability. A trucking rate cited in 1987 for hauls over 100 kilometers was 3.1 ¢/metric ton-kilometer.[83] For an inter-regional shipment of, say, 1,000 kilometers, this comes to 1.4 ¢/lb for pure (refined) lead and, assuming that the average battery weighs 18 kg and contains 9.5 kg of lead, 2.7 ¢/lb for the lead content of spent batteries (assuming that no other part of the battery, such as the sulfuric acid and the plastic, can be reclaimed). Transportation distances of up to 1,600 kilometers for spent batteries are not uncommon.[84]

Even more important than the availability and price of spent batteries as a determinant of profitability in secondary lead smelting is the price of lead, which, as has been seen, is captive to a sometimes-capricious worldwide marketplace. 1990 "on average was quite profitable for the lead industry as the LME cash price achieved the highest annual level since 1980."[85] In 1991, on the other hand, "London Metal Exchange prices fell by over 30 percent" from 1990 and "very few lead producers made profits."[86] In January 1992, "secondaries were squeezed by having to pay higher junk-battery prices at the same time that lead prices were falling."[87]

In April 1992, when the North American producer price of lead was 35 ¢/lb and used battery prices ranged from 6 to 6.5 ¢/lb, secondary lead smelters were said to be in a "profit pinch."[88] At the time, the LME price was about 24-24.5 ¢/lb. Considering that Asarco's price premium was 4.75 ¢/lb, the net price of lead in the U.S. was therefore about 29 ¢/lb. This was 22.5-23 ¢/lb over the price of spent batteries.

In February 1992, Ross Metals declared that the existing spread between the prices of lead and spent batteries — 22 ¢/lb, the difference between 28 ¢/lb for lead and 6 ¢/lb for spent batteries — was "not sufficient for profitability."[89] The company stated its intention to sell lead for no less than 31 ¢/lb and pay no more than 4-4.5 ¢/lb for spent batteries beginning March 1. Regardless, Ross Metals shut down in July.

Because spent lead-acid batteries contain lead, their prices tend to rise when the price of lead rises. Still, the margins of secondary lead producers improve when the price of lead increases. After all, scrap lead is only one component of the cost of producing secondary lead. In a 1987 study, the Bureau of Mines estimated for each of three model facilities representing the range of secondary-smelter sizes that lead scrap accounted in 1985 for 25 to 32 percent of total operating costs, excluding the cost of capital (an estimated average of 3.5 ¢/lb for compliance with pending environmental, safety and health regulations was included in operating costs).[90] In another study, in 1988, the Bureau of Mines estimated that in 1987, lead scrap accounted on average for 33 percent of total operating costs, including the cost of capital (in this case, 4.1 ¢/lb for compliance with existing regulations was included in operating costs).[91] From June 19 to July 20, 1992, while the price of lead increased by nearly 5 ¢/lb, prices for used batteries increased on average by 0.25-0.50 ¢/lb to around 6.5 ¢/lb.[92]

7.0 OUTLOOK

The U.S. Department of Commerce forecasts that lead consumption in the U.S. will grow by 1.3 percent per year from 1992 to 1996.[93] All forms of production will grow at a slower rate (implying either an increase in net imports or a draw-down of inventories): mined lead by 0.5 percent per year, primary lead by 0.7 percent per year, and secondary lead by 1.0 percent per year. The production share of secondary lead is therefore expected to increase. This will be the case worldwide, too, as environmental awareness — of, for example, the benefits of recycling lead to avoid having to dispose of it as a hazardous waste — increases.[94] The consumption share of storage batteries in the U.S. is forecast to continue growing to 82.8 percent in 1996.[95]

The Bureau of Mines projects that U.S. lead demand will grow by 0.5-1.5 percent per year in the 1990s.[96] The Bureau of Mines also expects storage batteries to become an even more dominant end use, in part because "source reduction" pollution prevention strategies will probably reduce lead consumption in such markets as solder, paints and coatings, ceramics, packaging (especially where food is concerned), and cosmetics.[97] The low end of the growth range, 0.5 percent, can be expected if source reduction strategies are aimed at ammunition, the number two market after storage batteries. The high end of the range, 1.5 percent, could be attained depending on the development of the use of lead-acid batteries for load leveling of electricity and for electric vehicles.

Load leveling involves charging batteries at times of low electricity demand and then discharging them to supplement power supply at times of peak demand. Several pilot programs have been undertaken, the largest of which is a battery energy storage plant in Chino, Ca. that uses a battery containing 2,000 metric tons of lead. "If successful, this use could increase worldwide lead demand by more than 700,000 metric tons by the year 2000."[98]

Electric vehicles are another major potential growth market for lead. California has taken the initiative by requiring that emission-free (i.e., electric) vehicles comprise 2 percent of new cars sold in the state by 1998, with increasing requirements for following years (e.g., 10 percent by 2003). Alternative battery materials have received much attention, but "most experts agree that time-honored lead-acid technology will deliver the power for electric vehicles in the near- to mid-term."[99] General Motors, which is closest to bringing an electric car to market (the Impact, which will use an 870-pound lead-acid battery, could be on the market by late 1992), has said that "the only batteries that will work in the near term without problems and at a practical price are lead-acid batteries."[100,101] By 2001, there could be 300,000 electric cars in the U.S.[102]

Other potential new applications for lead include in nuclear waste disposal (as a containment medium for high-level radioactive waste), asphalt additives (as a stabilizer to help prevent hardening and cracking), and liquid metal magnetohydrodynamics (a method of generating electricity by passing an electrically conducting fluid through a magnetic field).[103] The Commerce Department concludes that "certain uses of lead may be eliminated through legislation... However, potential new uses of lead could more than offset any restrictions."[104]

The Bureau of Mines projects that worldwide lead demand will grow in the 1990s by 1.5 percent per year, more than in the U.S. This is mainly because the growth rate of the automobile population in the rest of the world — most of which is not fully developed — is expected to be higher than in the U.S. This will lead to faster growth in the demand for automotive batteries in the rest of the world. From about 60 percent currently, storage batteries are projected to account for 70 percent of worldwide lead consumption by the end of the decade.[105]

The Bureau of Mines predicts that large lead production surpluses in the near term are not likely, as worldwide production capacity will be constrained by substantial capital requirements and high costs of environmental compliance.[106] Nevertheless, RSR Corporation has announced that it plans to open a secondary lead smelter in the Southeast, either in North Carolina or South Carolina.[107] Start-up is three to five years away. The plant, which will cost about $60 million, will have a reverberatory furnace and an electric-arc furnace. Annual capacity will be about 109,000 metric tons and about 150 workers will be employed. More than 6 million storage batteries will be processed annually. The company believes that batteries will be available for the plant. For example, batteries that are currently being exported from the Southeast can be redirected.

In addition, GNB Inc. and Asarco are contemplating investing in new secondary lead smelters.[108] However, no announcements have been made. On the other hand, Fluor Corporation, the parent of Doe Run, "has made it known over the past two years that it wouldn't mind getting out of the lead business."[109]

The future course of lead prices will depend, as always, on the interaction of global supply and demand. Metals & Minerals Research Services Ltd., a British firm, foresees that as a result of "widespread concern about tightening emissions standards," planned additions to lead production capacity in the middle of the 1990s will not keep up with worldwide growth in lead demand.[110] The flood of exports from the former U.S.S.R., which may keep prices down for a while, should be consumed by 1995.[111] Metals & Minerals Research Services concludes that "the struggle to boost operating rates as demand growth gets into full swing in 1993-94 should see quotations rising above 35 cents a pound by the end of that time."[112]

8.0 REFERENCES

1. U.S. Department of the Interior, Bureau of Mines. "Lead: A Chapter from Mineral Facts and Problems, 1985 Edition." Washington, DC, 1985. Page 4.

2. Reference 1, p. 4.

3. Reference 1, p. 11.

4. U.S. Department of the Interior, Bureau of Mines. "Annual Report 1990: Lead." By William D. Woodbury. Washington, DC, April 1992. Page 17.

5. U.S. Department of the Interior, Bureau of Mines. "Minerals Yearbook 1989: Lead." By William D. Woodbury. Washington, DC, October 1990. Page 16.

6. Reference 1, p. 4.

7. U.S. Department of the Interior, Bureau of Mines, Minerals Availability Field Office. Information Circular 8962, "Lead and Zinc Availability - Domestic." Denver, CO, 1983. Page 3.

8. Reference 5, p. 17.

9. "Secondary Lead Model Plants for New Facilities (Draft)." Memorandum from Rich Pelt, Radian Corporation to George Streit, U.S. Environmental Protection Agency. Research Triangle Park, NC, July 9, 1992. Pages 6,7.

10. Reference 9, p. 9.

11. Reference 5, p. 4.

12. Reference 4, p. 5.

13. "EPA Begins Cleanup of Interstate's Lead Smelter in Ala." American Metal Market, May 5, 1992, p. 4.

14. "Secondaries' Margins Mend as Primary Lead Prices Grow." American Metal Market, July 21, 1992, p. 1.

15. Reference 4, p. 5.

16. U.S. Department of the Interior, Bureau of Mines. "Mineral Commodity Summaries 1992." Washington, DC, 1992. Page 100.

17. Dun and Bradstreet, Inc. Million Dollar Directory, 1991. New York, NY, 1992.

18. Reference 4, p. 5.

19. Radian Corporation. "Process Description and Emissions." Chapter 3 of the Secondary Lead NESHAP Review. Prepared for the U.S. Environmental Protection Agency. Research Triangle Park, NC, July 17, 1992. Page 1.

20. U.S. Department of the Interior, Bureau of Mines, Intermountain Field Operations Center. Information Circular 9156, "Domestic Secondary Lead Industry: Production and Regulatory Compliance Costs." Denver, CO, 1987. Page 2.

21. Reference 17.

22. Reference 16, p. 100.

23. Reference 1, p. 2.

24. "Secondary Lead Producers Squeezed." American Metal Market, January 31, 1992, p. 2.

25. "Doe Run Keeps Smelter Running Despite No Pact." American Metal Market, May 7, 1992, p. 1.

26. Reference 4, p. 26.

27. Reference 4, p. 18.

28. Reference 4, p. 4.

29. Reference 1, p. 2.

30. Reference 1, p. 2.

31. Reference 4, p. 4.

32. Reference 4, p. 26.

33. Reference 4, p. 5.

34. Reference 16, p. 101.

35. Reference 16, p. 100.

36. U.S. Department of Commerce, Bureau of the Census. 1987 Census of Manufactures, Industry Series.

37. Standard & Poor's Investment Services Corporation. Industry Surveys. New York, NY, September 5, 1991. Page M 86.

38. Reference 4, p. 17.

39. "Doe Run Cuts Lead Emissions." American Metal Market, June 16, 1992, p. 3.

40. Reference 16, p. 101.

41. Reference 4, p. 5.

42. Reference 16, p. 101.

43. Reference 1, p. 9.

44. "Upturn in Lead Prices Seen." American Metal Market, April 29, 1992, p. 5.

45. Reference 14.

46. "Battery Recycling at 97.8% Rate in U.S." American Metal Market, May 19, 1992, p. 9.

47. U.S. Department of Commerce, International Trade Administration. 1992 U.S. Industrial Outlook. Washington, DC, January 1992. Page 14-10.

48. Reference 19, p. 4.

49. Reference 46.

50. "EPA Offers 'Buyout' Proposal." American Metal Market, August 10, 1992, p. 2.

51. "Lead-Hungry RSR Pledges Protection." American Metal Market, February 24, 1992, p. 1.

52. Reference 20, p. 3.

53. "New Secondary Lead Smelter Set." American Metal Market, August 14, 1992, p. 1.

54. Reference 47, p. 14-9.

55. U.S. Department of the Interior, Bureau of Mines, Intermountain Field Operations Center. Open File Report 55-88, "Impact of Existing and Proposed Regulations on the Domestic Lead Industry." Denver, CO, 1988. Page 4.

56. Reference 4, p. 6.

57. "Demand for Lead Could Increase by 2%." American Metal Market, January 14, 1992, p. 6A.

58. "Battery Producers Hope Lead Holds on to Price Strength." American Metal Market, July 7, 1992, p. 1.

59. Reference 37, p. M 85.

60. Reference 47, P. 14-10.

61. Reference 4, p. 7.

62. "Lead and Zinc on a Long Slow Rebound." Engineering & Mining Journal, May 1992, p. 61.

63. Reference 4, p. 7.

64. Reference 24.

65. Reference 1, p. 11.

66. Reference 16, p. 101.

67. Reference 1, p. 11.

68. Reference 20, p. 3.

69. Reference 16, p. 100.

70. Reference 47, p. 14-10.

71. "Canada Grabs for Lead Scrap." American Metal Market, July 7, 1992, p. 7.

72. Reference 47, p. 14-10.

73. Reference 37, p. M 86.

74. American Metal Market, August 13, 1992, pp. 15,16.

75. Reference 74.

76. "Asarco, RSR, Schuylkill Bump up Prices for Lead." American Metal Market, July 30, 1992, p. 1.

77. "RSR's Secondary Lead up 2¢." American Metal Market, July 7, 1992, p. 16.

78. U.S. Department of the Interior, Bureau of Mines. "Mineral Industry Surveys: Lead Industry in March 1992." Washington, DC, June 1, 1992. Page 1.

79. Reference 20, p. 9.

80. Reference 20, p. 9.

81. Reference 20, p. 3.

82. "Secondary Lead Smelters Shut Five Furnaces, Cutting Capacity." American Metal Market, February 13, 1992, p. 1.

83. Reference 20, p. 10.

84. Reference 20, p. 3.

85. Reference 4, p. 1.

86. Reference 57.

87. Reference 24.

88. "Feb. Battery Shipments Up." American Metal Market, April 6, 1992, p. 6.

89. Reference 82.

90. Reference 20, pp. 9,11.

91. Reference 55, p. 23.

92. Reference 14.

93. Reference 47, p. 14-9.

94. Reference 5, p. 16.

95. Reference 47, p. 14-9.

96. Reference 4, p. 12.

97. Reference 4, p. 12.

98. Reference 47, p. 14-11.

99. "The New Electric Cars Will Still Need Lead-Acid Power." American Metal Market, August 13, 1992, p. 8.

100. Reference 47, p. 14-11.

101. "Battery Debate Heats Up Again." American Metal Market, January 13, 1992, p. 8.

102. Reference 101.

103. Reference 47, p. 14-11.

104. Reference 47, p. 14-11.

105. Reference 4, p. 12.

106. Reference 4, p. 12.

107. Reference 53.

108. Reference 53.

109. "Doe Run, Union Set Talks Today." American Metal Market, July 10, 1992, p. 2.

110. Reference 62.

111. "More Cuts Needed for Metals Upturn." American Metal Market, January 15, 1992, p. 5.

112. Reference 111.

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16. ABSTRACT

Under the authority of the 1990 Clean Air Act Amendments, a National Emission Standard for Hazardous Air Pollutants (NESHAP) is proposed to control emissions from Secondary Lead Smelters. This document presents background information on the Secondary Lead Smelters industry collected to facilitate the Economic Impact Analysis performed in report number EPA-453/R-94-039.

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